

Rural Wireless Communications System (RWCS)

**The Project of Human Resource Development
Through Utilizing The Information Technology for
Rural Community Vitalization in Kingdom of Thailand**

**National Electronics and Computer Technology Center
Japan International Cooperation Agency**

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Rural Wireless Communications System (RWCS)

1. Prologue

1.1 Background

The Kingdom of Thailand (hereinafter referred to as Thailand) has adopted an aggressive approach to creating an information-oriented society since the administration of former Prime Minister Thaksin Shinawatra. Examples of this approach are the 10th Socioeconomic Development Plan of the Kingdom of Thailand 2007-2011 (the superior level plan) and the National IT Policy Framework: IT2010 (2001-2010). Aiming for the construction of a knowledge-based economy and society, IT2010 has been advanced with emphasis placed on the utilization of basic information technology, development of IT human resources and construction of information and telecommunications infrastructure. This has led to the rapid advancement of information orientation in Thailand and makes the country a medium-level IT nation in international terms. On the other hand, construction of the information and telecommunications infrastructure in provincial cities has been slow: rural areas still do not have access to telephones, the internet and other information and telecommunications infrastructure. As a result, this has led to the emergence of a so-called digital divide between urban and rural areas, and this is seen to be contributing to other disparities in terms of economy, education and quality of life in recent years. Rectification of the digital divide has thus become one of the priority development issues facing Thailand.

Against this background, the Government of Thailand in 2005 submitted a request to the Government of Japan for technical cooperation concerning model development and demonstration testing technology for a wireless communications system in provincial areas. Following this, the feasibility of receiving permission for allocation of frequency for the implementation of demonstration testing by the National Broadcasting and Telecommunications Committee (NBTC) was confirmed and preconditions for the full-scale implementation of cooperation were prepared. Consequently, work on the Project is ready to commence with the National Electronics and Computer Technology Center (NECTEC) as the project implementing agency.

According to Section 50 of NBTC ACT2010, the ACT stipulates NBTC to prepare Universal Service Obligation (USO) plan with consists of I. Area and target to be achieved, II. Timeframes, III. Cost of Investment and IV. Estimation of USO levy contributed by operators. From series of discussion with NBTC, project has learned that USO has set targets for improving broadband as basic infrastructure with appropriate time frame and rules for operator contribution (I, II and IV). In order to determine cost of investment and to allocate the budget for implementing the broadband communication project, USO has to rely on vendor-based simulation result or vendor testing result in the area that may different from USO target areas. With the simulator that is created from real trial in USO target areas, prioritizing USO fund to develop broadband infrastructure in rural area is more accurate and appropriate to the targets.

1.2 RWCS Development Model

- Objectives
 - To assist Universal Service Obligation (USO) of NBTC as a manual to effectively and efficiently determine budget allocation on target rural area.
 - To recommend wireless broadband plan that is suitable and specifically designed for target rural area.
 - To simulate theoretical number of base stations required for the candidate area.
 - To capture requirements of local demand to ensure the benefit of local community.
- Target Scope
 - The project targets on wireless broadband technology and has implemented WiMAX in rural area zone B (Zoning definition is pre-defined by USO and to be described in the later section)

Table 1: Suburban and Urban area comparison

	Suburban	Urban
Density	Low density, Scatter	Dense
Distant to backbone	Far from backbone	Near backbone
Number of subscriber	Few subscribers and has low ARPU	Many subscribers and has high ARPU
Commercial potential	Telecom company is not interested to invest (may not possible to recoup from investment)	Telecom company is interested to invest (usually possible to gain recoup after investment)
USO support	Need USO support	No need USO support

*ARPU is short for Average Revenue Per User

As we can see from Table 1, suburban area or here we refer to zone B has low population and normally residential area is scatter throughout the area. Not to mention with the average income of people, it takes operators more to invest in network to cover the area but has lower chance to recoup from the investment. To put in a nutshell, without support from USO, it is unlikely that private company will expand broadband network to zone B.

While it seems to take a sledgehammer to crack the nut for USO to develop broadband to the rural areas, project has come up with a solution to implement wireless broadband technology. The wireless broadband such as WiMAX technology can have a large area of coverage from a single base station that can take up to 5 kilometers in radius. In addition, comparing with wired based BB infrastructure, not only the implementation cost of wireless based infrastructure can be highly reduced, but also, it enhances installation productivity since it helps saving implementation time and takes less maintenance cost. Users can also use network connection on the go and this can be considered an advantage compared to fix line.

Although technologies providing high-speed wireless communication are nothing new, WiMAX has been adopted in larger scale worldwide, especially bringing advantages in metropolitan area. Further, WiMAX is a good option to reach high speed connection to zone B area where wired connectivity is no economically viable. Last mile connectivity in the rural area currently constitutes as much as 40% of the operational costs of broadband service providers. Providing wired connection to end users requires large investment in terms of manpower, material and time. Establishing WiMAX service can reduce the size of investments.

Key point conclusion

- WiMAX is a technology that can provide telecom operator independent service as long as the operator license is available locally.
- WiMAX is faster than WiFi, and, most importantly, WiMAX has a much greater coverage. WiFi has a limitation in coverage. On the other hand, LTE/3G is targeted only for mobile operators limiting its use for mobility, while WiMAX can cover fixed, nomadic and mobility in wider coverage. Not to compete, but to co-exist and synergize with other technologies in the area.

1.3 How to utilize this model document as a Guide-Line

- Assist Pre-assessment of rural development area targeting to effectively and efficiently prioritize and allocate USO fund

This document will explain the concept of CAPEX simulator and show how we derive it from the proof of concept in field test. This recommended CAPEX simulator is evolved from WiMAX project in Mae Hong Son province, but generalized to suit with the areas classified as zone B. Based on the CAPEX simulator; one can then estimate the implementation cost and can fine tune it to match with coverage or user need criteria.

- Reference to promote USO and RWCS Deployment

By assessing the impact, WiMAX Mae Hong Son project depicts as an example on increasing broadband communication penetration rate to rural area. Also a good guideline to deploy RWCS matched with a local demand and has earned high satisfaction level and usage. Without trial frequency license support from NBTC, the project would never be successful.

2. RWCS Development Modeling

2.1 RWCS Deployment Process

This section will explain some key procedures of RWCS deployment processes as a recommendation. Most of the contents are based on experience from project of human resource development through utilizing the information technology for rural community vitalization in the Kingdom of Thailand. The project has implemented wireless communication system in Mae Hong Son province. In order to develop RWCS and easily monitor and keep track of the overall activities, it is necessary to carefully consider the process of work and plan for it beforehand. The proposed process of RWCS deployment is shown in Figure 1.

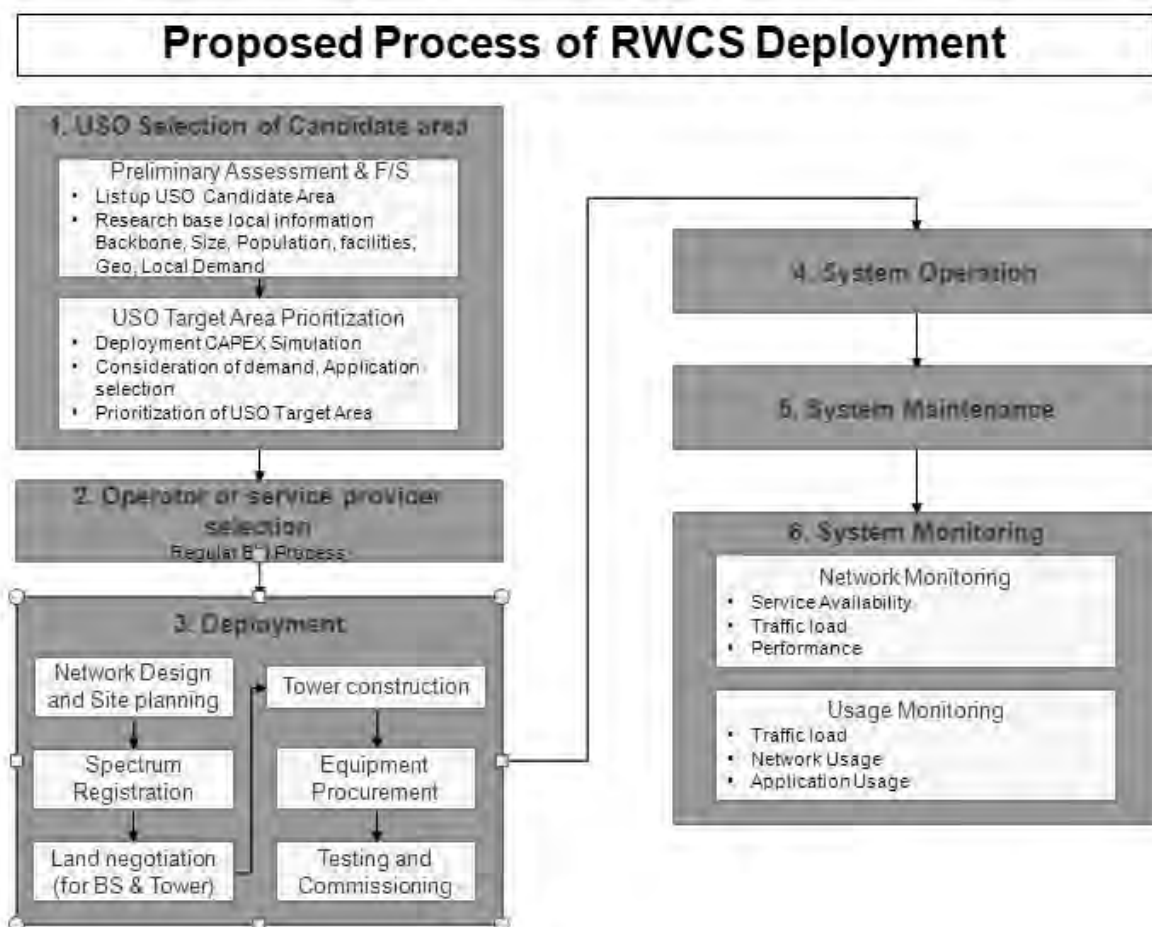


Figure 1: Proposed Process of RWCS Deployment

The RWCS Deployment Process comprises of:

1) USO Selection of Candidate area

Referred to Telecommunications Business Act 2001, Section 17, the commission has duty to provide telecommunications service in rural areas, or low rate of return areas, or any area where there is no or insufficient service providers or where there is insufficient supply of service to meet the user demand. In order to provide telecommunications service in rural

areas, area and target has to be defined. Therefore, the zoning concept plays important role here. USO has divided area into three zones (see Figure 2) which are commercial zone (Zone A), market gap zone (Zone B) and access gap zone (Zone C). To elaborate on zoning type, zone A is considered to have market-led mechanism possibility. This possibility is also true with zone B but still lack of broadband services while zone C has no commercial possibility and lack of broadband services. In term of coverage, zone A, zone B, zone C cover 19 percent, 19-71 percent and 71-100 percent of the area whereas in term of population they are 37 percent, 37-75 percent and 75-100 percent, respectively. In this report, we are strictly focusing on zone B since basic infrastructure and backbone network are supposed to be available to the area although this zone may encounter some limitations in availability and support from service providers.

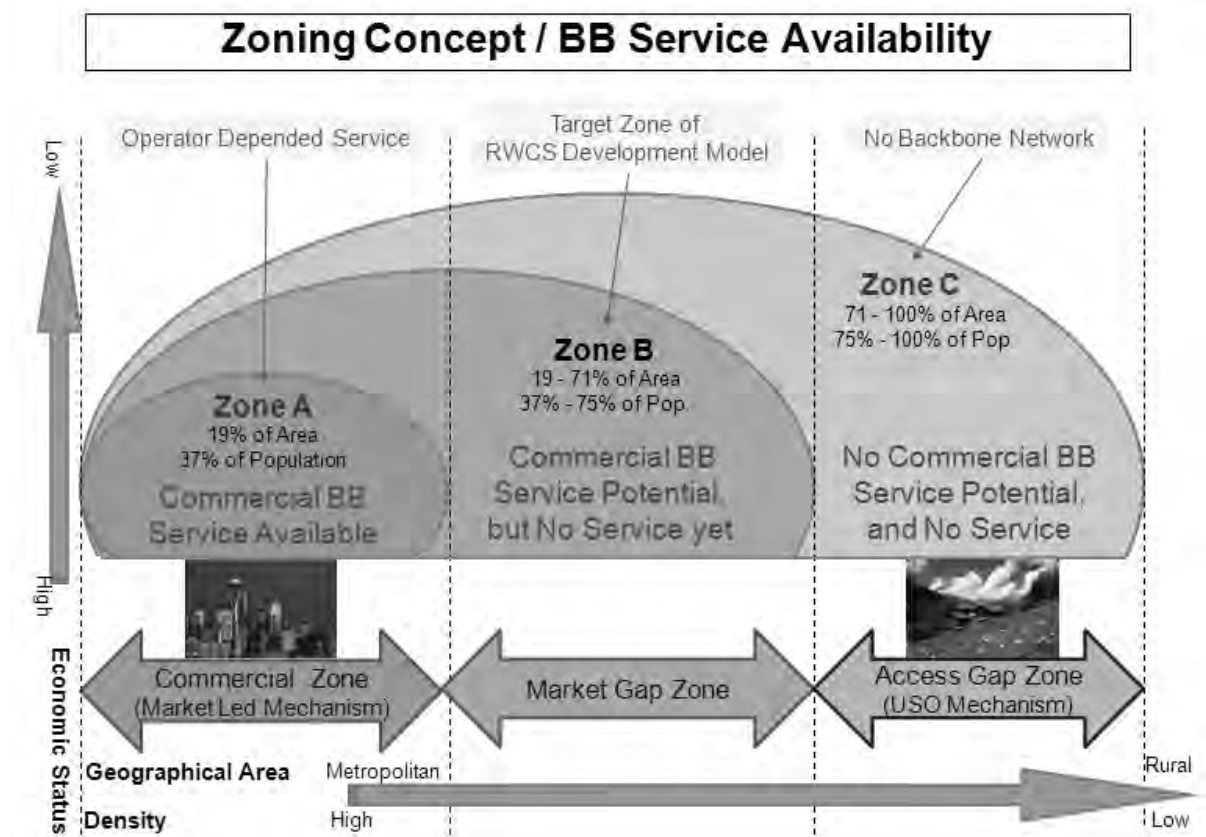


Figure 2: NBTC Zone Concept

- Preliminary Assessment & and Field Study

Additional information can be found by conducting field study or research on preliminary information such as backbone availability in the area, size of the area, population, facilities, geographical characteristics and local demand on application. Also use situation and frequency of use are recommended items which shall be surveyed on each potential area, if possible.

- USO Target Area Prioritization

Although implementation and application of the RWCS model to all the keen areas in the zone B is not feasible, this guide will provide a tool to help prioritizing by providing capital expenditure simulation, which we will explain in more detail in later part. Also, the user

demand is important for decision making on area selection, too.

2) Operator or service provider selection

This can be simple. Operator or service provider is selected from bidding process in general

3) Deployment

RWCS deployment is consists of several sub-processes as following:

- Network Design and Site planning
- Spectrum Registration
- Land negotiation for Base Stations(BS)
- Tower construction
- Equipment Procurement
- Implementation
- Testing and Commissioning

4) System Operation

System operation includes the system operation organization structuring, troubleshooting process engineering, incident escalation. System operation ensures that the system is up and running without disruption or if the service disruption occurs, it will have the minimal impact in the event.

5) System Maintenance

6) System Monitoring

- Network Monitoring: to monitor the status and service availability of the network and the network performance,.
- Usage Monitoring: to monitor the traffic of users, usage of applications and how the system is being utilized.

2.2 Background Concepts of RWCS Development

1) Issue / Facts

What convinced us to pay a special attention to the deployment of broadband in rural areas is the fact that only 19 percent of the area in Thailand has broadband internet service available and most of it locates in the center of the country, Bangkok and major cities in each part of Thailand. This creates a large gap between rural and metropolitan broadband connectivity area. Although telecommunication infrastructure has existed in market gap zone, it is considered not commercially viable for private sector only to afford last mile connection cost. This is because people in rural area has low income and thus cannot afford the connection cost. To solve this problem, USO has a role for developing sustainable model

with cost within a reach.

2) Solutions (RWCS, WIMAX)

With the goal to develop sustainable last mile connection , highly reliable, cost effective wireless communication which can provide wider coverage is a highly recommend solution. With wireless communication or to be more specific WiMAX, it can provide high-speed throughput performance with wide area of coverage (about 5km in radius from base station) and does not require wire connection to the last mile target, so it is easy to deploy and support the wireless BB with mobility, locally.

2.3 Key success factors for RWCS Development

1) Capital investment assumption (CAPEX Simulator) for USO fund prioritization

With provided some fundamental inputs such as geographical characteristics of the area, expected throughput, cost of backbone infrastructure, CAPEX simulator can help USO to prioritize fund by providing estimation of capital investment assumption cost and can adjust it easily according to demanded throughput and number of subscribers of the target area. CAPEX simulator is highly flexible and adjustable on the cost of network equipment and mobile subscriber equipment. By using the simulator, USO can see total capital expenditure to prioritize the budget. This will assist USO to estimate a reference bidding price in the range.

2) Relevancy to Local demand

A thorough knowledge of the target area, such as its geography, social and economic characteristics is essential to understand the local demand properly. In addition, it is important to take consideration of existing telecommunication infrastructure, expansion plan and electricity stability into account. The practical way to do this is to conduct a technology trend survey and baseline survey by a team comprise of an economists and telecommunication specialists and have them visit the target areas to gather all essential information necessary for the preliminary design of the project. Before starting network system implementation, linking stakeholders and the team needs to properly capture local user needs, expectation, current level of connectivity and how they are currently using the Internet or telecommunication services. The local government shall be invited to support and to get actively involved with the project for local support and sustainability of the project afterwards.

3. Key Preliminary Assessment Process

3.1 Area targeting

1) Size of Area and population/Density: One way is to submit official request on area, population and density information to department of provincial administration, ministry of interior.

2) Geographical Characteristics: Official data such as geographical characteristics, land elevation and aerial photo can be bought or requested from Royal Thai survey department, Royal Thai armed forces headquarters. The CAPEX simulation will require the input of proportions of the 4 major geographical types preliminarily categorized as flat open field area, inside valley, river or lake area and city.

3) Weather Characteristics: Data such as temperature, humidity of each season can be retrieved from Meteorological department, ministry of ICT.

4) Base ICT Infrastructure

Whether there is a backbone network service available in the target area or not shall be very critical, Zone B is categorized as the area that there is a backbone connectivity and commercial access service available already in the area. The base data can be found at the Ministry of ICT (TOT, CAT).

5) Required facilities and types (schools, government office, private offices, community centers, hospitals) and applications that serve user needs. These valuable data can be found during the technology trend survey.

6) Demanded performance (throughput) and over-subscribers ratio: The information in regards to the local demand can only be found from the baseline survey, the actual throughput and over-subscribers ratio can be calculated by telecommunication and network engineers.

3.2 Concept for Assumption of Initial CAPEX

Once the target area determines, facilitating face to face meetings with each of the suppliers and related operators is a next important step. It is good to get started the meeting with a short presentation about the project background and objectives. The operators are also encouraged to talk about their plans for expanding their networks in rural areas. In order for CAPEX simulator to come up with the cost assumption of expenditures, some parameters are needed as inputs and we will describe in more details, hereinafter.

- Estimation of Geographical Characteristics Proportions of the area in percent and Service Delivery Target

Target area must be categorized to flat open field, city and inside valley area depending on its geographical characteristics. Decision to define each area characteristics can be made observing aerial photos with maps from Royal Thai survey department. Moreover, in term of coverage, user behavior has to be pre-determined either it fix, nomadic or mobile user so

that proper service delivery target is suitable for that type of user and cell overlapping percentage can be adjusted by CAPEX simulator.

- Estimation of Cost of Tower Construction

Whether to rent or to build a new tower depends on project budget and availability of existing tower in target area. Apart from tower and supporting material itself, good grounding system, GPS antenna and cable, tower observation light and tower painting are crucial for the safety of base station equipment and can affect network up-running time and performance of overall. The total cost of tower construction and concerning accessories can be acquired from vendor's quotation.

- Estimation of Base Station(BS) and CPE related Equipment Cost

List of base station and network equipment cost such as base station indoor and outdoor unit and network servers should be requested to vendor. With the cost quoted in breakdown details, CAPEX simulator can be adjusted to match with project requirement and budget more efficiently. CPE equipment cost is determined from number of subscribers and is added to total project cost at later.

- Backbone Infrastructure State

Necessary information on existing backbone, distance to target area, possibility of capacity expansion and back-up plan has to bring to discussion with operators. So, project can assess the cost of backbone and practically design and implement network to have good throughput and user experience.

3.3 Concept and Key Assessment Factors to match with Local demand

- Research of benefit of wireless broadband to local community by Demand Survey.

Similar to their counterparts in the cities, people in rural areas would like to communicate with friends, family, coworkers and access information of all sorts for study, work, entertainment, capacity building and many other purposes. Communication is a vital part of their daily social and economic activities. All of these items create demands for telecommunication services. In order to assess local demand, a demand study by conducting local demand survey is needed to determine:

- 1) The level of demand for different telecommunication services at determined applications that are suitable for their lifestyle, work and etc.
- 2) The potential rates of interest on doing the project such as local government agreement on basic support (land, equipment housing, electricity) and number of people who shows strong interest in the project.

- IT Literacy and Capacity measurement

It is considered an inconvenient truth that majority of local people who live in rural area have knowledge limitation in technology and lack of IT equipment hand on experience.

The wireless broadband project often involves with many of complicated and high-end technology instrument so background knowledge in IT of local administration is very important to project continuity and sustainability. If the survey result shows that the IT literacy is low, series of technical training with real equipment can help them increase their perception and understanding level of the technology using in the project.

- Applications selection: There are few steps in determining application for rural area users.
 - 1) Collect and analyze background data of users such as highest education level, major of their study, work organization,
 - 2) Use statistic to segregate users into groups such as education, community or public related groups.
 - 3) Make decision based on groups of users such as e-learning is suitable to education group and application should not be more complicated than user's background.
- Usage monitoring and Impact measurement

With the concern of the effects of project implementation, effectiveness of the telecommunications system will be observed through conducting regular monitoring. Regular monitoring is configured to monitor network availability, throughput, signal strength and frequency of usage of users and data should be kept in log file server. In case where problems occur during operation hours, solutions can be handled and taken care with network administrator in time.

In order to gauge the impact on local vitalization of introducing a new wireless broadband system in rural area, conducting survey is needed. Impact survey targets are to collect and analyze data on system status, users' experience and usage as well as to identify project success factors and on-going issues that need to be addressed for further actions or solutions in the future.

4. Proof of Concept by Field Test

4.1 Technical Background

The main goal of the field test of the Rural Wireless Communication System (RWCS) is to comprehend the performance of RWCS in term of service coverage and network capacity. The service coverage information is used to determine the size of one wireless cell which is directly related to the Capital Expenditure (CAPEX) of the wireless system. The service coverage is varied on several factors including the geographical characteristics. The field test also examine on the network capacity of RWCS whether it can support to the local demand applications such as eLearning, videoconference.

Service Coverage Performance Test

The coverage area of wireless system depends on several parameters as the followings:

- 1) Transmitted Power: the transmitted power is the signal strength that transmits from transmitter of the wireless equipment. The higher transmitted power, the extender of wireless signal which means the larger coverage area. The transmitted power such as the maximum EIRP (Equivalent Isotropic Radiation Power) is limited by the Regulator rule of each country. For example, in Thailand, the maximum EIRP of 2.4 GHz WiFi is up to 100mW, while 5.8 GHz WiFi is up to 1W. The transmitted power on the unlicensed frequency band (i.e., 2.4 GHz, 5.8 GHz) is low comparing to other license frequency bands. On the other hand, in the licensed frequency band, only the operator who owns the licensed frequency can operate on the assigned frequency which is much higher EIRP. Therefore, the wireless technology operating on the licensed frequency band is allowed higher EIRP and then provides more service coverage area. WiMAX and 3G operate on the licensed frequency (i.e., 2.1 GHz band for 3G or 2.3 or 2.5 GHz band for WiMAX)
- 2) Frequency Band: The signal with low frequency can travel farther than the one with higher frequency. The higher frequency, the smaller coverage area
- 3) Receiver Sensitivity: Receiver sensitivity is the minimum signal strength that the receiver can detect and communicate. The equipment with high receiver sensitivity can detect the very low signal. Therefore, the receiver equipment can locate farther away from the transmitter. The higher receiver sensitivity, the larger coverage area.
- 4) Modulation techniques: Orthogonal Frequency Devision Multiplexing (OFDM)
- 5) Antenna technologies: the smart antenna such as MIMO or Beamforming provides the larger coverage area.
- 6) Geographical area: the distance of the signal travelling through the valley is short comparing to travelling through the flat area. The obstacles can block the signal.
- 7) Environment: Figure 3 shows the line-of-sight and non-line-of-sight environment. The line-of-sight provides more coverage than the non-line-of-sight.

From the field test, the WiMAX equipments with standard configuration are deployed. The parameters 1 to parameter 5 above are set to the values that commonly deployed in WiMAX commercial service in several countries (see Table 2). The field test will focus on the

parameter 6 (**Geographical characteristics**). The geographical characteristics of the area influence the signal propagation. For examples, the valley typed area obstructs the signal propagation. The city type area creates the non-line-of-sight environment.

The Project identified Mae Hong Son Province in northern part of Thailand as a pilot site, of which geographical characteristic is mountainous and rural, so that the feasibility and effectiveness of intended rural wireless communication system model can be properly measured.

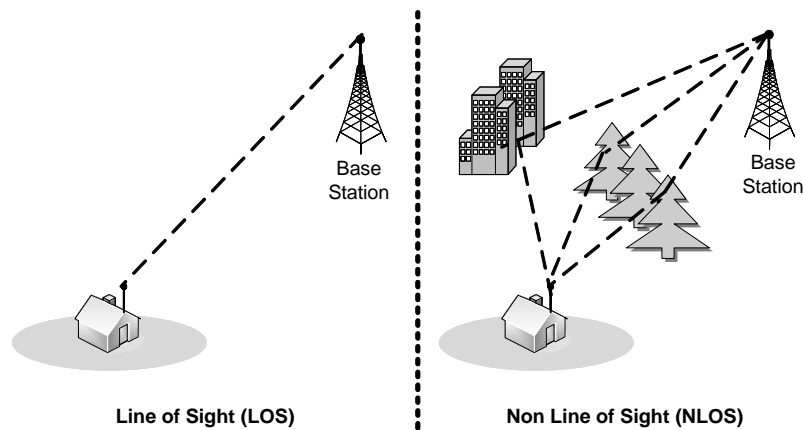


Figure 3: LOS and NLOS environment

Table 2: WiMAX Parameters

WiMAX Parameters	Specifications
1. Transmitted Power	<ul style="list-style-type: none"> Max. Tx Power 38 dBm
2. Frequency Band	<ul style="list-style-type: none"> 2.500 – 2.690 GHz
3. Receiver Sensitivity	<ul style="list-style-type: none"> Effective -70 dBm for high capacity Effective -85 dBm for high reliability at cell edge
4. Modulation	<ul style="list-style-type: none"> OFDM Modulation
5. Antenna	<ul style="list-style-type: none"> MIMO 4x2 (4Rx, 2Tx) Gain 17.3 dBi Polarization Linear 2 x +/- 45 degree Azimuth Beamwidth 65 degree Elevation Beamwidth 6.5 degree

Besides the geographical characteristics, **weather characteristic** during the field test is also investigated to check if RWCS is resistant to various weather conditions.

Application Performance Test

Applications commonly used in the rural area such as eLearning, VoIP and Videoconference are tested on RWCS. The test will validate if the RWCS is suitable for the common rural applications.

4.2 Field Test Objectives

- To deliver RWCS Development model
- To deliver CAPEX simulation model
 - To define "Parameters" by Coverage per geographical characteristic types to simulate necessary cell size.
 - To deliver CAPEX simulation Tool
- To understand the local demand
- Assumption of total effective communication capacity after the implementation
- To monitor usage by expected demand to validate the impact

4.3 Field Test Process and Procedures

Figure 4 shows the block diagram of field test process.

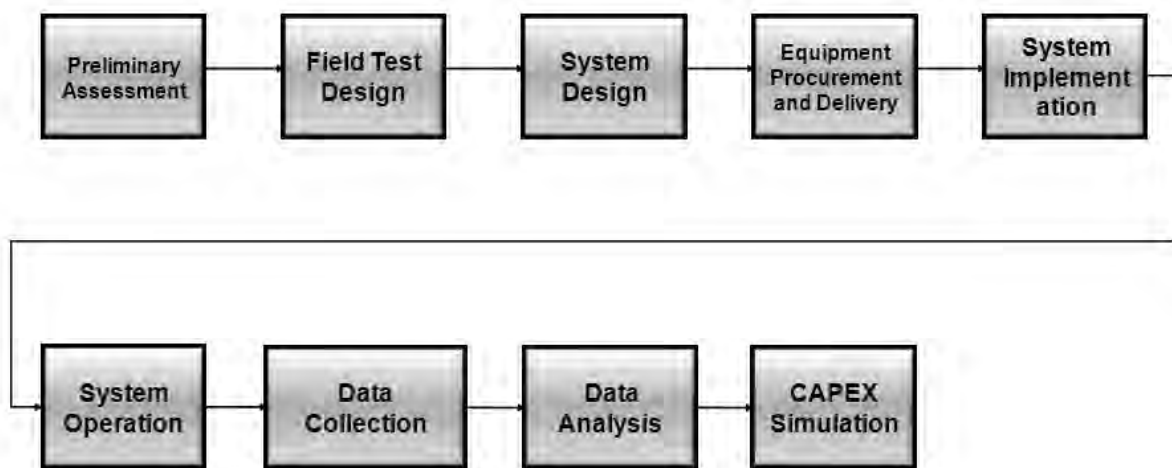


Figure 4: Field Test Process

The field test process consists of nine sub-processes.

1) Preliminary Assessment: the first process of the field test is to gathering the necessary information of the target rural area. It evaluates the existing infrastructure and examines the local demand. The information is acquired through the series of survey such as Demand Survey, Technology Trend Survey, Baseline Survey as well as Site Survey. The survey data becomes the basis for the later stages.

2) Field Test Design: this process is to design the scope and procedure of field test. The field test is focused on three main areas, 1) Service Coverage Area with geographical characteristic, 2) RF Performance with weather characteristic and 3) Application Performance Test. The result of field test design determines the types and specification of RWCS components.

3) System Design: the systems design includes hardware design, software design and the

appropriated site location that fully support the field test. The outcome of system design is the BOM (Bill Of Material) of equipments as well as their specifications.

4) Equipment Procurement and Delivery: this process involves the equipment procurement and the process to verify equipment delivery (i.e., provisional acceptance test).

5) System Implementation: this process involves the system installation, system testing and the final acceptance test (FAT). After the system implementation process, the system is ready to operate and to be field tested.

6) System Operation: the process aims to make sure that the system operates as the design and has the proper troubleshooting when the problem arises.

7) Data collection: the field test is conducted in this step.

8) Data analysis: the result of the field test during the data collection process will be analyzed and the outcome is the parameters that determine the CAPEX Simulation.

9) CAPEX Simulation: to create a tool that calculates CAPEX needed to be allocated in the target area.

4.3.1 Preliminary Assessment

Figure 5 shows the block diagram of preliminary assessment

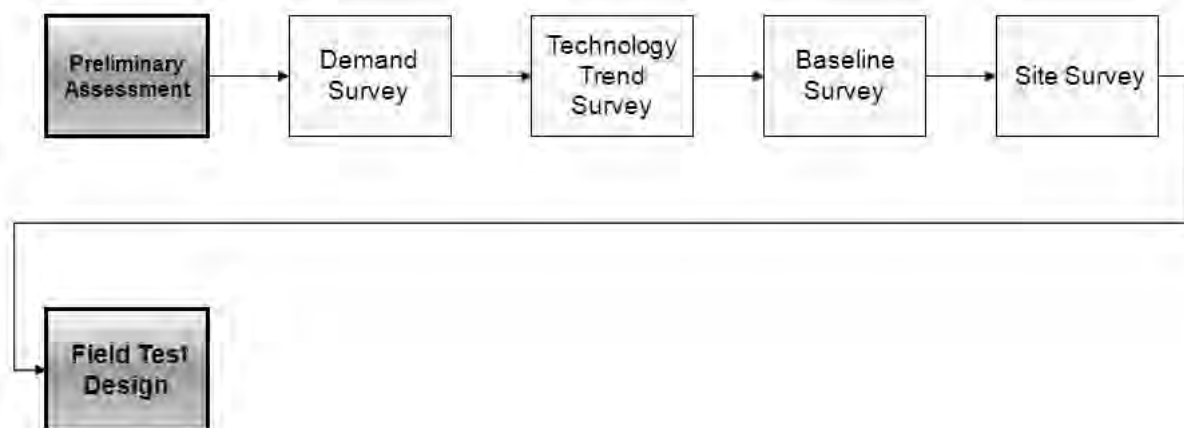


Figure 5: Preliminary Assessment Process

The preliminary assessment is the process gathering the necessary information of the target area through a series of survey: Demand Survey, Technology Trend Survey, Baseline Survey and Site Survey.

Demand Survey is the survey to inspect the existing or required applications that serves the needs of local users. It also identifies any environmental constraints and current conditions and problems in existing applications. The degrees of difficulties ease of use, hardware or software requirements, constraint concerning applications are also examined.

Technology Trend Survey is the survey to investigate the current state of information and telecommunications infrastructure. For examples, the existing Internet accessibility, the

speed of current Internet, the availability and stability of electrical power, the current status of ICT and so on.

Baseline Survey is the survey to capture the current condition of target area. The survey items, scope and targets are set based on some assumptions. The results from the baseline survey will be taken as “before” state of the project and will be ascertained in the impact survey compared with “after” the project.

Site Survey is the survey to examine the characteristics of the target area in various aspects. For examples, the geographical characteristics of the area (i.e., hill type, city or flat open field), population, income, ICT infrastructure, and the potential target users.

Methods of survey are varied depending on the topic, time, budget or any constraints. It can be online questionnaire to the target audiences, site-visited interview and Internet search. More detail about baseline survey, technology trend survey and demand survey of the project can be found in Appendices xxx.

4.3.2 Field Test Design

Figure 6 shows the block diagram of field test design process

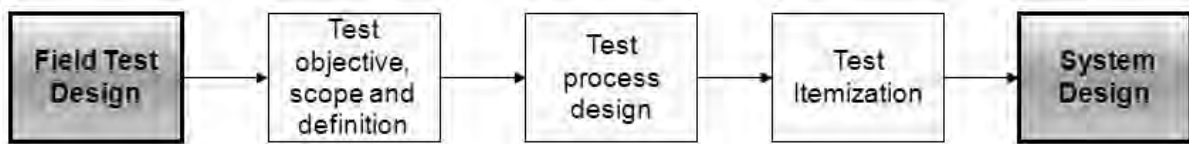


Figure 6: Field Test Design Process

The test design process consists of three steps:

- 1) Test objective, scope and definition
- 2) Test process design: the step to perform the field test
- 3) Test itemization: the list of the field test

In the project the test design is focused on three areas: 1) Service Coverage with geographical characteristic, 2) RF Performance with weather characteristic and 3) Application Performance Test.

Service Coverage Area with geographical characteristics

Objectives

- To conduct the RF measurement of Basestation in different geographical area
- To analyze the relationship between RF measurement and the area

Target area for field test is categorized into 4 types of geographical characteristics typically found in rural area: City area, Flat open field area, Inside valley area and River or lake area.

The field test is to measure RF signal strength transmitting from WiMAX basestation in different geographical characteristics within the target area. RF measurement captures the propagation properties of RF signal of the area. The result of the field test will be the input of Atoll software simulation planning tool.

RF Performance with weather characteristic

Objectives

- To measure RF signal at various locations in different season along with the weather record
- To analyze the relationship between RF measurement and the weather

This test aims to investigate if the weather condition affects the RF properties of WiMAX system. RF signal strength is measured from different area throughout the year as well as the corresponding weather condition. The test tries to identify if there is any relationship between the fluctuation of weather condition and RF signal strength.

Application Performance Test

Objective

- To measure the APL performance to observe the impact of RWCS implementation
- Four applications to be tested: VoIP, eLearning, Videoconference, Video streaming

Four applications are tested on the RWCS. The application performances such as throughput, delay, quality of service (QoS) of the applications are observed and evaluated. The application performance test provides the answer if RWCS can support the wide range of applications in rural area.

4.3.3 System Design

Figure 7 shows the block diagram of the system design process.

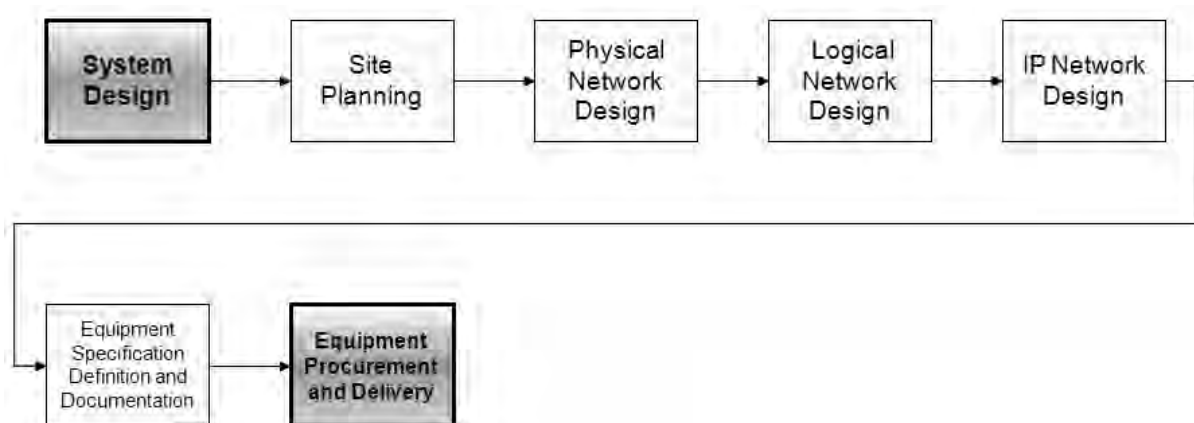


Figure 7: System Design Process

The system design typically contains the components as the followings:

1) Site Planning: The site survey is conducted to evaluate the location of equipment installation. The samples of questions needed to be answers

- Need the new constructed tower or rent the existing one
- Land and facility negotiation for the location of installed equipment and cost of rental or purchasing.
- Wire way for cabling installation
- Existing facility such as electrical power. The stability of the electrical power system in the area.
- Disaster prone area or not. Disaster recovery plan should be prepared.

2) Physical Network Design: to design how equipments physically interconnect. The design determines the size of the space, size of server rack, air-conditioning capacity and so on. It also includes the backup power design such as the size of Uninterrupted Power Supply (UPS) and power stabilizer based on the power consumption of equipments and desired backup power duration.

3) Logical Network Design: The design of the network configuration. How to partition the network, VLAN configuration, Security configuration, Switch Port assignment.

4) IP Network Design. Assignment of IP address: The standard IP address assignment is recommended in order to effectively manage the network.

5) Equipment Specification and Documentation: Equipment specification based on the design is created and forwarded to the vendor for procurement. It is important to document all details of the design.

In the project, three districts in Mae Hong Son (i.e., Mueng, Mae Sarieng and Pai) are selected to be the target project site as shown in Figure 8.

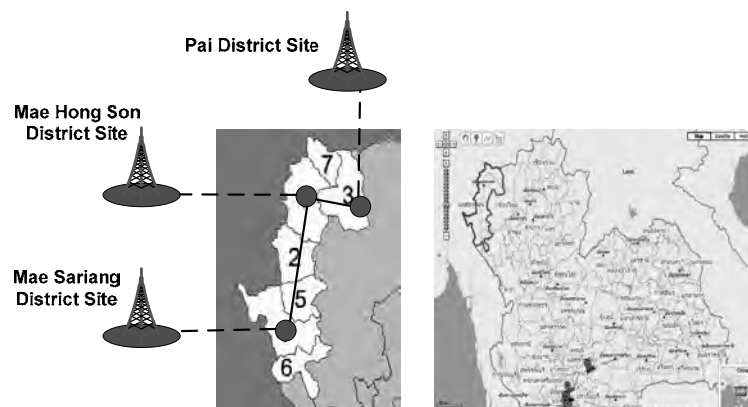


Figure 8: Project Sites

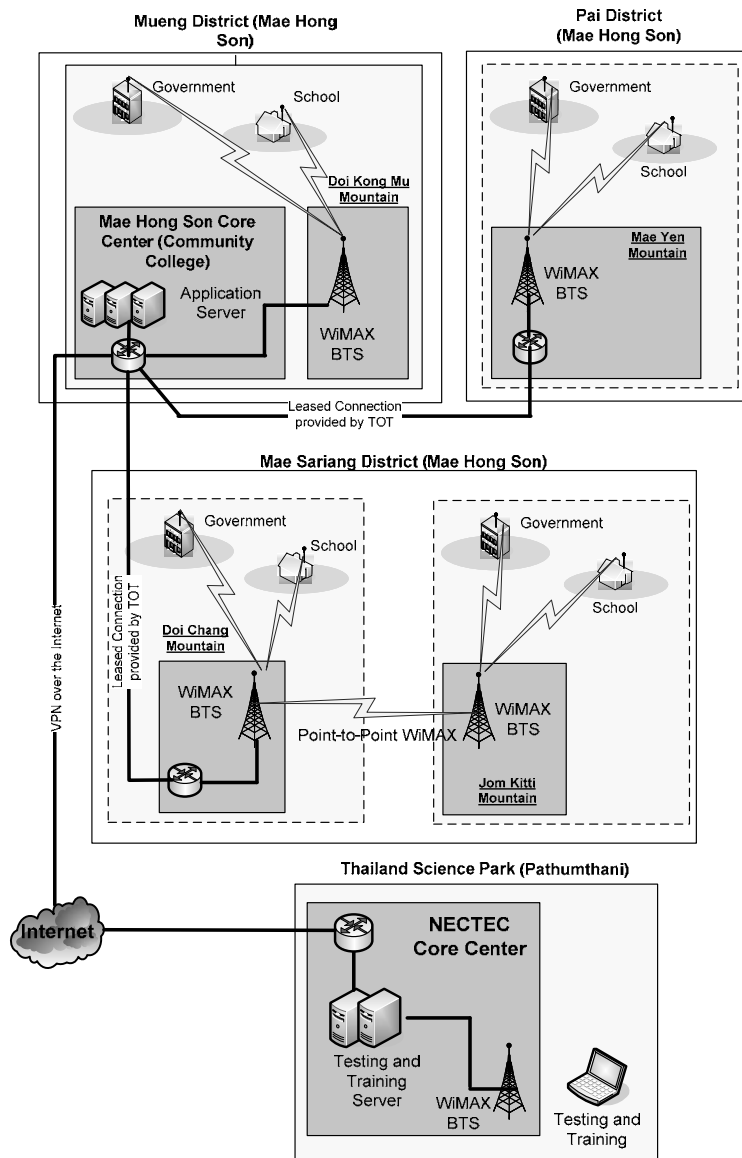


Figure 9: System Architecture

Figure 9 shows the system architecture. Three sites (Mueng District Site, Mae Sariang District site and Pai District site) are interconnected with the leased connection provided by TOT to create the Intranet of the project in MHS. All three sites reach the Internet through MHS core center at MHS Community College. NECTEC can reach MHS community college for the remote administration through VPN over the Internet. The last mile distribution of the Mae Hong Son site uses the combination of WiMAX Point-to-Multipoint system, Wireless Point-to-Point system and WiFi technology. WiMAX basestations were installed in three districts.

Mae Hong Son Base Station is located on the top of Doi Kong Mu Mountain. It provides the WiMAX coverage within 5 km radius of Mae Hong Son District. Leased connection between base station and Mae Hong Son Community College (called Mae Hong Son Core Center) down below the mountain is shown in Figure 10. Mae Hong Son Core Center provides several application services such as e-learning service, videoconferencing service, VoIP service. Mae Hong Son Core Center also links to Pai Base Station, Mae Sariang Base Station and to NECTEC through VPN over the Internet.

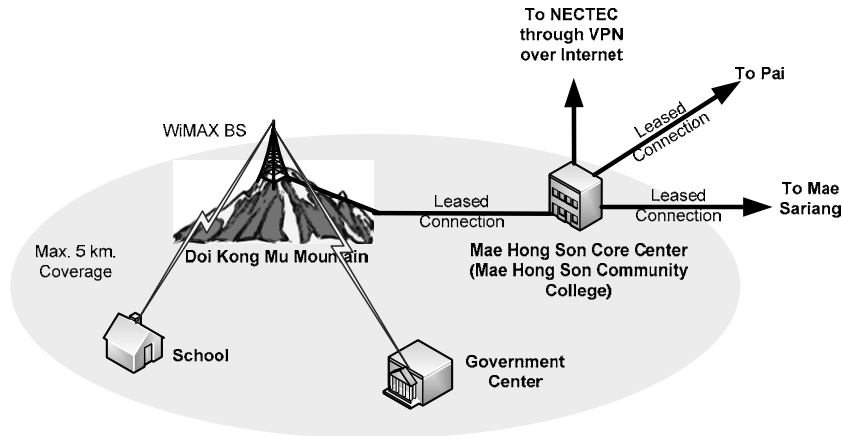


Figure 10: Mae Hong Son Base Station Site

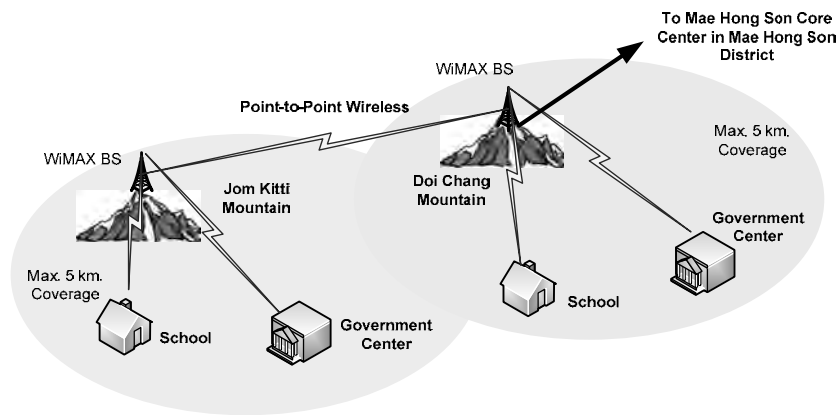


Figure 11: Mae Sarieng Base Station Site

In Mae Sarieng district there are two WiMAX base stations, one is on the top of Doi Chang Mountain and the other is on the top of Jom Kittu Mountain. Two base stations are interconnected with Point-to-Point wireless link. Doi Chang base station connects to Mae Hong Son Core Center through leased connection as shown in Figure 11.

In Pai district, there is one WiMAX basestation on the Mae Yen Mountain. The BS will provide maximum 5 km. WiMAX coverage in Pai area. The BS connects to Mae Hong Son Core Center through leased connection as shown in Figure 12.

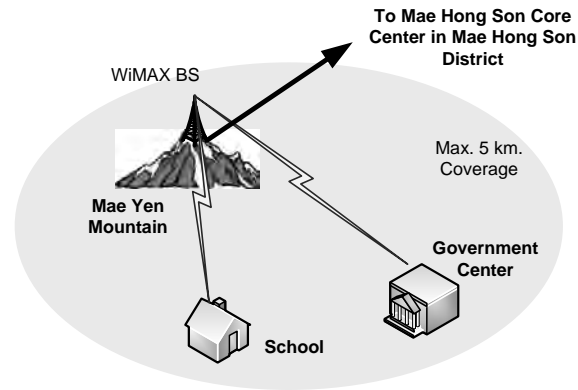


Figure 12: Pai Base Station Site

The project is to provide the WiMAX last mile distribution to various client sites which can be categorized into School, Government Center and Community Center. Each client site requires the different type of application services. The detail configuration of the client site is demonstrated in the later sections. Table 3 shows the number of client site of each location. Figure 13, 14, 15 show the map of BS and all client sites.

Table 3: Number of Client Sites

Client Site	Number of Locations			
	School	Gov. Center	Community Center	Total
Mae Hong Son District site	9	8	2	19
Mae Sarieng District site	12	3	1	16
Pai District site	6	3	1	10
Total	27	14	4	45



Figure 13: Wimax BS and Clients in Mueng Mae Hong Son District



Figure 14: WiMAX BS and Clients in Mae Sarieng District



Figure 15: WiMAX BS and Clients in Pai District

Figure 16 shows the sample of the physical network diagram of WiMAX basestation site.

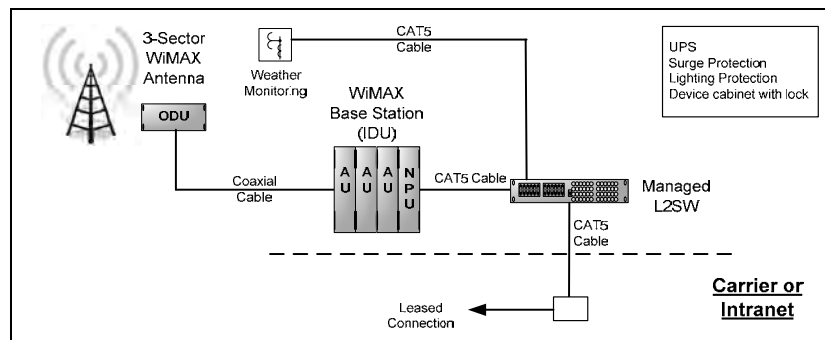


Figure 16: Physical Network Diagram of WiMAX Basestation Site

4.3.4 Equipment Procurement and Delivery

Figure 17 shows the block diagram of the equipment procurement and delivery process.

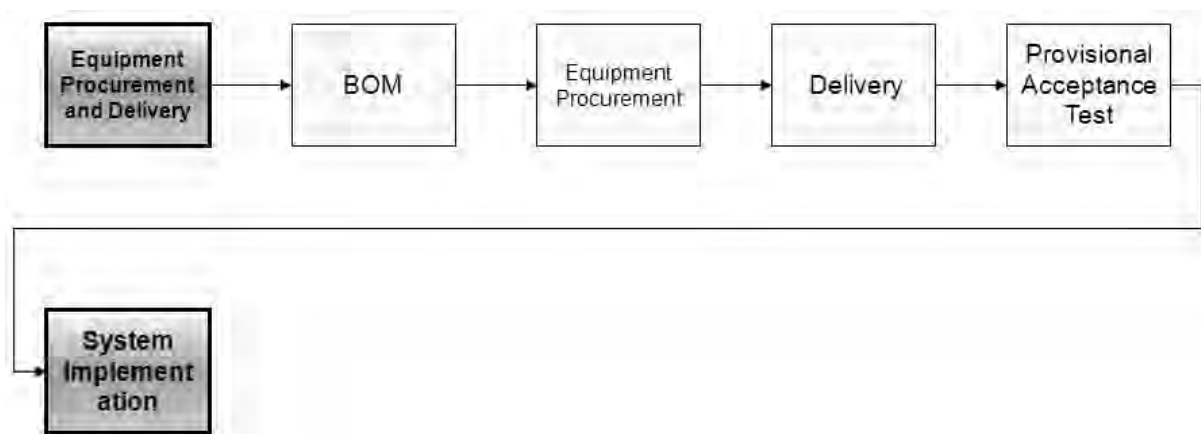


Figure 17: Equipment Procurement and Delivery Process

The equipment procurement and delivery contains the following:

- 1) Bill of Material (BOM): List of all equipments and specification is documented.
- 2) Equipment procurement: Term of Reference (TOR) of the equipment and installation service are announced to the public for RFP (Request for Proposal) and RFQ (Request for Quotation).
- 3) Delivery
- 4) Provisional Acceptance Test (PAT): it is the process to check the number and specifications of all delivered equipments. It will be checked against the details specified in Term of Reference. All labels and ID codes for each item need to be prepared for PAT.

After this process, all equipments are ready to be installed in the process of system implementation.

4.3.5 System Implementation

Figure 18 shows the block diagram of the system implementation process

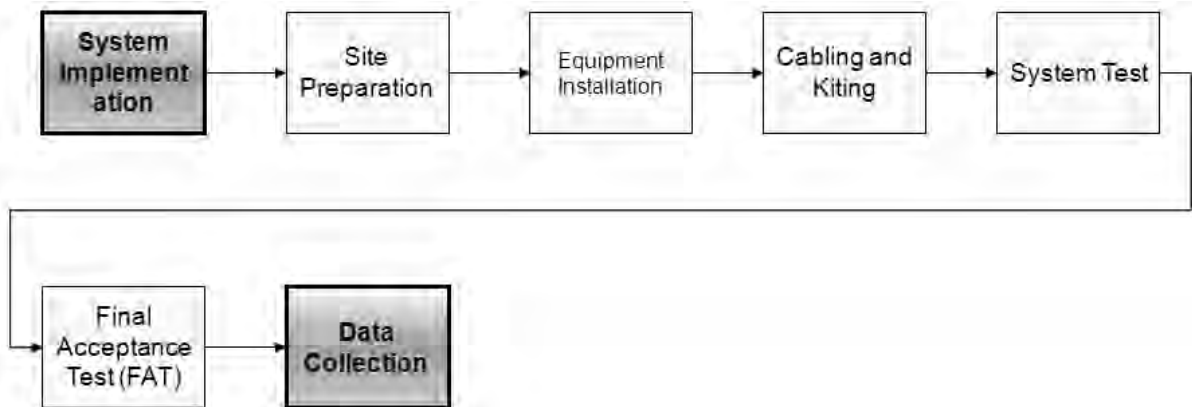


Figure 18: System Implementation Process

The system implementation process contains the following steps:

- 1) Site preparation: The location, own negotiation, facility and any extra construction of all sites need to be prepared before the equipment installation. The meeting should be held between the contractor and the project manager to clarify about the schedule, process and contact point.
- 2) Equipment Installation
- 3) Cabling and Kiting
- 4) System Test: the system test should be conducted by the contractor or the assigned party to make sure that all systems perform as the designed. The system test report is submitted to the project manager as a required document for the Final Acceptance Test (FAT).
- 5) Final Acceptance Test (FAT): the process to verify and accept all hardwares, software installed and their operation.



Figure 19: Tower Construction

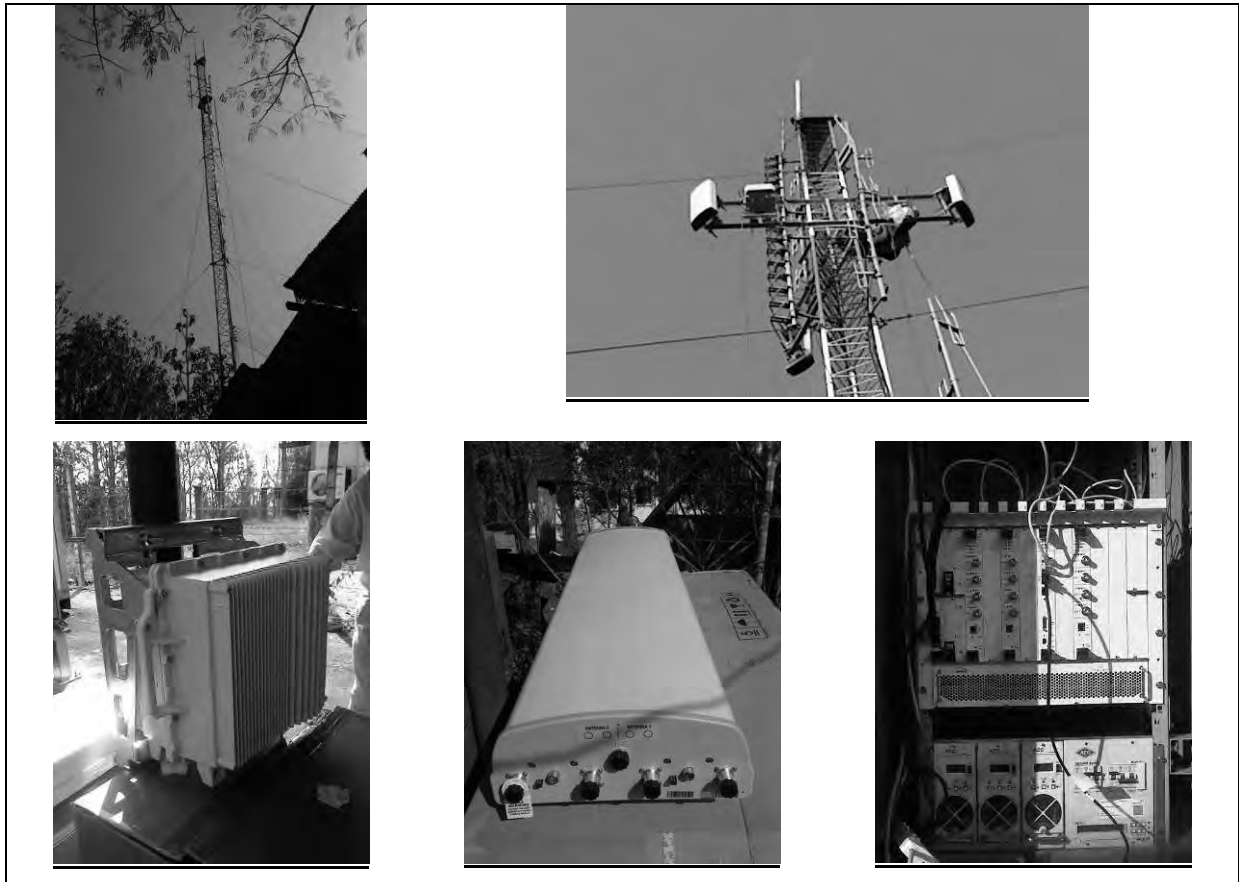


Figure 20: WiMAX Installation

4.3.6 System Operation

Figure 21 shows the block diagram of the System Operation.

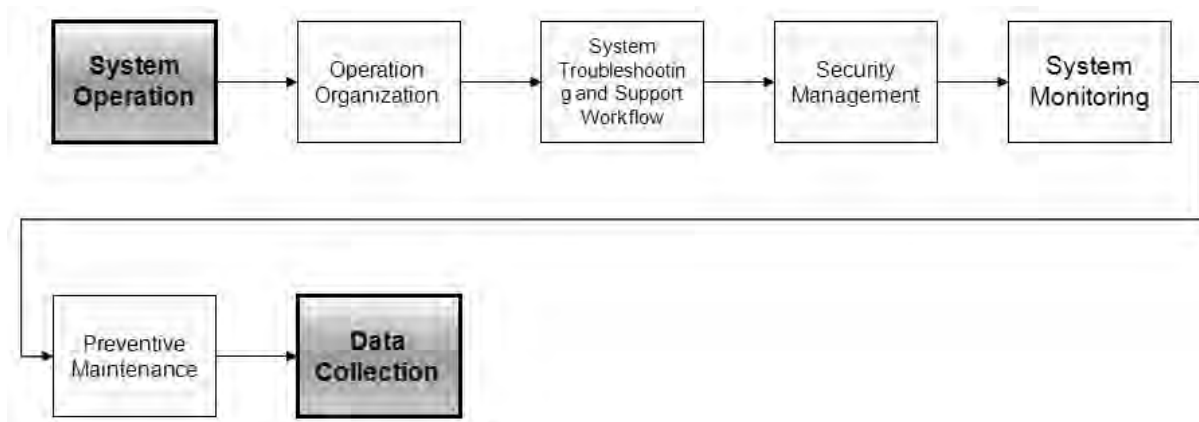


Figure 21: System Operation Process

The system operation refers to a process that is responsible to maintain the system up and running without interruption. If the problem occurs, the system operation team will recover the system back to normal in the shortest period of time with the minimal impact. The system operation plays an important role to promote the usage of RWCS when the local users fully use and rely on very much on the system.

The system operation process consists of the following:

- 1) Operation Organization: the system operation organization needs to establish and clearly defines the role and responsibility of each member. The operation organization also define how to deal with the third party service provider.
- 2) System Troubleshooting and Support Workflow: when the problem occurs, it is important to plan the troubleshooting process and the procedure of how each person in operation organization handles the situation. The incident escalation flow needs to be defined. For examples, who is the contact person to response the incident, how to get the support in different situations.
- 3) Security Management: it defines security standard and policy used in the system. It covers hardware, software and people-ware that help system being secure. For example, antivirus software, security update schedule and backup policy. The backup policy defined the process of how to backup the data in the system.
- 4) System Monitoring: the process to monitor the service availability and performance of the system.
- 5) Preventive Maintenance: it defines how to periodically perform the maintenance service on the system. The preventive maintenance includes hardware maintenance and software license maintenance. Preventive maintenance helps the system operating smoothly, reducing the possible downtime and prolonging the lifespan of the system.

In the project the system operation is a key component of RWCS. The details are shown in Appendices xxx: System Operation Guideline.

4.3.7 Data Collection

Figure 22 shows the block diagram of the data collection process

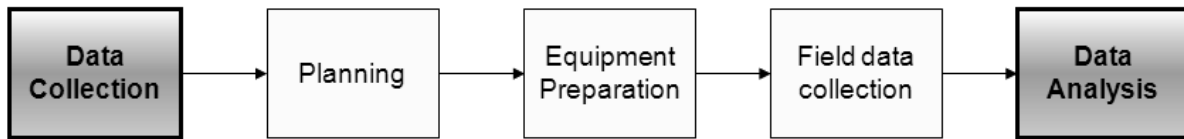


Figure 22: Data Collection Process

The data collection process consists of three steps:

- 1) Planning: Several aspects of data collection are defined in the planning process. For example, the number of points to measure RF signal to capture each type of geographical characteristics, the number of time during the year, the gears for RF measurement. The testing procedure has to be pre-defined to make as a standard in each time of measurement.
- 2) Equipment Preparation: Hardware, software, people-ware preparation. The list of equipments such as WiMAX CPE, spectrum analyzer, GPS, location map or google earth map needs to be prepared.
- 3) Field data collection

In the project, the data collection is focused on RF signal strength measurement in several locations that represents each type of geographical characteristics (i.e., flat area, city area, inside valley area and river area). RF signal strength is measured corresponding with GPS location. In the case of R

Service Coverage Area with geographical characteristics

In the project, we conduct the data collection in three district area in Mae Hong Son. Figure xx shows the activity of field data collection. Measurement equipments such as spectrum analyzer, GPS, notebook with software tool are installed inside a van. The omnidirectional antenna and MIMO WiMAX USB dongle are installed outside the van. The van drove to different locations in various geographical characteristics to measure the RF signal strength.



Figure 23: Field Data Collection

All measurement points with corresponding GPS coordinate are plotted on the map. Figure 24 shows the measurement points (color dot) on the Mae Hong Son map.



Figure 24: Field Test Measurement Point in Mueng District

RF Performance with weather characteristic

We installed the weather station to record the weather condition at Basestation and also record the RF signal at CPE site throughout the year as well. RF signal at CPE site is very stable throughout the year regardless of any weather condition. This is conforming to the fact that WiMAX system operates on 2.5 GHz frequency band that is not affected by the weather condition such as rain, mist or temperature. We can conclude that WiMAX system is very robust to the weather condition.

Application Performance Test

There are four applications to measure the performance through WiMAX connection comparing to the existing ADSL connection on a client site. Four applications consist of

1) VoIP: to measure the voice call quality between two client sites. The call quality is measured in MOS (Mean Opinion Score). The result of VoIP performance (see Table 4) between two WiMAX CPE sites (Boripat school and MSR library) is very good (i.e., high MOS).

Table 4: VoIP Performance

No.	Site 1 Name	Site 1 WiMAX CPE RF Status (RSSI/CINR) (dB)	Site 2 Name	Site 2 WiMAX CPE RF Status (RSSI/CINR) (dB)	Test Result		
					Can register to Server ? (Yes/No)	Can make a call to each other ? (Yes/No)	MOS Score (1-5)
1	Boripat School	-37/33	MSR Library	-47/37	YES	YES	4.25

2) eLearning: to measure the performance in term of time to download a content from the eLearning server to client. Table 5 shows the result of the speed and time to download or upload from/to eLearning server. It compares the performance between WiMAX and ADSL connection. WiMAX provides high speed download and upload and yields less time.

Table 5: eLearning Content Download Performance

No.	Server Location	Site 1 Name	Site 1 WiMAX CPE RF Status (RSSI/CINR) (dB)	Site 1 ADSL Speed Configuration (DL/UL)	Test Result (File size 30 MB)			
					WiMAX CPE			
					UL Average Speed (Mbps)	UL Time (min.sec)	DL Speed Average (Mbps)	DL Time (min.sec)
1	Core 1	ICT Center	-57/27	2Mbps/2Mbps	4.22	1.02	5.89	0.44
					ADSL			
					1.92	2.17	1.65	2:33

3) Videoconference using AcuConference Software: to measure the quality of voice and video of videoconference between two clients sites. The quality is measured in MOS of voice and video. Table 6 shows the performance of videoconference between two WiMAX sites. Good performance of voice and desktop file sharing. Moderate performance on the video.

Table 6: Videoconference Performance using AcuConference

No.	Site 1 Name	Site 1 WiMAX CPE RF Status (RSSI/CINR) (dB)	Site 2 Name	Site 2 WiMAX CPE RF Status (RSSI/CINR) (dB)	Test Result		
					MOS Score of Voice (1-5)	MOS Score of VDO (1-5)	MOS Score of Desktop File sharing (1-5)
1	ICT Center	-57/27	Pai Vitayakran School	38/38	4	3.5	4

4) **Videostreaming:** to measure the QoS of videostreaming from video server to clients. The QoS of videostreaming is determined by the total delay time of videostreaming. It is measured by Total delay time (sec) = {Total running time (from start to finish) of the video clip} – { Actual running time of the video clip}. We used the video clip with 720p resolution with 2 Mbps encode bit rate. The actual running time of video clip is 213 second. We measure the total running time of the video clip and calculate the total delay. Table 7 shows the videostreaming performance from the server to client with different connection (i.e., WiMAX or ADSL). Both WiMAX and ADSL provide good quality of video (high MOS) due to the media play buffering the content before playing back. WiMAX provides much shorter delay than ADSL.

Table 7: Video Streaming

No.	Site 1 Name	Site 1 CPE RF Status (RSSI/CINR) (dB)	Site 1 ADSL Speed Configuration (DL/UL)	Test Result Video Streaming 720p Bit rate 2Mbps (Running time 213 seconds)			
				WiMAX CPE - AcuLearn Core1			
				MOS Voice (1-5)	MOS VDO (1-5)	Playback Time (Sec)	Delay (Sec)
1	ICT Center	-57/27	2Mbps/2Mbps	4	4	217	217 – 213 = 4
				ADSL - AcuLearn Core 1			
				4	4	338	338 – 213 = 125

4.3.8 Data Analysis

Figure 25 shows the block diagram of data analysis process

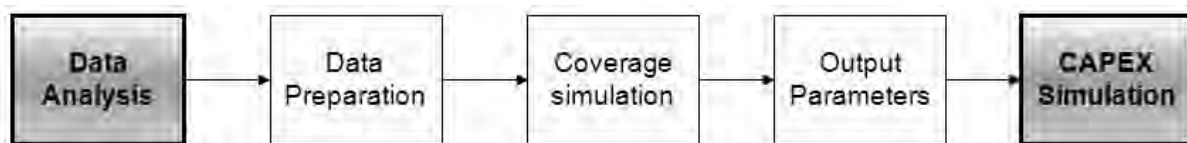


Figure 25: Data Analysis Process

Data analysis consists of three processes:

1) Data preparation: Collection data is checked, verify and normalize to the form that is ready to import to the RF simulation tool.

2) Coverage simulation: this step uses the RF simulation tool to simulate the coverage. Collection data is imported to RF simulation tool to re-calibrate the result to become more accurate. The result of RF simulation tool is the RF propagation map.

3) Output parameters: The RF propagation map is analyzed and determine the output parameter which is “the signal coverage of each geographical type”.

In the project, Atoll simulation tool is used as the RF simulation tools. The simulation workflow is shown in Figure 26. Figure 27 shows the calibrated RF simulation map in Mueng district area.

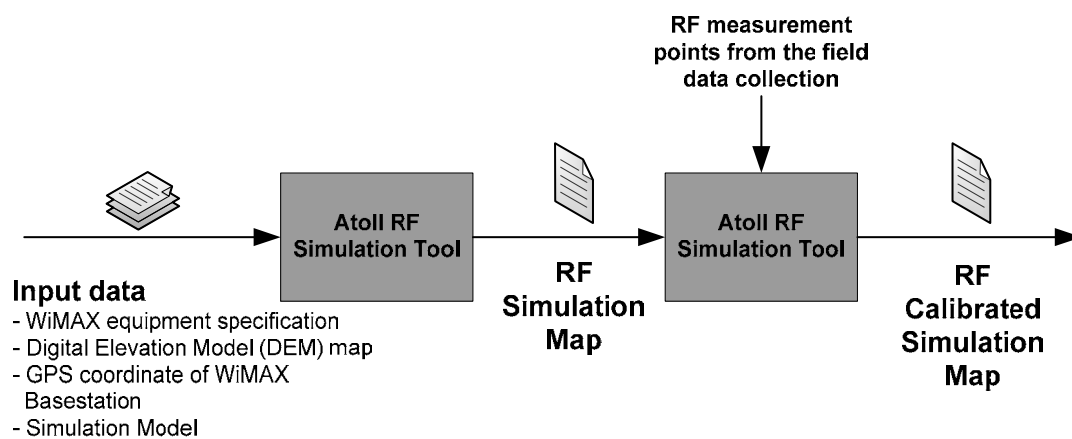


Figure 26: RF Simulation Workflow

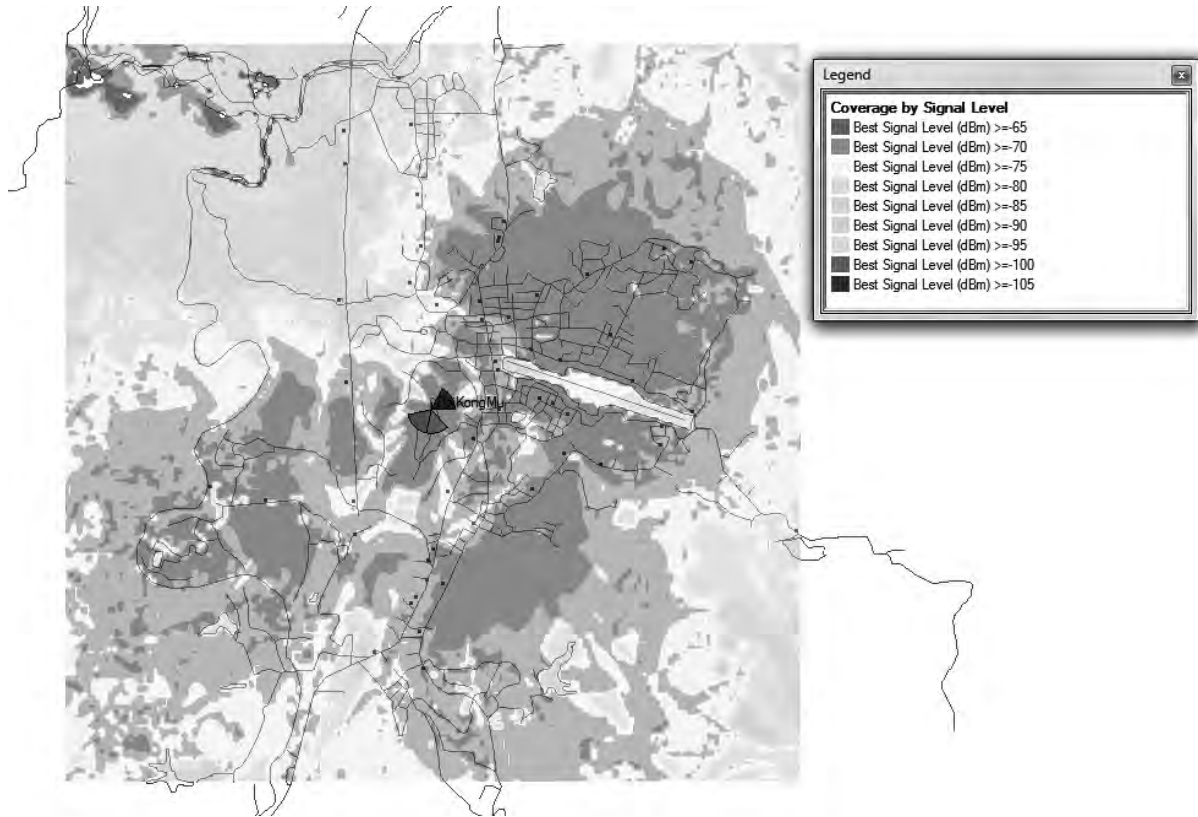


Figure 27: Calibrated RF Simulation Map in Mueng district area

From the calibrated RF simulation map, we determine the coverage of each geographical type. The output result is shown in Table 8. This result becomes the input of CAPEX simulator. There are two criteria of the coverage cell size is 1) Capacity based cell size and 2) Coverage based cell size

The capacity based cell size is the size of WiMAX cell that provides the high bandwidth to clients. The data rate or bandwidth of WiMAX is directly related to the level of received power at the receiver. The higher received power, the higher order modulation scheme (i.e., 64QAM) and the higher bandwidth or data rate. At the cell edge that has the received power of around -70 dBm, the client will operate at high data rate. On the other hand at the cell edge that has the received power around -85 dBm, the client gets the enough robust signal for the stable communication. This case is called the coverage based cell size. The coverage based cell size provides the adequate signal level to communicate and provide the decent data rate.

Table 8: Result of RF field trial testing

Geographical Characteristics	Cell radius (km.)	
	Capacity Based Cell (-70 dBm received power)	Coverage Based Cell (-85 dBm received power)
Flat open field area	2.8	4
Inside valley area	1.2	2.4
River or lake area	2.8	4
City area	2.4	3.6

4.4 CAPEX Simulation Modeling

CAPEX means the capital expenditure of the deployment of the WiMAX system in the target area.

4.4.1 WiMAX Cost Structure

CAPEX WiMAX cost structure consists of

1) WiMAX basestation equipment cost: the total cost of WiMAX basestation equipment is proportional to the number of cell site in the target area. The example of the component of WiMAX basestation is

- WiMAX BS set (i.e., BS indoor unit, BS outdoor unit, WiMAX antenna, GPS sync.)
- Power supply and power regulator unit
- Backup power unit (Generator)
- Network equipments

2) WiMAX core equipment cost: the cost of WiMAX core equipment at Core center. The example of the component of WiMAX core is

- AAA Server
- DHCP and DNS server
- Network Management Server (NMS)
- Network Monitoring Server
- Log server
- Network equipments
- L3 Firewall
- L7 Firewall

3) Tower cost: the total cost of tower is proportional to the number of cell site in the target area. Either new tower construction or rental the existing one can be selected.

4) WiMAX CPE cost: this is the cost of WiMAX CPE. Normally the WiMAX CPE cost will not be included in the CAPEX because a customer bears the cost of WiMAX CPE.

5) Backbone infrastructure cost: From our CAPEX simulation, the backbone infrastructure cost is not included.

4.4.2 Number of Cell Calculation

From the field trial test, we found the RF coverage of flat open field is similar to RF coverage of riverside. Therefore, in the number of cell calculation, the flat open field and riverside area are considered to be the same performance of geographical characteristics

Definition

- R , radius of a cell (km.)
- P_{overlap} , percentage of cell overlap
- R' , radius of a cell with percentage of cell overlapping adjustment
 - Fix service: 5% cell overlapping
 - Nomadic service: 10% cell overlapping
 - Mobility service: 20% cell overlapping
 - $R' = R \times \frac{(1 - P_{\text{overlap}})}{100}$
- A_{cell} , area of a cell (km²) based on hexagonal cell shape, $A_{\text{cell}} = \left(\frac{3\sqrt{3}}{2}\right) \times (R')^2$
 - $A_{\text{cell,flat}}$, area of a cell (km²) in flat open field area, $A_{\text{cell,flat}} = \left(\frac{3\sqrt{3}}{2}\right) \times (R'_{\text{flat}})^2$
 - $A_{\text{cell,valley}}$, area of a cell (km²) in inside valley area, $A_{\text{cell,valley}} = \left(\frac{3\sqrt{3}}{2}\right) \times (R'_{\text{valley}})^2$
 - $A_{\text{cell,city}}$, area of a cell (km²) in city area, $A_{\text{cell,city}} = \left(\frac{3\sqrt{3}}{2}\right) \times (R'_{\text{city}})^2$
- A_{area} , the size of target area (km²)
 - P_{flat} , the percentage of flat open field area within the target area
 - P_{city} , the percentage of city area within the target area
 - P_{valley} , the percentage of inside valley area within the target area
 - P_{none} , the percentage of area that has no services
 - Such that $P_{\text{flat}} + P_{\text{city}} + P_{\text{valley}} + P_{\text{none}} = 100$

Therefore,

- A_{flat} , the size of flat open field area (km²), $A_{\text{flat}} = A_{\text{area}} \times \frac{P_{\text{flat}}}{100}$
- A_{city} , the size of city area (km²), $A_{\text{city}} = A_{\text{area}} \times \frac{P_{\text{city}}}{100}$
- A_{valley} , the size of inside valley area (km²), $A_{\text{valley}} = A_{\text{area}} \times \frac{P_{\text{valley}}}{100}$
- TP_{demand} , throughput demand per one client (Mbps)
- TP_{cell} , throughput or bandwidth provided in one cell (Mbps)
- Oversub, oversubscription value

- ClientNum, number of client in the area

Number of cell calculation is based on two criteria

1) Number of cell to fulfill the coverage requirement

Number of Cell = Number of Cell in Flat area + Number of Cell in Inside_Valley area
+ Number of Cell in City area

$$= \left(\frac{A_{\text{flat}}}{A_{\text{cell,flat}}} \right) + \left(\frac{A_{\text{valley}}}{A_{\text{cell,valley}}} \right) + \left(\frac{A_{\text{city}}}{A_{\text{cell,city}}} \right)$$

2) Number of cell to fulfill the throughput demand of clients

Throughput provided by WiMAX in one cell is directly related to the total spectrum bandwidth used in one cell. From the field test, the effective spectrum efficiency of WiMAX system is 1 bps/Hz. If WiMAX system uses 10 MHz channel bandwidth for one sector antenna and there are three sectors in a cell, the total spectrum bandwidth in one cell is 10 x 3 = 30 MHz. Therefore, total throughput provided in one cell = 30 Mbps.

Total throughput demand of all clients = $TP_{\text{demand}} \times \text{ClientNum}$

Bandwidth provisioning to support all clients = Total throughput demand x Oversub

$$\text{Number of Cell} = \frac{\text{Bandwidth Provisioning}}{TP_{\text{cell}}}$$

The total number of cell calculation is the maximum number of cell from two criteria.

4.4.3 Grand Total Cost

$\text{Grand Total Cost} = \text{WiMAX Core Equipment Cost} + (\text{WiMAX BS Cost} + \text{Tower Cost}) \times \text{No. of Cell}$

4.5 Demand Analysis and Validation Method

As described in section 4.3, the first step before starting the project is to conduct the preliminary assessment on the target area. Base Line Survey, Technology Trend Survey and Demand Survey provide the important information of the area in order to have the proper project design. Key finding from technology trend survey influence how we design the system. Demand survey also influences the project activity planning to serve the users' needs. Base Line Survey provides the basis information to be compared after the project launch for one or two years to measure the impact of the project. During the project, the usage monitoring is used to see the progress of the usage. At the end of project, the impact survey is conducted to measure the impact by the project. The methods of the survey in the project are online questionnaire and on-site interview. The process is showed in Figure 28.

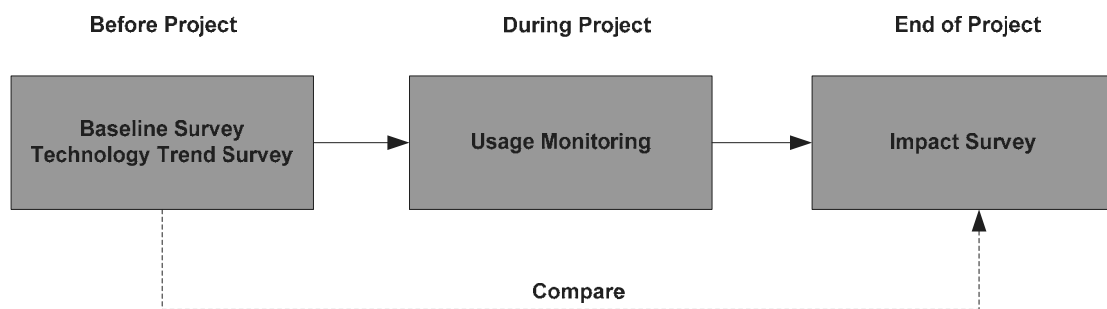


Figure 28: Survey Process

4.5.1 Baseline Survey

In the project the objective of the Baseline Survey is to gauge the impact on local vitalization of introducing a new wireless communications system in Mae Hong Son Province. The survey will target the items listed as the following.

1. Power supply situation at the base station installation site
2. The line conditions from the base station to the WiMAX center device
3. Type of backbone, speed, LAN environment on local sites, PC layout
4. Validity of the outdoor antenna installation,
5. Validity of the CPE installation site and the state of local facilities (air conditioning, power supply, security, indoor wiring conditions, etc.).

The detail result of the survey can be found in Appendices: Report for Baseline Survey / Technology Trend Survey / Demand survey

4.5.2 Technology Trend Survey

In the project the objective of the Technology Trend Survey is to capture the current state of information and telecommunications infrastructure. Survey is conducted on the test model sites in Mae Hong Son. In specific terms, the survey will target mainly for the 4 areas as follows:

1. Base station and information and telecommunications infrastructure in the model area
2. Situation regarding the use of applications

3. Conditions of wireless communications technology
4. Survey of local resident needs

The detail result of the survey can be found in Appendices: Report for Baseline Survey / Technology Trend Survey / Demand survey.

4.5.3 Demand Survey

In the project, the Demand Survey examine the users' needs. The survey items are as follows.

1. The level of difficulty, ease of use, hardware requirements and constraints concerning eLearning applications currently in implementation based on the IT Valley Project.
2. The degree of needs consistency, contents, level, target users and level of satisfaction of curriculums currently in implementation based on the IT Valley Project.
3. New demand for IT curriculums.
4. The IT level of school teachers in the model areas, local government officials in Mae Hong Son Province and e-learning users.
5. Physical constraints such as frequency of power outages.
6. The discipline learning level centering on IT knowledge of candidate trainees.

The detail result of the survey can be found in Appendices: Report for Baseline Survey / Technology Trend Survey / Demand survey.

4.5.4 Usage Monitoring

The usage monitoring will keep track of the activities and level of usage of the installed system. The automated system helps logging the usage data and then analyzing later. The high usage user is selected as the model usage site. The low usage user is subject to investigate the cause of low usage.

4.5.5 Impact Survey

The objectives of this impact survey are two-pronged: to collect and analyze data on current system status, users' training experience, and actual e-learning content development and usage as well as to identify project success factors and ongoing issues that need to be addressed for further actions in the next phase of the project.

4.6 Field Trial Output

The output of the field test is the following:

1) RWCS Development Model

RWCS process and process and process is described in the section 4.2 – 4.5. The real implementation using WiMAX system is executed in Mae Hong Son province to validate the process and procedure.

2) CAPEX Simulation Model and Tools

The CAPEX Simulation is developed to estimate the total implementation cost of RWCS in the target rural area. The tool is developed on VB on Microsoft Excell Macro.

3) Local demand and impact

The demand survey was conducted within the project and described in the Baseline, Technology Trend, and Demand survey report in Appendices. Impact survey also investigates the impact of the project which is described in Impact Survey Report in Appendices.

4) Local capacity development

The project has conducted the training to the local more than 20 times. The subject is divided into two areas

- Technical Training: The target audiences are system administration. The training covers the seminar and practical training on the basic networking, advanced networking, wireless communication, system administration and system operation training.
- Content development training: the target audiences are school teachers and students. The seminar and practical training covers the content development, software tool and remote classroom.

5. CAPEX Simulator

CAPEX simulator is developed on Microsoft Excel Macro Sheet. The requirement to run the CAPEX simulator is Microsoft Office 2007 or later and need the Macro Enable (see Figure 29). There are three sheet tap used in the software: Instruction tab, CAPEX Simulation tab and WiMAX Cost Structure tab.

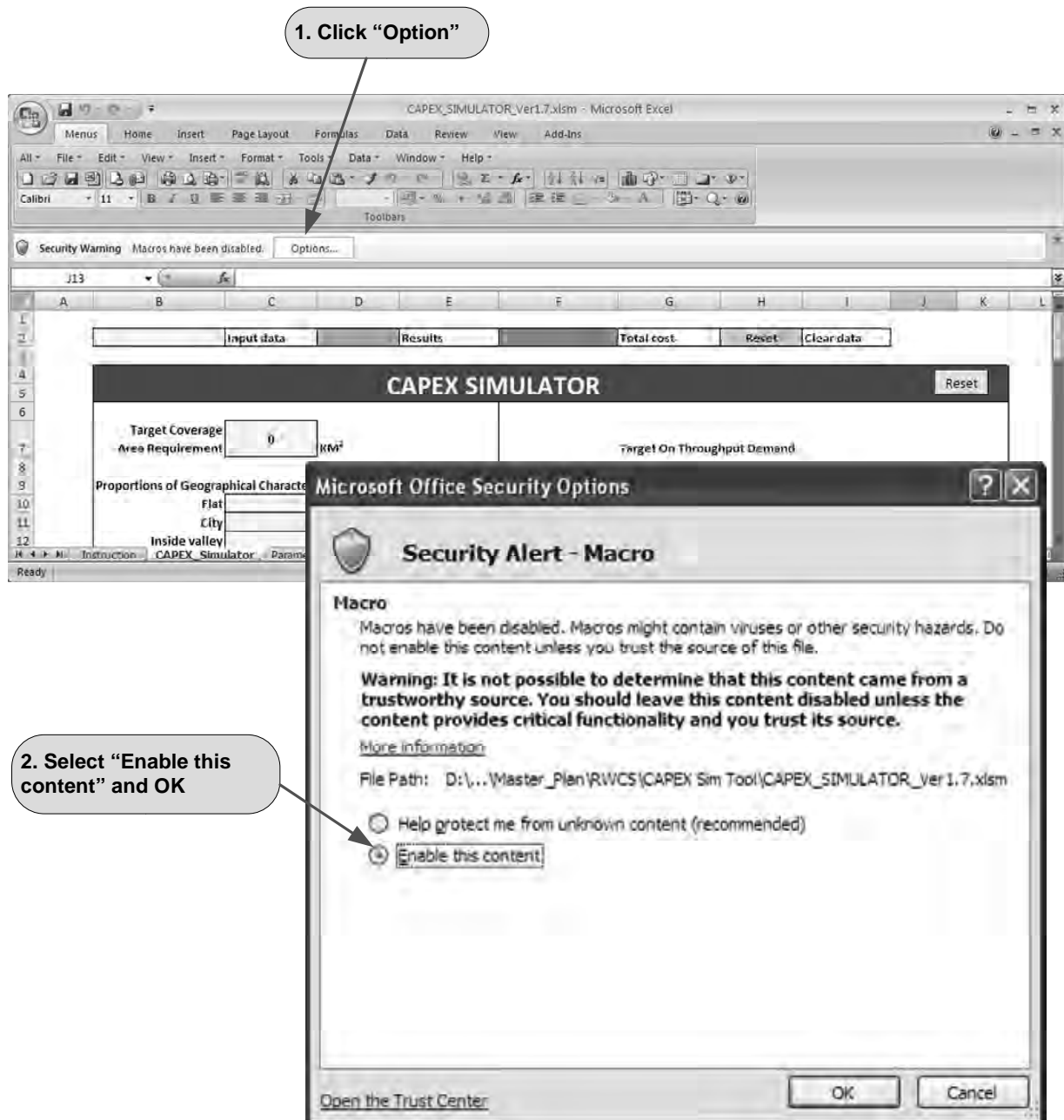


Figure 29: Enable Macro

Step 1: Enter Data for Number of Cell calculation based on geographical characteristic (see Figure 30)

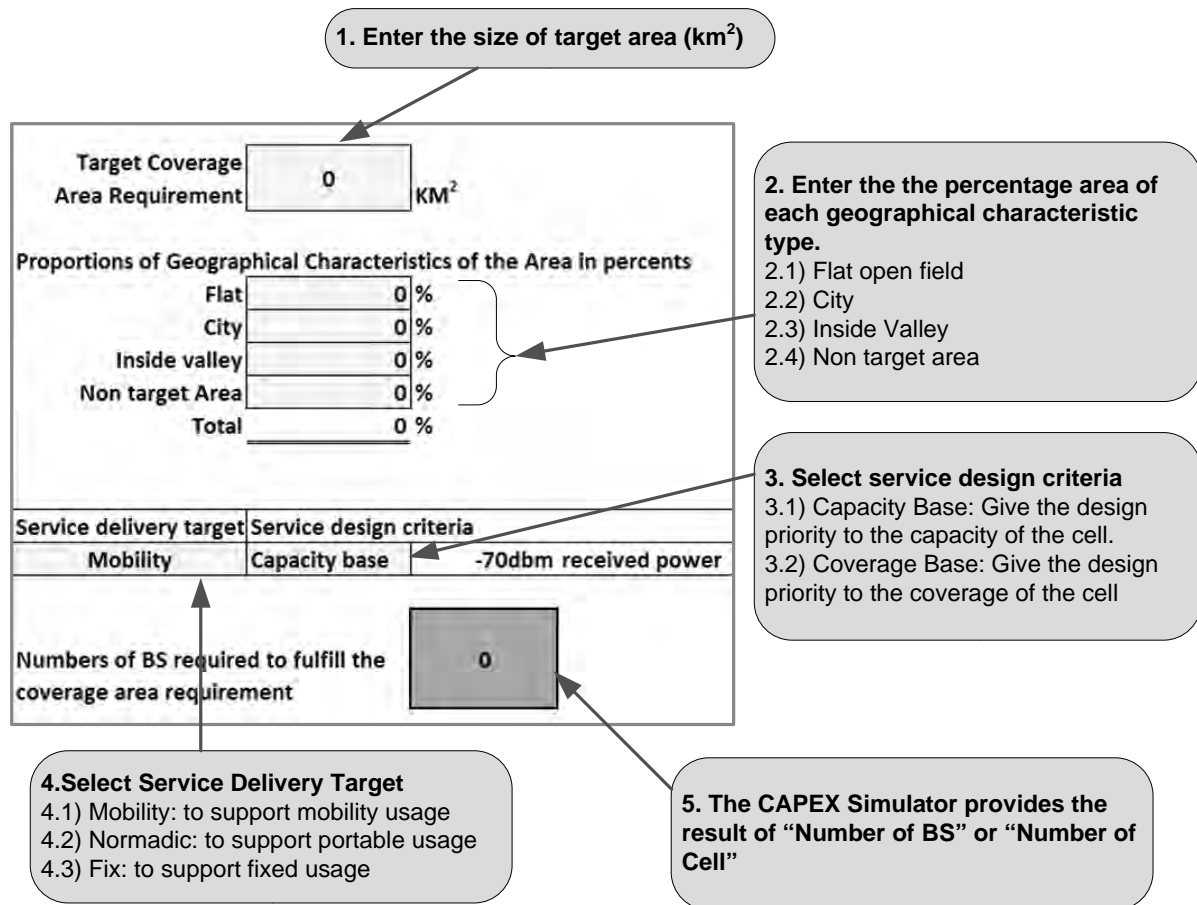


Figure 30: Number of BS calculation based on geographical characteristic

Step 2: Enter Data for Number of Cell calculation based on throughput demand of client (see Figure 31)

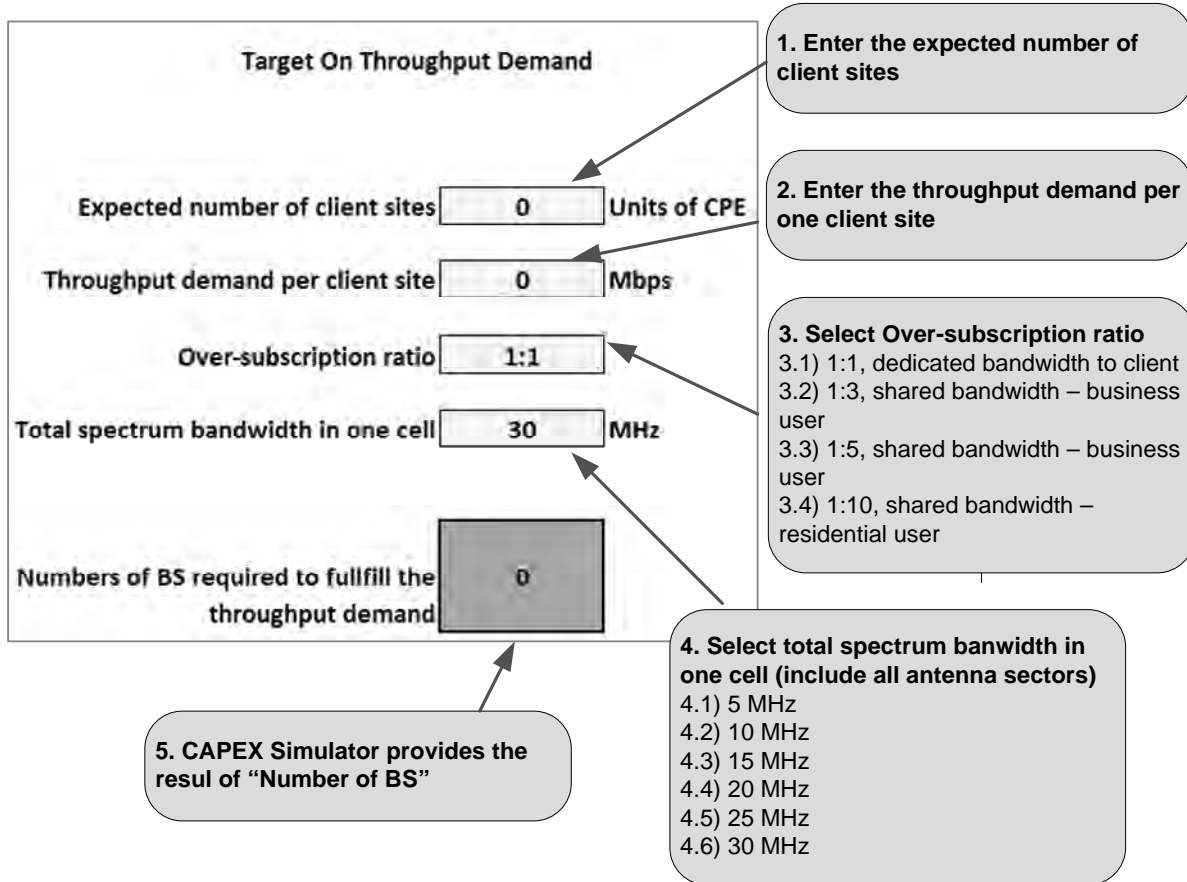


Figure 31: Number of BS calculation based on throughput demand of client

Step 3: Summary the number of BS cell

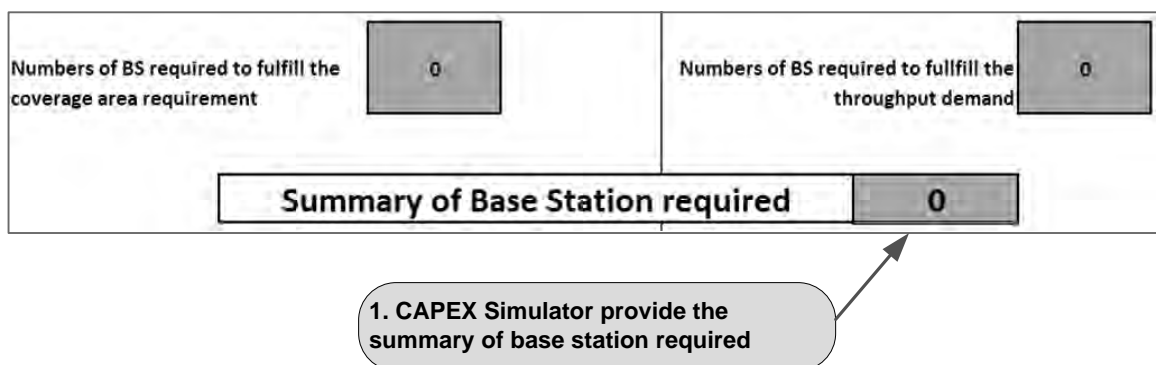


Figure 32: Summary of Base Station required

Step 4: Select the tower cost assumption (see Figure 33)

1. Select the tower cost assumption
 1.1) Build: build the new tower
 1.2) Rent: rent the existing tower

Base Station Tower Cost Assumption

Build
1,600,000 Cost per Site

Figure 33: Select Tower Cost Assumption

Step 5: Total Cost (see Figure 34)

WiMAX Core Equipment Cost 2,500,000 THB	WiMAX BS Equipment Cost 2,100,000 per Site x 0 Sites Total WiMax BS Equipment 0 THB	Base station tower Cost 1,600,000 per Site x 0 Site Total Base station tower Cost 0 THB	CPE Cost 10,000 per unit x 0 Units Total CPE cost 0 THB
Grand Total (excluding CPE cost)		0 THB	

Total Cost of Deployment excluding CPE cost

Figure 34: Total Cost

The CAPEX simulation does not include the cost of backbone infrastructure. User can modify the cost of equipment on WiMAX Cost Structure tab.

6. Lessons Learnt and Recommendations

6.1 Key points for Application of RWCS model to USO target area

- Local Demand recognition in major rural specific application area (e-Learning, e-Government, e-Health and tourism, etc.)

The preliminary assessment process such as demand survey is a crucial step to determine the application demand in the target rural area. The application of RWCS that can vitalize the rural community will be well accepted and receives the good support from the community as well as the local government. In MHS case, most of the area is mountainous area. People have to spend more time and money for travelling within or between the provinces. Videoconference application is very well accepted from the local government in which the local government can have the remote meeting among districts. Teachers and students have high demand on the eLearning. Schools in MHS tend to be lacking of the teachers and also have high turnover rate of teachers. eLearning can be used as a tool to strengthen the education of MHS. The economy of MHS relies very much on the tourism. The application that supports the tourism is a wish list for the local business such as hotel, tour guide.

- Capacity building and local Training

From the project, we found that in order to be successful in implementing and maintaining the RWCS the local people who use or operate the system need to get involved from the start and receive training. The project conducts a series of training in two areas, one is the training about the system administration for local administrators and the other is the training about how to develop the eLearning contents targeting on school teachers and students. Local administrators of each project site act as a helpdesk or the first line of system support to the users. More than ten practical training provides to the local administrators during the project and expect to provide more training after the project as well. In order to have the knowledge stay in the local, the working group is formed. The technical working group consists of the local administrators and it will be the place that members will help each other. The content development working group focuses on the content development. The members provide the local training within the local teachers.

- Operator Independent local service

Most operators typically give higher priority providing the Internet service to city area than the rural area where it has low return of the investment. Even the rural area has the demand. Therefore, the local operator would fill this gap by providing the services specifically for the local people. It can better serve the local need. The starting the service may require high starting investment. USO fund could play the important role to support the local operator during the startup.

6.2 Key Points for Implementation of RWCS

- Logistics planning considering geographical constraints

In the project, we learnt that geographical constraint has the impact on the schedule of the implementation. Equipments transportation and tower construction may take longer time. Therefore, the logistics planning need to take the geographical constraints into the consideration. Location survey provides the useful the information about such constraints

- Security of Power source, prevention of black-out

In MHS, the stability of power source is low. The blackout may occur as frequent as ten times a day and each blackout may last half an hour or half day especially during summer time. This has the great impact on the service continuity and reducing the lifespan of the equipments. Several equipments are broken due to the unstable power source. The backup power source needs to be carefully designed to reduce the impact of the power shortage. However, the expedite on power improvement of MHS requires the influence from the local and central government.

- Selection of vendors

The selection of vendors affects on the level of maintenance service. The vendors that have the local support and good support structure will provide the good service according to the SLA (Service Level Agreement). Therefore, the selection of vendors for RWCS is important.

- Consideration of Disaster Prevention

During the project there are several floods and landslides in MHS area. The latest landslide incident in August 2011 near one of the basestation posted a serious threat to the WiMAX tower. The project team managed to remove the tower and secure the safety in time. Service got influence from the incident. Therefore, the lesson learnt is the disaster recovery plan is very crucial to minimize the impact when the disaster occurs

6.3 Key Points for Post RWCS Implementation

- Sustainability planning

The benefit or impact to the rural area does not only occur during the RWCS implementation but also during post RWCS implementation. During the post implement the RWCS must continue the service and makes some adjustment if necessary whenever local demand changes. At the end of RWCS implementation the sustainability plan must be drawn up to make sure the smooth transition of NECTEC ownership of the service and maintenance to the ownership of the local organization. The success of sustainability plan depends on several factors including 1) local ownership 2) budget to maintain the system and service 3) capability of staffs to maintain the system. Definitely the new owner must come

from the local in order to understand the local need and to be able to sustain the system in the long run. Owner must come with adequate budget to continue the service. The budget may come from different parties to alleviate the burden of one organization. Furthermore, the business model should be defined to obtain the source of income that can sustain by itself. The ability of staff is also important. Therefore, the sustainability plan should include the local training to build the local capacity for the project.

- Impact Monitoring

In order to capture the impact of the project, the “before the project” state of the target area should be captured and compare with the result of the “after the project” state of the target area. Impact survey should continue to conduct after the project once a year to see the progress in the long run. This information is very helpful to become the lesson-learnt for the other projects later.

- System Operations and Maintenance, Local Support

The system operation and maintenance should be continued. The system operation organization may be altered according to the new owner. Other processes such as System Troubleshooting and Support Workflow, Security Management, System Monitoring and Preventive Maintenance would not be much different.

6.4 Recommendations

- Utilize the RWCS model to
 - promote WiMAX to rapidly achieve milestones of USO NBB Policy
 - reference CAPEX/Specification assumption
 - effectively and efficiently prioritize and allocate USO fund
 - to promote RWCS and application of RWCS model to rural area in Thailand
- Expedite WiMAX Spectrum Allocation specifically for rural area
- NBTC to exempt initial backbone operational cost for certain period
- Promote usage of the network
- Contribute for local capacity development

7. Epilogue

This RWCS Development Model document can be used as a guideline for NBTC or other organizations that plan to deploy the wireless technology in rural area. CAPEX simulation provides the convenient tool to estimate the cost of wireless deployment. Hopefully this document would be applied for other provinces.

We would like to express the special thanks to NBTC for the project support and providing the direction of RWCS development model.

Very sincere gratitude to JICA for the great project support for both project equipments and technology transfer. Without JICA support, this project definitely could not happen.

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Thanks to all others that contribute to the project.

Lastly we would like to thank to MHS people for the support in many ways. Hopefully the project will have the benefits and the impact to the MHS and the local people.

EOD

Appendices:

Baseline, Technology Trend, and Demand Survey Report

Case study Report

System Operation Guideline

Field Test Guideline and Procedure

Impact Survey Report

CAPEX Simulator

HRD-WiMAX Project:

Report for

Baseline Survey / Technology Trend Survey / Demand survey

HRD-WiMAX Project

Oct 18th, 2009

Vol. 001

Revision 009DF

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 7. Action in Future / recommendations 18

Appendix

Appendix A: BL survey study item (WiMAX).doc

Appendix B: Analysis_BLQues_Table_R6.xls

Appendix C: BLQues_Chart

Executive Summary

Executive Summary

Report of
Baseline Survey / Technology Trend Survey / Demand Survey

HRD-WiMAX Project
Oct 11th, 2009
Vol. 001
Revision 007DF

Executive Summary Content

1. Objectives of Survey
2. Target Audience and Areas
3. Conclusion
4. Recommendations & Actions to be taken

1. Objectives of Survey

① Baseline Survey

To gauge the impact on local vitalization of introducing a new wireless communications system in Mae Hong Son Province. The results from the baseline survey will be taken as "before" state of the project and will be ascertained in the impact survey compared with "after" the project.

1. Objectives of Survey

② Technology Trend Survey

The current state of information and telecommunications infrastructure to be surveyed on the demonstration testing model site selected local model areas.

③ Demand (Needs) Survey

To inspect conditions of such sites for base station and infrastructure development and to identify if there are any environmental constraints under current conditions and problems in existing curriculums and/or contents and applications.

2. Target Audience and Areas

1. The target audiences of the Baseline Survey are categorized into following three groups:

- ① School group including teachers and students
- ② Government group including IT personnel
- ③ Community Center group including the head of community center and IT personnel.

2. The survey is **focused** on the following two areas:

- ① Baseline survey to gather the basic information of IT and also the existing IT technologies (i.e., Technology Trend Survey) at the model sites such as the number of PCs, the speed and type of the Internet connection, the capacity of the backbone, IT personnel, the Internet usage and etc.
- ② Demand survey to gather the basic information of applications and IT activities at the model sites such as IT curriculum, eLearning, IT contents and material, IT training, and etc.

3. Conclusion

■ Baseline Survey Result

- ① Still lacking of PCs comparing to the number of students
- ② The speed of the Internet connection is not adequate for the bandwidth demanded for the application
- ③ The stability of electricity such as blackout, voltage fluctuation is a major challenge in MHS
- ④ Lack of IT administrator or IT trained personnel resource especially in the wireless technology area



"HRD-WiMAX project foresees some impacts on how people or students access the Internet"

3. Conclusion

■ Demand Survey Result

- ① Mae Hong Son needs to increase the number of qualified IT teachers.
- ② E-Learning systems can be used to accompany teaching activities.
- ③ The skills to operate ICT systems as well as creating contents for various subjects are still lacking
- ④ Teachers already realize that eLearning systems can be useful as teaching management tools.



"It is timely for HRD-WiMAX project to proceed in the area of eLearning system training and content management and creation"

4. Recommendations & Actions to be taken

■ Recommendations & Actions to be taken

■ Stabilize Electricity Supply in MHS

HOW?

Collaborate with number of parties such as Mae Hong Son government, Electricity Authority, the policy from the central government to Address this issue and request the resolution.

■ Increase the speed of the Internet connections up to the level of application usage demanded in MHS

HOW?

- ① Establish WiMAX based infrastructure in MHS to provide local users in HHS both accessibility and smooth enough connections to run the applications.
- ② Assist in improving throughput utilizing WiMAX wireless technology as a last mile solution.

4. Recommendations & Actions to be taken

■ Recommendations & Actions to be taken

■ Increase IT education standard in MHS

HOW?

- ① Arrange a series of eLearning and content development workshops to train local teachers as well as other local people who are interested in teaching their skills to local children
- ② A sustainable model of MHS local CP to disseminate and transfer the knowledge gained from NECTEC must be developed and form a group within the content developer community in the local area to apply the model.

■ Socio-Economic Impact Measurement

HOW?

For future impact survey planned in a half of year and a year after the service launch, by learning from this time of base line survey, the project shall consider the method of measuring the impact and define indicators in each areas for future impact survey and elaborate a plan to take measurement of the impact in accordance to the surveyed items with each of the indicators defined.

4. Recommendations & Actions to be taken

■ Recommendations & Actions to be taken

■ Issues found in the Technology Trend survey shall be revisited to consider the potentiality working with such donor as JICA.

HOW?

To follow up on the issues found in Technology Trend Survey, further hearings shall be carried out by the project and make proposition to JICA as to the solutions in the future.

Background

The Kingdom of Thailand (hereinafter referred to as Thailand) has adopted an aggressive approach to creating an information-oriented society. Examples of this approach are the 10th Socioeconomic Development Plan of the Kingdom of Thailand 2007-2011 (the superior level plan) and the National IT Policy Framework: IT2010 (2001-2010). Aiming for the construction of a knowledge-based economy and society, IT2010 has been advanced with emphasis placed on the utilization of basic information technology, development of IT human resources and construction of information and telecommunications infrastructure. This has led to the rapid advancement of information orientation in Thailand and made the country a medium-level IT nation in international terms. On the other hand, construction of the information and telecommunications infrastructure in provincial cities has been slow: rural areas still do not have access to telephones, the internet and other information and telecommunications infrastructure. As a result, this has led to the emergence of a so-called digital divide between urban and rural areas, and this is seen to be contributing to other disparities in terms of economy, education and quality of life in recent years. Rectification of the digital divide has thus become one of the priority development issues facing Thailand.

Against this background, the Government of Thailand in 2005 submitted a request to the Government of Japan for technical cooperation concerning model development and demonstration testing technology for a wireless communications system in provincial areas. Upon this request, the Government of Japan has responded to Thailand to form “The project of human resource development through utilizing the Information Technology for rural community vitalization” in April of 2009 and the Project commenced from a process of conducting surveys such as a baseline survey to capture the current situation in the target sites, Technology to understand the current technology level and also a demand survey.

The baseline survey is conducted at the commencement of the Project in order to measure the current situation and baseline variables on the premise of measuring project’s impacts in 6 months and 12 months time period, while the Technology trend survey is to analyze important assumptions that may affect the project’s proceedings in the future. The demand survey was carried out to capture the local demand in the use of the content, content development applications and LMS applications.

1. Objectives and Survey items

1.1 Baseline Survey

In order to gauge the impact on local vitalization of introducing a new wireless communications system in Mae Hong Son Province, the survey items, scope and targets were set based on some assumptions. The results from the baseline survey will be taken as “before” state of the project and will be ascertained in the impact survey comparing with “after” the project. In specific terms, the survey will target the items listed below. (For more detail list of the survey items for the baseline survey in accordance with the PDM, please refer to the Appendix A.)

- ① Power supply situation at the base station installation site
- ② The line conditions from the base station to the WiMAX center device

- ③ Type of backbone, speed, LAN environment on local sites, PC layout
- ④ Validity of the outdoor antenna installation,
- ⑤ Validity of the CPE installation site and the state of local facilities (air conditioning, power supply, security, indoor wiring conditions, etc.).

A macro level survey specifically for geographical area of MHS was also conducted additionally by the Socio-Economic Impact team of NECTEC in August 2009, for such survey items as job situation, employment rate and numbers of industry.

The Macro level survey items include the following:

- ① Number of populations, percent change, and density
- ② Number of births, deaths, registered-in and registered-out
- ③ Number of households having information technology
- ④ Number of registered commercials
- ⑤ Number of labor forces
- ⑥ Industry type
- ⑦ Educational background of employments
- ⑧ Number of schools, students, teachers, ratio of students/classroom and ratio of students/teacher.

1.2 Technology Trend Survey

The current state of information and telecommunications infrastructure will be surveyed on the demonstration testing model site selected out of Mae Hong Son Province, Mae Sariang, Pai and the model area. In specific terms, the survey will target mainly for the 4 areas as follows:

- ① Base station and information and telecommunications infrastructure in the model area
- ② Situation regarding the use of applications
- ③ Conditions of wireless communications technology
- ④ Survey of local resident needs

1.3 Demand (Needs) Survey

In the Demand Survey, it is to inspect conditions of such sites of base station and infrastructure development and to identify if there are any environmental constraints under current conditions and problems in existing curriculums and/or contents and applications.

The survey items are as follows. (For more detail list of the survey items for the baseline survey in accordance with the PDM, please refer to the Appendix A.)

- ① The level of difficulty, ease of use, hardware requirements and constraints concerning eLearning applications currently in implementation based on the IT Valley Project.
- ② The degree of needs consistency, contents, level, target users and level of satisfaction of curriculums currently in implementation based on the IT Valley Project.
- ③ New demand for IT curriculums.
- ④ The IT level of school teachers in the model areas, local government officials in Mae Hong Son Province and e-learning users.
- ⑤ Physical constraints such as frequency of power outages.
- ⑥ The discipline learning level centering on IT knowledge of candidate trainees.

2. Survey Method and Process

2.1 Survey method

National Electronics and Computer Technology (NECTEC) and Japan International Corporation Agency (JICA) study team conducted baseline, technology trend and demand survey among local site participants of the Project of Human Resource Development through Utilizing the Information Technology for Rural Community Vitalization with the collaboration of IT Valley Project Mae Hong Son for Celebrating the Auspicious Occasion of HM the King's 80th Birthday Anniversary. The study was divided into two phases and with two different methods; site-visited interviews and an online survey. With two phases, the non-interviewed sites can response to the survey later and thus save cost and time consuming in interviewing method.

2.2. Respondent and set of questions

The survey was administered to local project participants and their students in Thai language and later translated into English for analysis purpose. Project members are categorized into 3 groups; which are school, government and community. Each group was fed with uniquely designed set of questions to match with its background. The first phase survey was conducted to selected members by site-visited interviews while the second phase was conducted to all project members by Google Docs web-based online survey. The reason to cover interviewed sites as respondents in second phase is that NECTEC and JICA study team intended to cover more details from the respondents then decided to add some additional questions to the first phase questions. (For more details, please refer to the appendix B: Questionnaire.xls)

Interviews to local sites visited

1. Information is collected by having interviewers ask questions and record answers.
2. Information is collected from only a subset of the population to be described (a sample) rather than from all members due to time constraint

Online survey

1. Project staff formulated questionnaire and put to the Google docs website.
2. Administrator distributed set of questionnaires according to group of project members to respondents by email.
3. Confirmation of receipt of questionnaire is done by calling to each respondent.
4. Information is intended to collect from all of the population but some sites did not reply.
5. The responses rate is around 90 percent.

3. Target Audience of the survey

The target audiences of the Baseline Survey are categorized into three groups:

- 1) School group including teachers and students
- 2) Government group including IT personnel
- 3) Community Center group including the head of community center and IT personnel.

The survey is focused on the following two areas

- 1) Baseline survey and Technology Trend Survey focuses to gather the basic information of IT utilization in the area and also the existing IT technologies in use at the model sites such as the number of PCs, the speed and type of the Internet connection, the capacity of the backbone, IT personnel, the Internet usage and etc.
- 2) Demand survey is purposed to gather the basic information of applications in use and current IT activities at the model sites such areas in IT curriculum, eLearning, IT contents and material and IT trainings.

4. Key Finding

Key findings from each question are as follows. (For more details, please refer to the appendix C:BLQues_Chart)

Questions 1-10 (Computer and Internet connection)

- Over 60% of the organizations or model sites have less than 60 staffs (not including students)
- About 58% of the organizations have 21-100 computers. All computers are connected to the Internet.
- Almost all organizations have the Internet connection. 82% of organizations use ADSL for the Internet connection and others use leased line.
- There are four ISPs in the area (i.e., TOT, CAT, TT&T and IPStar). TOT has the highest share (66%) among ISPs.
- Most organizations (81%) have only one or two system administrators.
- 67% of organizations do not have the system for ID and authentication.
- For antivirus software used in organizations, ESET and AVG have almost 70% share of antivirus software followed by McAfee, Kaspersky and Trend Micro.

Question 11 – 18 (Server, server room, electricity condition)

- 72% of organizations have their own servers and among 79% of these have no server racks or appropriated server room condition (i.e., key lock, air conditioning).
- 76% of the servers have 24/7 runtime.
- 15% of organizations have no server UPS and 76% have server UPS with only less than 10 minutes power interruption protection time.
- Over 75% of organizations experience daily or several blackouts per week. 85% of blackouts take less than 1hour to recovery.
- Most organizations experience very poor voltage stability due to voltage drops, surges and fluctuation.

Question 19-23 (Wireless access)

- Wi-Fi is the dominant wireless access technology among those organizations that utilize wireless access.
- There are one or two Wi-Fi access point in most organizations.

Question 24-31 (Application usage, wireless and Internet training)

- All people can access the Internet. Most people access the Internet everyday. 44% spend 1-3 hours on the Internet per day. 49% spend 4-10 hours per day.
- Search engine, web browser, email and e-learning are among the more popular applications.

- Only a few organizations use the community application provided by NECTEC (i.e., LinuxSIS, LinuxTLE, Gimp, OpenOffice, Lexitron).
- Most organization do not have wireless technology training instructor or receive any wireless training.

Question 32-39 (For Students)

- Half of schools have more than 500 students.
- Distribution of numbers of students using computers resembles distribution of school size implying most students can use computers.
- Most schools provide the Internet access for students.
- About half of students get online daily. Most of students (87%) spend 1-3 hours on the Internet per day.
- Search engine, web browsing and email are among the more popular applications.

Question 40 (For Teachers)

- 71% of teachers trained other teachers to support IT subject teaching at least once a year.

Question 41 (For Teachers)

- Almost half of teachers have asked students about the way of IT lessons through questionnaire and so on.

Question 42 (For Teachers)

- Out of 32 schools, 1~2 schools responded that they manage and maintain 100% of their existing IT contents, digital materials and tests (exams) by themselves, while 5-6 schools responded only 70% are self managing, 10-13 schools showed 50% and the rest less than 50% are self managing digital data.

Question 43 (For Teachers)

- The frequency of management and maintenance of PCs and IT equipment: every day (5 schools), every lesson (2 schools), weekly (2 schools), monthly (9 schools), every term (3 schools), annually (1 school), and regularly (3 school).
- Feedbacks from responders on the way of management and maintenance of PCs and IT equipment: checking of equipment condition using equipment maintenance list, using repair record, and usage record of computer and computer room, clean every computer, assign teacher for computer lab, qualified technician visit for continuous maintenance, 24 hours maintenance of server and internet

Question 44 (For Teachers)

- Almost half of teachers have experience to share their own experience in teaching and managing with other school teachers. .

Question 45 (For Teachers)

- Total of 68 comments were obtained. (Please reference details in 4. Analysis section)

Questions 46-87 (For teachers)

- Many trained teachers have left school over the past 2 years
- 47% reported IT curriculum being planned, if not already applied.
- One third of teachers teach IT more than 3 hours a day.
- Most teachers are interested in all IT subjects equally, with eLearning is at the top of the list at 7%.
- More than half of the answers believed that there were many opportunities to be employed in IT-related industry.
- 43% had no programming experience, 28% had knowledge of programming but no experience, 29% had programming experience between 1-3 years.
- Programming experience: 23% PHP, 23% C/C++, 21% VisualBasic, 27% none
- Database experience: 38% can use MySQL, 33% can use Access, 16% did not have experience with databases.
- Network experience: 15% had no network experience, 8% could set firewall, 11% could set mail server, 11% could set DNS server, 12% could set FTP server, 7% could set SSH server, 15% could install Linux/UNIX server, 11% could design LAN, and 4% could design WAN, and 6% could configure router.
- Word, Dreamweaver and Excel are the top 3 desktop applications used by teachers.
- Use of IT in future: roughly equally split between Computer Network building, Web page creation, Online library system, Computer security, and two others, each with 12-18%
- Most teachers have some experience teaching via e-learning.
- Many teachers say they never been trained to use Learn Square.

- Almost all of responders were interested in teaching using eLearning.
- Most teachers think e-learning is necessary or helpful to students.
- Most teachers are interested to use e-learning to teach students.
- Half of responders only have time to create eLearning contents at weekends, 17% had about an hour a day.
- Time to create eLearning contents: One third said summer vacation and one third said weekends. The rest is a combination of after class, not at all and any time.
- IT studies time: one third studied IT during lunchtime and one third at night. The rest are a combination of morning and afternoon.
- Appropriate subjects for eLearning content creation: responders selected gave all subjects roughly equal importance.
- Over 74% had hardware or software problems often.
- Most hardware or software problems were resolved by the teachers/responders. Only 11% were resolved by vender.
- Most of learning questions were resolved either by internet search or discussion with colleagues.
- [e-learning] 3/9 had learn sq training, 4/9 had used learn sq
- [e-learning] 9/9 are interested in learn sq training, 6/9 are interested to join LMS training, 3/9 will decide when they see what topics will be trained
- [e-learning] various reasons of not currently using learn sq inc. no follow-up, moved to another school, HW/SW problem, never been trained in the first place
- [e-learning] 5/9 currently using learn sq, and finding it not too hard or not too easy
- [e-learning] 4/9 find learn sq useful as teaching mgmt tool
- [e-learning] 2/9 also uses Moodle, 2/9 used Authorware and e-learning on web, 5/9 never used other LMS

Questions 86-106 (86-105 are for students, and 106-114 are for teachers)

- Most students are between 11-20 years old.
- By 23% of respondents attend GIMP from the school.
- Almost half on students find IT class is difficult.

- In response to the question “Do you study other than in the class” by 39% students study 1-2 hours per week and by 32% 3- 4 hours per week and almost all students study IT during the night by 80%.
- About the coding experience only less than 20% of students have coding experience. Surprisingly, most of respondents (43%) had no programming experience. Meanwhile 20% use PHP program. By 72% of respondents had no database experience and by 17% use MySQL. Only less than 20% of students have some network setup experience.
- Top 3 desktop software for student are Word, Excel and GIMP. The IT subjects ,that most of respondents are interested to take in the future, are GIMP(109) Linux (71) and Computer network (51) respectively.
- Various response from the IT Job preference question mainly prefer on graphic designer (24%).
- In the future, 26% of respondents tended to use HP/Web page creation in the future.
- More than half of student had no e-learning experience.
- More than 80% express interest in e-learning. More than 80% of students think e-learning is helpful.
- More than 80% of students show interest in developing e-learning contents. By 26% of respondents indicate that HP/Web page creation is the .Various response on Application of IT Technology question,26% on HP/Web page creation,58% on computer network building and 19% on online library system.

5. Analysis and Summary from Key Finding

The Analysis and Summary from Key Findings for each survey are as follows:

5.1 Baseline and Technology Trend Survey

- Computers: By comparing the number of PCs in school with the number of students, PCs are not adequately disseminated. Most of the PCs can access the Internet. This implies that most model sites have the LANs to interconnect PCs and share the Internet connection. Most students have enough skill to use the computers.
- Server and Server room: Around two thirds of organizations manage their own servers with 24/7 runtime. However, the site condition to support the server is not adequate such as lack of air conditioning to control the temperature of the server room, lack of appropriate server rack cabinet, lack of UPS capacity for the server to hold server operation for more than 10 minutes of the blackout which is not enough for the frequent and long electricity blackout of Mae Hong Son.

- Electricity: Over 75% of organizations experience daily or several blackouts per week. Most of blackout duration is less than one hour. Moreover, the electricity is unstable (i.e., voltage drops, fluctuations, surges).
- Internet access: around 98% of model sites have the Internet connection. ASDL is the majority internet access technology in use. TOT is the most popular ISP among others (e.g., CAT, TT&T and IPStar). Only a few sites use the leased line for the internet connection. Most of connection speed is less than 1 Mbps shared with large group of users in the organization. Therefore, internet access is slow and inconvenient and it is impossible to exchange image data and conduct streaming, etc.
- Internet usage: Most people access the Internet everyday and spend 1-10 hours daily and especially most students spend around 1-3 hours daily. Search engine, web browser, email and eLearning are among the more popular applications for both staffs and students.
- Wireless access: Limited use of wireless technologies is seen at the model sites. Wi-Fi is the most popular wireless technology that the model sites use. However, the limited Wi-Fi access points are deployed.
- Wireless technology training and instructor: There are not many IP personnel or maintenance staff in schools. The highest number on model sites is three, but usually there is only one staff member. Furthermore, most organizations are still lacking of the wireless technology training instructors.
- Community applications developed by NECTEC: Examples of community applications developed by NECTEC such as LinuxSIS, LinuxTLE, Lexitron. The limited number of organizations uses NECTEC community applications.
- PC environment problem: More than 15 teachers answered computers are not enough, obsolete, low quality and break down often; teachers have to fix broken computer while having to teach at the same time; unstable power supply and power failure are causing damages to computers.
- Budget and material problem: No official budgetary support for computer facility which result in lack of software, anti-virus programs, and materials to teach; school and teachers need to afford by themselves, which is heavy burden.
- Comments from responders are as follows.
 - Lesson time problem: The time of the lesson is too short, i.e. 16:30-20:00
 - Teachers problem: Not qualified, lack of knowledge in troubleshooting hardware problems; not enough time to learn more for self development for computer maintenance; small numbers of teachers have to teach many subjects; and limited chance to receive training due to regulations.
 - Students problem: Large gap in IT capability among students and students lack IT, English, typing basics which delay progress of the lessons; it is impossible to assign

homework since students don't have computers at homes because of poverty; computer is the minor subject which is of low interest among students; and hill tribe Students have little basics and skill to use computers.

- Other problems: Other school activities interrupt IT lessons; computer rooms are used for other subjects; and some parents fear their children will fail the grade if they take IT lesson.
- The population of MHS is 254,804 (age 0-14: 55,936, 15-24: 38,829, 25-59: 97,000, 60-84: 21,186, over 85: 1,570, unknown: 4,618, and not Thai nationality: 37,235).
- The percent change is -0.14. The population density is 20.09 per sq. km.
- The number of births is 3,594, deaths 1,323, registered-in 10,669 and registered-out 10,851.
- The number of households having computers is 3,860 while that not having computers is 52,323.
- The number of households having access to the internet is 1,530 while that not having access to the internet is 2,330.
- The number of mobile phone user is 28,083 and none user is 198,786.
- The number of registered commercials is 26 and that of juristic person is 346.
- The number of employments is 140,744 while that of unemployment is 1,307.
- Top three occupations are agriculture (108,563), own business /retailer/dealer (6,653), and construction (4,585).
- The educational background of employments is mostly uneducated (49,660), primary school (20,228), and pre-high school (12,292).
- The minimum wage rate in MHS is 147 baht/month.
- Average monthly income per household is 6,544 baht. (average monthly income per household in Northern Region is 13,146 baht)
- The number of schools in total is 347 and separate by level of education open as follow; 2 Kindergarten, 268 Kindergarten-elementary, 58 Kindergarten-Lower Secondary, 5 Elementary, 2 Elementary-Upper Secondary and 8 Lower-Upper Secondary.
- The number of students in total is 48,884. (8,392 Pre-elementary, 26,258 Elementary and 14,234 Secondary)
- The number of teachers in total is 2,055. (262 Pre-elementary, 1,076 Elementary, 566 Secondary and 151 No teaching)

- Ratios of students per classroom are 14 for Pre-elementary, 15 for Elementary and 30 for Secondary.
- Ratios of students per teacher are 35 for Pre-elementary, 25 for Elementary and 26 for Secondary.
- Proportion of school use the Internet per total school is 97.04

5.2 Demand Survey

- Finding I: more qualified IT teachers are needed in the area to lift the standard of IT teaching. eLearning systems and contents may be used to alleviate such problem.
- Finding II: two top requirements in terms of IT subject are computer networking and web design.
- Finding III: Knowledge about eLearning systems and content creation is still lacking. However, most teachers are keen to gain knowledge about eLearning systems and content creation. Survey results suggest that teachers rarely have free time to create new contents.
- Finding IV: Half of students find IT classes too difficult.
- Finding V: One third of teachers have had LearnSquare training and found it useful as teaching management tool. All teachers are interested in joining future LearnSquare training. Some teachers stopped using LearnSquare for various reasons, including a move to another school, hardware/software problems, and no follow-up from NECTEC. Other LMS used by teachers include Moodle, Authorware, and eLearning on Web.

From the question 46-87, the target audiences were teachers. The survey questions for teachers can be grouped into 3 groups which are teacher's experience, IT Curriculum, and generic question. The details of the survey result are as following.

The survey shows that many trained teachers have left school over the past 2 years. We also asked about IT-Curriculum, most teachers think IT Curriculum fits the needs and 40% thought IT curriculum was appropriate for student level. Meanwhile, most of the teachers thought each IT course is too short and PCs and networks are too slow for IT curriculum. When asked about teaching time of each subject, a half thought teaching time was too short, and the other half thought it was appropriate. It is also notable that over a half of teachers said that IT contents were appropriate and two thirds thought the IT contents were somewhat effective.

Regarding to teacher's experience, 43% of teachers indicated that they had no programming experience while 28% had knowledge of programming but no experience and 29% had programming experience between 1-3 years. Twenty-three percent of teacher's experience in programming said that they had experience on PHP and C/C. In relation to database experience question, 38% of the teachers can use MySQL and 33% can use Access while 16% did not have experience with databases. About the network experience, the answer was somewhat scatter which 5% had no network experience, 8% could set firewall, 11% could set mail server, 11% could set DNS server, 12% could set FTP server, 7% could set SSH

server, 15% could install Linux/UNIX server, 11% could design LAN, and 4% could design WAN, and 6% could configure router.

From the question 88-106, the target audiences were students who mostly age between 11-20 years old (84%). Notably, more than half of student had no e-learning experience. However, over 80% express interest in e-learning. More than 80% of students think e-learning is helpful.

Regarding to student's experience, almost half on students find IT class is difficult. 23% of students indicated that they had attended GIMP from the school. About coding experience only less than 20% of students have coding experience. Surprisingly, most of respondents (43%) had no programming experience. Meanwhile 20% of the student use PHP program. Moreover, 72% of respondents had no database experience. Only less than 20% of students have some network setup experience.

In response to the question "Do you study other than in the class" by 39% students study 1-2 hours per week and by 32% 3- 4 hours per week. Almost all students study IT during the night by 80%.

Nonetheless, top three desktop software for students are Word, Excel and GIMP. The IT subjects, that most of students are interested to take in the future, are GIMP, Linux and Computer network respectively.

The less of the questions were asked generic questions and the survey founds that Word, Dreamweaver and Excel are the top 3 desktop applications used by teachers. Lastly, the answer of use of IT in future was roughly equally split between Computer Network building, Web page creation, Online library system, Computer security, and two others, each with 12-18%

6. Conclusion

Conclusion from the Base line survey and the Technology Trend survey

Mae Hon Son schools are still lacking of PCs comparing to the number of students. The speed of the Internet connection is not adequate for the bandwidth demanded by the application such as streaming video, eLearning. The instability of electricity such as blackout, voltage fluctuation is a major challenge in Mae Hong Son. It may cause the service interruption and the hardware failure. Most of organizations do not have enough IT administrator or IT trained personnel especially in the wireless technology area. Therefore, this project foresees some impacts on how people or students access the Internet.

Conclusion from the Demand Survey

Mae Hong Son needs to increase the number of qualified IT teachers in order to raise the standard of the local IT education. Subjects such as computer networking and web design are two of the most sought after subjects. E-Learning systems can be used to accompany teaching activities. However, skills to operate such systems as well as contents for various subjects are still lacking. Teachers already realize that eLearning systems can be useful as teaching management tools. Therefore, it is timely for this project to proceed in the area of eLearning system training and content management and creation.

7. Action in Future / recommendations

Electricity problem must be solved but it requires the significant resource and concerns the number of parties such as Mae Hong Son government, Electricity Authority, the policy from the central government. This issue must be addressed and clearly planned from associated organizations. Due to the geographical characteristics of Mae Hong Son, the wireless technology play the vital role in providing the Internet access to people with lower cost. Providing the wireless infrastructure and training personnel are considered important. For those issues found in the Technology Trend survey shall be revisited to consider their solutions and followed up further to conduct hearings by the project. With the results and recommendations accompanied, the project shall make a proposition to donors such as JICA for its resolutions.

IT education standard in MHS must be raised somehow. One way to achieve such goal is to start with the same teaching standard all over the region. eLearning system is a part of the solution. It can be used to assist local teachers as learning tool and learning management tool. Therefore, it is strongly recommended as future action to arrange a series of eLearning and content development workshops to train local teachers as well as other local people who are interested in teaching their skills to local children. Also, sustainable model to disseminate the knowledge gained by these local teachers must be developed and the model shall present of how to share the gained knowledge within the local group in the future.

For future impact survey planned in a half of year and a year after the service launch, by learning from this time of base line survey, the project shall consider a survey plan as to method of impact measuring and define indicators in each areas for future impact survey and elaborate the plan in accordance with each of the indicators defined along the surveyed items from this baseline survey. EOF

Case Study Report on WiMAX projects in the Kingdom of Thailand

HRD-WiMAX Project

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Appendix

1. Interview.xls : Questionnaire for the interviews conducted
2. MaeFahRuang-WiMAX.pdf : MFU project Presentation slides
3. Agenda_ChiengraiSiteVisit.doc: CCKPH project Presentation slides

Background

Due to a delay in the original delivery schedule of test equipments that JICA headquarter plans to procure for the HRD-WiMAX project, NECTEC has accepted a proposal to take a field trip as a part of additional trainings to visit and research other ongoing WiMAX related projects being conducted by National Telecommunication Committee (hereinafter, referred to as "NTC") for the case study.

1. Objective of the case study

The objective of the case study is to gain knowledge and learn through the similar projects that NTC is currently carrying out, so that the project can share the ideas and utilize any success factors that would be contributed from the related projects. Also, eventually to share information, ideas and lessons learnt in different projects to smoothly conduct such projects within an alliance of these projects.

2. Goal of the case study

The goal of this field trip is, as an part of technology transfer, for NECTEC personnel to gain as much knowledge as possible from two projects, namely, "Pilot Project of Tele-Center for rural area Education and development" (hereinafter refer to as "the Tele-Center Project") and "The Apply of WiMAX for establishing Communication Channel between Chiankhong Crown Prince Hospital (hereinafter, referred to as "CKCPH") and each destination" (hereinafter refer to as "the CKCPH Project") currently being conducted by NTC and to research and learn success tips for further proceedings of the project.

3. Outline of case study

(1) Case study team (hereinafter refer to as "the team") members

NTC hosted the trip and kindly coordinated time table and appointments with the target interviewees on behalf of NECTEC and JICA team. NTC also requested service providers and the venders which implemented the WiMAX system to the target project sites to accompany with us to Chainrai for this trip. The members of the team who visited the project sites and their titles are as follows.

① NTC

Mr. WaresBorvonsin / Division Director / Universal Service Bureau / NTC

Mr. Peerachaid Pongsiri / Senior Officer / Universal Service Bureau / NTC

② NECTEC

Dr. Kitti Wongthavarawat

Dr. Supakorn Siddhichai

Mr. Kitiwat Limmongkol

Mr. Songrit Srilasak

③ JICA Study Team

Mr. Mamoru Yasui

Mr. Akira Kishimoto

Mr. Yoji Murakami

Ms. Mayuka Kobayashi

(2) Timetable of the field trip activities

No.	Date	Time	Site Visited	Activity	Attendees
①	Aug. 27th, 2009	10:30am -12:30pm	Mae Fah Luang University (MFU)	1) Presentation of the project overview of "Tele-Center of rural area Education development infrastructure model" ("the Tele-Center Project") 2) Interview and hearing from the project manager and the members.	Vice President of FMU, Ms. Nareewan Chintakanond, PM: Dr. Thongchai Yooyativong (Dean) Person from a service provider, TT&T Person from a vender, Jasmine
②		13:30pm - 14:30pm	Ban Maekhawtom Tasood School	Local user site visit	Princeptal and a teacher
③		14:30pm - 15:30pm	Wat Fung Min Wittaya School	Local user site visit	A teacher
④		15:30pm - 16:30pm	Srikerd School	Local user site visit	A network administrator
⑤	Aug. 28th, 2009	10:30am -12:30pm	Chiankhong Crown Prince Hospital (CKCPH)	1) Presentation of the project overview of The Apply of WiMAX for establishing Communication Channel between CKCPH and each destination" ("the CKCPH Project") 2) Interview and hearing from the project manager and the members.	President of CKCPH, Project members Person from a vender, NEC
⑥		14:30pm - 15:30pm	Sathan Primary Care Unit (PCU)	1) Local user site visit 2) Interview with a patient using WiMAX	Administrator, Patient (User)
⑦		15:30pm - 16:20pm	Chiankhong Crown Prince Hospital (CKCPH)	Base station visit	NEC, Project members from CKCPH

(3) Research items

In this case study at this time of field trip, the team interviewed with the key informants of the projects to obtain information items listed below.

- ④ Project related information
- ⑤ Technical items
- ⑥ About utilization of wireless technology
- ⑦ Impact of the project activities
- ⑧ Legal Issues

(* for more details, please references attached file "Interview.xls " for Questionnaire for the interviews conducted)

(4) Method of case study

In order to gather information listed in (3) above, the team interviewed with the three target group of key informants as below.

- ⑨ After each of the presentation sessions facilitated by the project managers and members, the team conducted hearing sessions to the project members to request information provision in regards to the project related information ((3) ①), about utilization of wireless technology ((3) ③), Impact of the project activities ((3) ④) and legal issues or concerns ((3) ⑤).
- ⑩ At each of the base station site visits, Japanese experts and NECTEC persons has take insight tour to survey technical information ((3) ②) at server rooms and antenna locations.
- ⑪ In light to the survey of usability and impacts ((3) ④) of the wireless system provided by these projects, the team conducted interviews to actual users of the wireless system.

(5) Findings from meetings and interviews at MFU project sites ((5) ①~④)

⑫ Mae Fah Luang University (MFU)



About MFU, an “University of Opportunity”

Vice president of MFU, Ms. Nareewan Chintakanond has made a welcome speech and kindly explained the history and background of MFU.

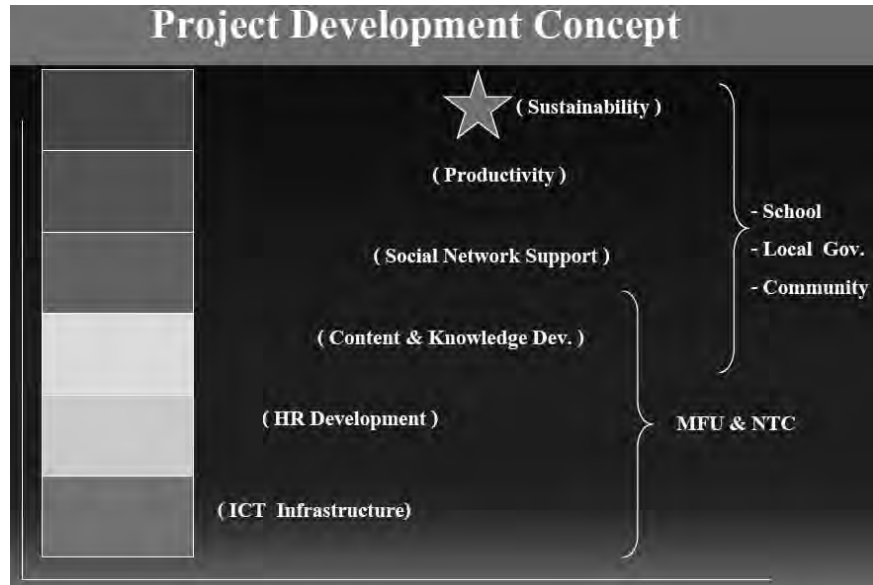
MFU is 10 years old university since its foundation in 1998 and its name of “Mae Fah Luang” comes from a meaning that Royal mother from the sky. The university currently has more than 8,000 students in variety of majors over 55 in such area as English, Science, Medical, Cosmetics, Computer and IT. MFU emphasizes strengthening relations with more than 20 foreign countries with almost 50 international academies by accepting more than 200 foreign students from abroad. MFU as autonomous school, is a public servant which is fully funded by Thai government. Also its private fund recourse collected by tuitions helps the university to manage its operation.

The proportion of government fund and private fund is 60:40. Even though MFU is a public servant, the employment of the teachers is in unique style like a private educational institution and bases on contract basis. As MFU's name come from a mother of the King, Kings Mother has contributed enormously to the establishment of the university and also for preserving the environment around the university to make it as the most beautiful University preserving nature like water recourse and natural forests. The slogan of MFU is to aim "An University of Opportunity" to equally provide opportunities to everyone.

About the project, "Tele-Center of rural area Education development infrastructure model" ("the Tele-Center Project")

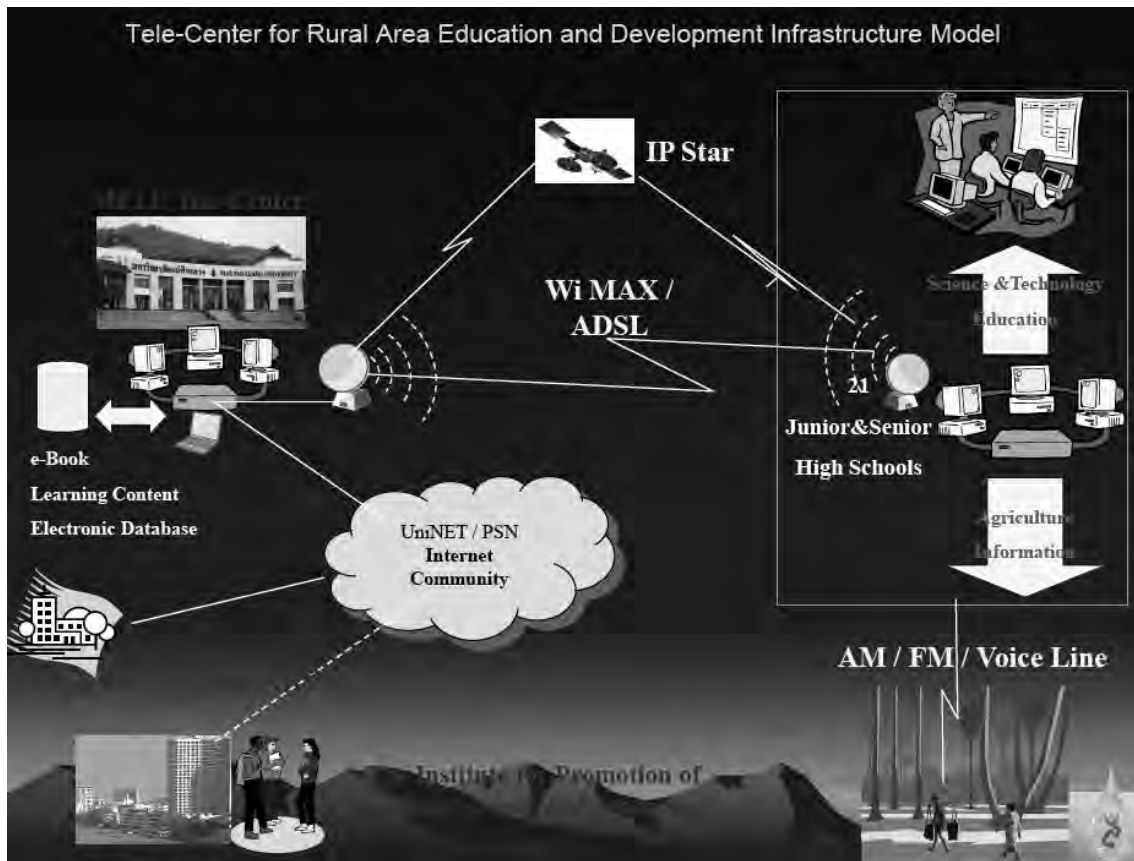
A dean of MFU, Dr. Thongchai Yooyativong is the project manager and he conducts the entire project at MFU with a support from a local network engineering service provider, TT & T. Dr. Thongchai Yooyativong presented the background of their project, "Tele-Center of rural area Education development infrastructure model" and the outline of his presentation is as follows.

This two-year project is fully funded by NTC with a budget size of 50 million THB and is also supported for the use of the existing frequency which belongs to NTC. The project was commenced in February, 2009 with 6 project members including the resource from the service provider to apply ICT to assist rural area especially in education area. The project phase are divided in 6 steps complying with its development Concept shown in the figure below, and the current status of the project is the implementation of step 3, Content & Knowledge Development and 4, Social Network Support.



The main objective of the project is to promote remote education by - A) developing high speed internet network infrastructure for the schools in rural area and B) developing human resource in local education scene in rural area.

For the A) aforementioned, the project established a network allowing 10GB class of inter school bandwidth. The target user sites are 21 middle-high schools and 15 local government offices in Chiangrai district. 400 pcs are donated by the project and all are connected to high speed internet using combination of various technologies such as WiMAX, Wi-Fi, IP satellite, and wired ADSL at the average throughput of 3 ~ 4Mbps per site. The project not only assists in developing network infrastructure, but also supports in provision of such applications as e-Learning, e-Book, VoIP, IP-VPN and Video conferencing system, etc. The infrastructure Model of the Tele-Center Project is as shown in the figure below.



As to the B) mentioned above, a comprehensive training program is currently provided by the project to 400 trainees at MFU in three stages of deployment, 1) MFU, 2) local schools to 3) the Community. Training subjects varies in the application areas as follows.

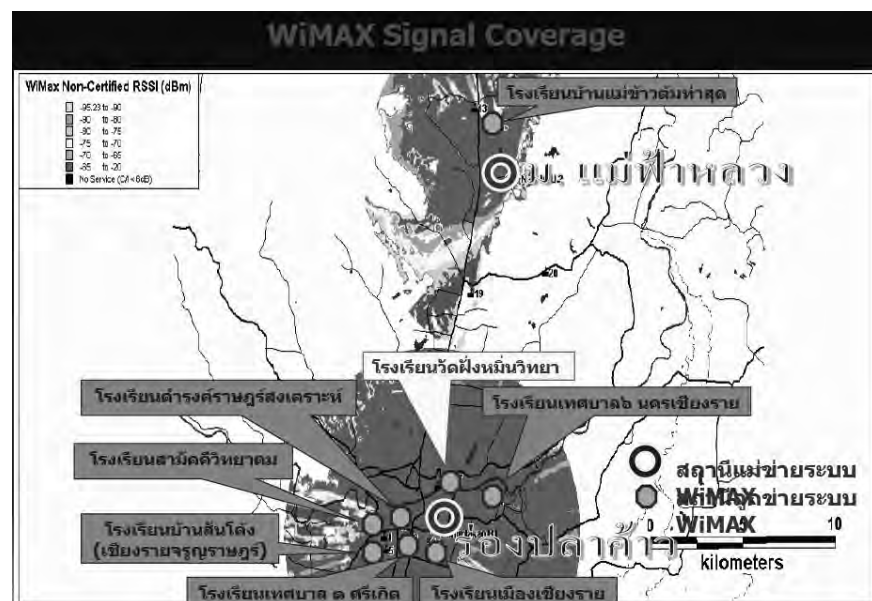
- Digital Content Development, Content Management System (CMS) such as “Joomla”
- “E-Book” content creation application developed by the project
- Learning Management System (LMS) such as “Moodle”, e-Learning
- Disk jockey application software for radio broadcasting, “Youth radio DJ Camp”
- 2D animation
- Web site creation
- HW maintenance, network design
- e-Commerce to promote One Town One Products (OTOP)
- e-Library

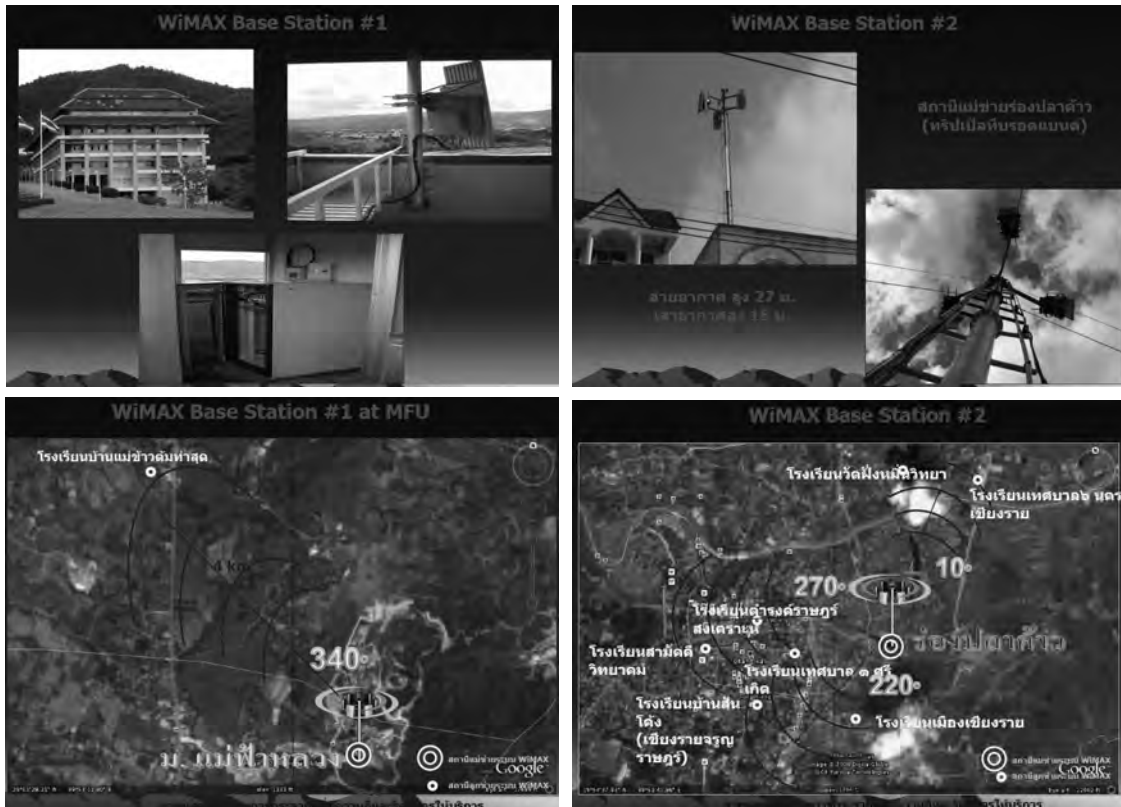
(* for more details, please references attached file “MaeFahRuang-WiMAX.pdf “ for Questionnaire for the interviews conducted)

About technical findings for WiMAX network infrastructure

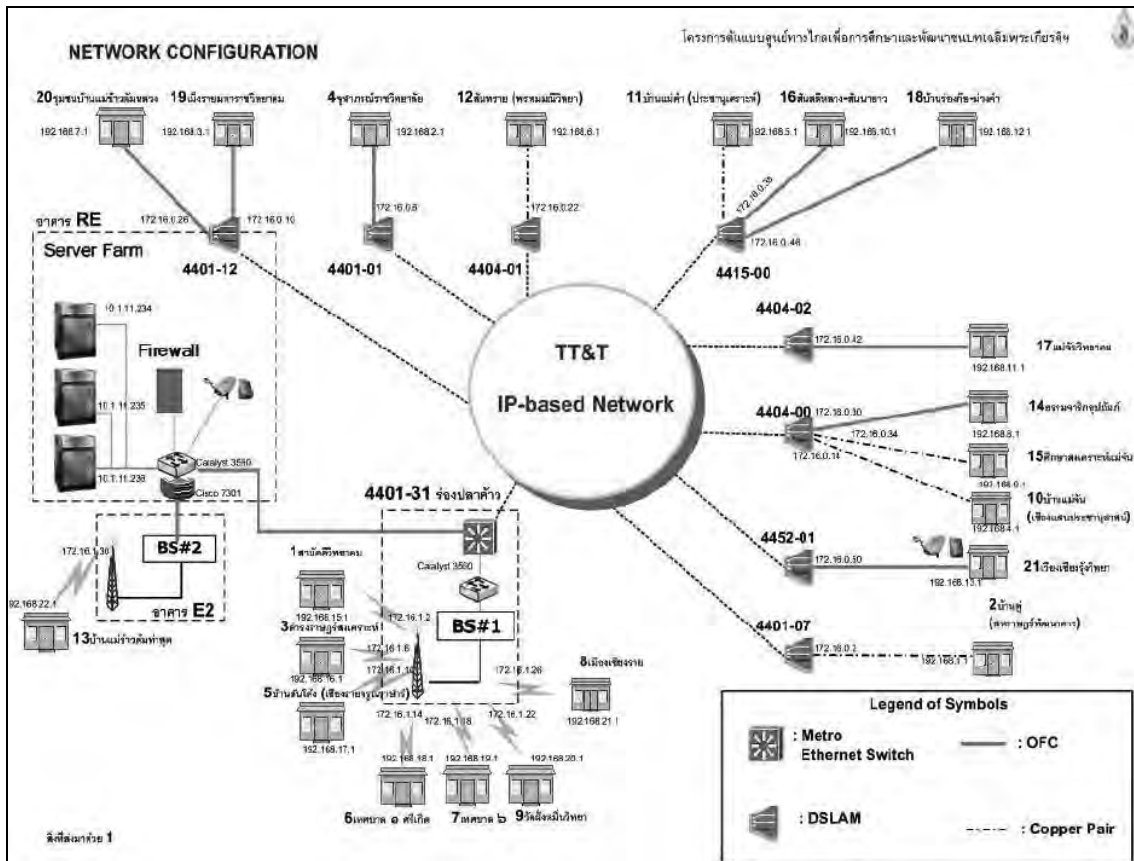
The Tele-Center Project implemented 2 base stations for the local distributions service in Chaingrai, one within the area of MFU campus and the other in the TT&T's telecom operation facility. The coverage of the WiMAX Signals is as shown in the diagram below.

Japanese experts found it interesting that the project adopted a design with unevenly balanced antenna angle configuration as for the sectoring method. Typically, in metropolitan areas, sectoring method of 120 degrees x 3 sectors or 60degrees x 6 sectors are adopted. However, in this project case, unevenly balanced sectoring in three sectors as 270 degrees + 220 degrees + 10 degrees is adopted. Perhaps, it is because it's designed considering the positioning of each site and the balancing of throughputs taken into account. This type of design is beneficial and can be referenced in the case of designing in the rural area with scattered site positioning.





The technical configuration of the network infrastructure is as shown in the diagram below. In regards to the network design, the project adopts topology of hybrid IP networking in the wide area IP network with the combination of DSLAM(A network device that bridges routers to high speed/volume backbone by binding multiple xDXL lines. A set of xDXL modems) of TT&T's backbone and OFC(Optical Fiber Communication) with WiMAX core and WiMAX access added. (Satellite network is also used partially.) This type of topology is similar to the IP networking planned for the HRD-WiMAX project and allows comprehensive IP network management by adding WiMAX technology to the existing IP network.



A procurement committee was formed for the equipment procurement. In 90 days, the project completed implementation of the WiMAX based network system vended by Cisco in October, 2008 and its technical specification and characteristics of the network infrastructure is as follows.

WiMAX Characteristics	
1. Frequency Range	: 2.496 – 2.690 GHz
2. Duplexing	: TDD
3. Channel Bandwidth	: 5 MHz
4. Air Interface Standard	: IEEE 802.16e
5. Max. power for Base station	: 40 W หรือ 46 dBm
6. Max power for CPE	: 1.25 W หรือ 31 dBm

Also the Tele-Center Project kindly shared the performance data obtained via

application testing and its results are as follows.

With respect to the performance, even though maximum throughput rated DL4.4Mbps/UL0.4Mbps does not seem magnificent, but the coverage area seen as 5.09km(450-650kbps) is remarkable with a condition being used as a terminal device of fixed external antenna. In regards to the reliability of the network, it can be said it is quite high since there is no packet loss and the delay stays in average of 88ms.

Features, Performance, & Applications Testing

Items	Results	Description
Network Entry	Satisfied	Use NavDiag Element Management System
Maximum DL/UL Throughput Test	Satisfied	DL: 4.4 Mbps (16QAM 3/4) UL: 0.4 Mbps (QPSK 1/2)
DL/UL Coverage Test	Satisfied	5.09 km with DL of 450-650 kbps
AMC Configuration Test	Satisfied	Automatic
Stability Test	Satisfied	No packet loss and 88 ms Avg. delay
Payphone	Satisfied	
QoS Categories	Satisfied	UGS, BE
Mobility Feature	Satisfied	Fixed and nomadic only

Features, Performance, & Applications Testing

Performance

	<u>Eqpt. Spec.</u>	<u>Results</u>
Delay	Max. 150 ms	90 ms
% Packet Loss	Max. 0%	0%
RSSI	Min. -80 dBm	-75 to -62 dBm
CINR	Min. 6 dB	21 to 34 dB

Applications

	<u>Spec.</u>	<u>Results</u>
IP-VPN DL	Min. 3 Mbit/s	4.3 to 5 Mbit/s
UL	-	2.4 Mbit/s

Other Services

Video Conferencing	Satisfied
Video Streaming	Satisfied
VoIP	Satisfied
Data Transfer	Satisfied

WiMAX Coverage (Km)	Backbone	Band used (MHz)	IEEE Specification	Frequency (GHz)	Modulation TDD/FDD	BS Output W, (dbm)	Throughput(Mbps)		Delay (ms)
							DL	UL	
4 ~ 5 Km	TT&T	5Mhz	IEEE 802.16e	2.4GHz~ 2.6GHz	TDD	40W (46dbm)	4.4Mbps	0.4~4Mbps	90~150ms

Some of the technical issues for the infrastructure development still remained even after the implementation. Along with the system implementation and some test runs, project's technical staffs found that there was a heat dissipation problem on outdoor CPEs by direct sun heat. At over 70 degrees Celsius of the device temperature, there are many cases seen that the CPEs installed outdoor becomes unstable. The project collected and evaluated the CPE temperature data from some local sites and finally came up with the most adequate variable setting as for its temperatures to be set at between 50 to 70 degrees centigrade. The project team worked some ways around to solve this problem by inserting the CPE unit into a ventilate box to avoid direct sun light to the CPE. It is very beneficial variable found as its operational technique by geographical weather characteristics, which can be applied to other projects in other areas.

Since the project bases on the IEEE 802.16e specification, mobility was also tested by distributing USB CPEs to 40 trial student users and came to their conclusion that the system can be accessible up to 90km of its mobility speed.

In regards to the stability of the network, off course wireless WiMAX can not supersede the stability of the wired ADSL, however, the project evaluates that the network service level and stability of the network accessibility through two of the current WiMAX base stations are at satisfactory level.

About training and Human Resource Development (HRD)

According to the development target, the MFU Project aims to 3 major steps focusing on MFU, Schools and Community. The project is providing various trainings shown in the figure below by making the best use of the network infrastructure developed by the project.



The project points out that HRD is more difficult work compared to developing the network infrastructure, especially, for the selection of target teachers, target community and the information to be provided to these targets. The coordination work for lecturers for such trainings also is a burden to the project work load; however, the project has its advantage to be able to manage teacher’s scheduling as MFU has its own IT school inside of MFU. The interviewer asked the question if the project has ever encountered any similar issue arose in MHS that local trained teachers or instructors tends to get transferred to another work place in every two year basis complying with MOE’s policy and cannot retain these disseminators at one site. The project responds to the question, as it has NTC’s full support to newly train new comers quite frequently, the issue seems not that critical to the project.

The project developed and provided application software, called “e-Book” to assist students and teachers to create digital books. As described in the later section of this report, every school is well trained for the “e-Book” and it seems that it is the most disseminated and the most used application at the local user sites through this project. It is also often used by the teachers as their e-Learning material creation tool. Since the project’s focus is in education area, the participation of the local users in creating local contents is the key factor for future success.



About some episodes and lessons learnt from the project proceedings

The MFU project leader claims that the most difficulty the project has ever encountered was to fit the gap of the level of participating schools and also the development of content and applications are the easy part, but to using them is the most difficult part. The project size is rather small; however, MFU is confident to its IT education as it has its own IT schools internally at MFU.

At this time of case study, the team found that another success factor is a sustainable dissemination of the knowledge gained through the trainings. In this project, 8 schools of local sites co-founded a working group which has its responsibility to share the trained resource to train other instructors in the workgroup. This way, the project could overcome the issue for not being able to retain trained instructors even in case of organizational transfer of trained teacher resource in every two years.

The MFU Project is currently proceeding to next development step focusing on “Community Development” status by establishing local community relations and training content creation, e-Commerce and Radio station operations.

Impact and its indicators for measurement

MFU considers that the training is a key success factor, therefore, the project measures its impact by the indicators such as the number of Training conducted, number of trainees trained and trainee’s popularity for the training

classes.



⑬ Ban Maekhawtom Tasood School



About Ban Maekhawtom Tasood School, one of local site connected to the WiMAX system

The Tele-Center Project currently has 7 sites connected to the system, and the team has visited 3 sites at this time of case study. Ban Maekhawtom Tasood School(BMTS) is one of the 7 local sites which commenced the service in Oct, 2008. The school has 500 students from kindergarten to 9th grader. BMTS has its own computer room connected to the Internet via ADSL, but it was over occupied so, NTC donated to expand another new PC room facility with 40 PCs with Wi-Fi + WiMAX connection which limits its use only by the middle school students. The use of this new facility is mainly distinguished in two areas, one for content creation by using LMS and e-Book, and the other is in general use for search engine, web browsing, online games, etc. There is a web camera also installed to allow TV conferencing.



There are 30 teachers in this school aggressively teaching digital content creation to their students by using the “e-Book” application software developed by the Tele-Center project. (Content created by students Shown in the above picture.) These teachers also use an open source Learning Management System (LMS), “Moodle” to share content in a local server. BMTS is one of the aggressive users of e-Book and both teachers and students are utilizing the software to create digital content. The teachers use e-Book mainly for sharing created content between other teachers in other schools and also to create teaching materials for such subjects as Mathematics, English and Science. The students create their own e-Book content as for their assignments from their classes.

As the Tele-Center project emphasizes HRD by training programs, BMTS especially appreciates MFU’s training for e-Learning content creation. BMTS recognizes its role to disseminate the knowledge and technology trained through the Tele-Center project and mandates every e-Book trained teachers to teach others. BTMS also provides its own 40 hour PC training class.

About technical findings in the use of the WiMAX network infrastructure

BMTS is in the distance of 3km away from the project’s base station and the system performance is monitored by MFU at all time. The average performance of the accessibility to the Internet from new PC room is in the

range of 2 ~ 2.5Mbps at down link while the old computer room with ADSL connection provides the throughput of 2Mbps. The indoor CPE's RSSI performance is 61dbm and its temperature was at 56 degree Celsius. Through the interview, the team found that, compared to Mae Hong Song area, there are not many power outage issues arisen in Chaingrai. The supply of electricity in Chaingrai seems very stable since the school has not encountered any power outage in past 5 months.

Comparing with the situation in the HRD-WiMAX project, the stability of electricity supply in Chaingrai is remarkably secured; therefore, it seems there is no necessity of UPS implementation at each site. Japanese experts note that the communication throughput is a bit faster than ADSL connection, as it is ideal.

Impact and perception of the users

BMTS measured internet usage before and after the WiMAX implementation and concludes there was a dramatic increase in the number of students' usage. The administrator of the new PC room considers that students are more inspired to use PC and Internet. A teacher now needs to be stationed in the PC room to monitor students ever since the usage of the Internet increases and it resulted in being able to see much unwelcome content on the Net. Overall, the users at BMTS are very much satisfied in the facility and the quality of the service provided by the Tele-Center project and even willing to expand the size of the facility and the throughput performance.

⑭ Wat Fung Min Wittaya (WFMW) School



About Wat Fung Min Wittaya School (WFMW), one of local school site connected to the WiMAX system

WFMW is a school for Monks and has about 200 students from grade 9 to 12. The students will remain monks after they graduate from the school, therefore, the school remains teaching at least basic level of IT knowledge. Until WFMW participated in the project, it did not have any accessibility to the Internet, but after the project implementation, it has now two PC rooms, one with 20 PCs connected through WiMAX and the other with 40 PCs connected via ADSL.



About technical findings in the use of the WiMAX network infrastructure

WFMW is in the distance of 2km away from the Tele-Center project's base station and the system performance is monitored by MFU at all time. The average performance of the accessibility to the Internet via WiMAX infrastructure was 2.37Mbps at down link and 0,9Mbps at up link at the time of site visit. Two of the outdoor CPEs' are installed, one as an active master and the other is for a backup. RSSI performance for active CPE's RSSI is 81dbm and its temperature was at 68 degrees Celsius and for the back up, it was 84dbm at the temperature of 64 degrees Celsius. A router is installed and it automatically switches only if the RSSI value goes less than 80dbm.



It is notable that an indoor CPE is installed outdoor. As shown in the left picture above, the cable pulled out of a plastic box is attached to the higher place of wall and connected to the external antenna at the height of the roof. This way, even though it is installed under the eaves, because the temperature of the indoor CPE contained in the plastic box which lacks enough ventilation dramatically increases due to the direct sun heat, the internal air temperature appears to be up to 70 degrees and it causes the CPE malfunctions. When the temperature increases, the engineers are taking measures by opening the plastic box. By opening the box, the temperature tends to decrease down to below 60 degrees. It was not clear to the team why the project installed an indoor device to outdoor, but this may not be the best solution in terms of temperature, humidity and security reasons. The throughput performance seemed to be remarkable.

Impact and perception of the users

WFMW used to only use PCs as stand alone without the use of network at first, but since the WFLU Project started, usage of the PC with Internet increased as the users recognize as its impact. WFMW greatly appreciates MFU's cooperation in training to enable content creation by both teachers and the students.

⑮ Srikerd (SKD) School



About Ban Srikerd School, one of local school site connected to the WiMAX system

SKD is a local school site of the WFLU Project that teaches students from 1st grade to 9th grades and the number of the teachers is 66 teaching 1,100 students. SKD is considered as a center of the key schools in the area emphasizing in education and insists to expand the IT education system. Originally, SKD has a computer room with wired connection to the Net, but

at this time of opportunity, the MFU Project implemented a new PC room connected to Internet via WiMAX and Wi-Fi, which has about average of 100 users using the computer facility provided by the Tele-Center Project.

About technical findings in the use of the WiMAX network infrastructure

SKD is in the distance of 1.5km away from the Tele-Center project's base station and the system performance is monitored by MFU at all time. The average performance of the accessibility to the Internet via WiMAX infrastructure is 2.9Mbps at maximum and its average performance is 2.7Mbps. The indoor CPEs' are installed in a box to avoid rains as shown in the picture below.



Applications that SKD users use are mostly the content creation tool, "e-Book" provided by the Tele-Center Project for e-Learning content which is shared by MFU. An issue pointed out at this site was instability of the network. This is considered to have been occurring either by the Wi-Fi or WiMAX, but the cause is currently not clarified as of yet. The users seems satisfied with the current set up, however, their preference is a "faster" system as always.

Here again, an indoor CPE is installed outdoor under the eaves. However, it is installed to the place has no affect by direct sun heat, there seems not be a temperature issue here. Since the location is in a distance of 1.5km from the base station, the throughput performance seems remarkable at 3Mbps of its speed.

Impact and perception of the users

SKD has developed a PC room reservation system, and by booking through the net, average of 100 users are booked for the use of the PC facility. As seen in the situation that SKD limits user's occupancy within one hour, the usage of the facility and its operation seem to be effective and efficient. As

the network administrator points out that children tends to rather be on the internet more than playing outside as they used to, even though most of the usage are for web browsing, the internet usage at SKD is indeed increased as its impact compare to before the Tele-Center Project.

Teachers are using OSS LMS, “Moodle” collocated in a different site, but the lack of current throughput performance via WiMAX does not allow to freely using the application. All 66 teachers used to use the Moodle until the day the system crashed, and then resulted that the only 10 teachers uses the application currently. This indicates that the operation is the network is keen to sustain the motivation of the users.

Another finding from the activities of SKD is the way of disseminating the knowledge gained by MFU training for teachers. Within the local school network, 8 schools form a workgroup and develop mutual IT curriculums. Therefore, IT trainers once trained by MFU can be shared by the workgroup. This way, the workgroup can share the trained resource within the workgroup even if any transfer of trained and skilled teachers is usually requested by MOE to move to other schools every two years.

(6) Findings from meetings and interviews at CCKPH project sites ((6) ①~③)

① Chiangkhong Crown Prince Hospital(CCKPH)



About Chiangkhong Crown Prince Hospital, one of local hospital site connected to the WiMAX system

CCKPH is a local hospital located in Chaiangkong area in Chiangrai province which is rather small town with a population of 60,000. CCKPH has 90 beds as a public hospital and is charge for the operation of 17 PCUs (Primary Care Unit) in the area. NTC has invested 20 million baht to this pilot project to run a trial for the WiMAX based the remote medical system. Dr. Somprat Munjit, a director of management and the operation of the CCKPH takes an initiative of this CCKPH project, and as he takes fully

charge of the project, it is indeed a ideal model for a new project implementation.



About the project, “The Apply of WiMAX for establishing Communication Channel between CKCPH and each destination”



In prior to the Project implementation, CKCPH has taken preparation activities in December, 2008 as a preliminary case study. This preliminary case study was conducted as a pilot project at Lomsal Hospital with 4 working officers participated from MOPH (Ministry of Public Health) and 17 persons assigned from CKCPH and 3 PCUs. CKCPH set up a Working Executive Committee which consists of 4 board members and 11 proceeding Committee members to handle and manage WiMAX issues. Before the trial was commenced, training was put in place to train 4 administrators for 9 days and 16 operation officers for 3 days, both taken place in January, 2009.

The CKCPH Project started WiMAX system implementation in Aug., 2008 and completed in Dec. of 2008 followed by the service commencement in Jan. 2009. It seems that the implementation went smoothly in rather short time period, because of the preliminary pilot project conducted at Lomsal Hospital. The CKCPH project team is structured with 20 members who consist of 4 administrators and 16 operators, fully managed and operated by NTC fund of 20 million baht. The project aims for the trial of WiMAX technology utilization in the medical field.

The system provides major application features such as Video Conference, data transfer of patients' data as well as the data for PCU service jobs and Internet accessibility via WiMAX. A simple video conference application enables remote diagnosis so called "Tele-health" service at CKCPH between the hospital and 3 PCUs connected via WiMAX. The image of the Tele-health service with WiMAX is as shown in the pictures below.

Image of Tele-health service with WiMAX system



The video conference system is also utilized as a tele-medicine as well, so that patients not only can have a remote diagnosis, but also can be provided with the prescriptions after the diagnosis.

VOIP is used to inter-communicate with other sites and it is very much appreciated by the users. The list of major activity supported by WiMAX system is as shown in the diagram below.

Activity list that will be supported by W MAX System

Item	Description
1	Vedio Conference - Consult Case - The existing Telephony communication such as Telephone service will be replaced with VoIP / WIMAX.
2	Send & Receive Data - OP/PP Data (12/18 Folders) - TBH_DB.MDB (Data base of service job for PCU) - High definition Image files
3	Refer Case such as DM,HT,COPD ,,etc
4	Calling Medical Record from Data base of CKCPH (Hospital) (HospitalOS + HospitalOS PCU)
5	Internet via CKCPH(hospital) 's system



The project plans to start providing medical knowledge through the system in the future and also to facilitate a log analysis feature to see the usage of ftp and IP-phones.

(* for more details, please references attached file “Agenda_ChiengraiSiteVisit.doc“ for Questionnaire for the interviews conducted)

About technical findings for WiMAX network infrastructure

The CKCPH Project implemented 1 base station that includes ASN, BS, AS and CME for the local distributions service in Chiang Khong with a support from the vender, NEC. There are 4 fixed WiMAX access stations with PCs equipped with camera, IP phone and IP-Camera. The project enhances its scope of the experimentation out to mobility trial as well. The project implemented several stations equipped in the emergency vehicle (ambulance) to measure the mobility performance. The case study team measured the throughput performance, and when using ftp, DL was 8.3Mbps and UL was 1.3Mbps, and when using IP-phone, DL was 224Mbps and so was UL. This indicates it is showing decent performance at the use of each application.

The technical configuration of the network infrastructure is as shown in the diagram below. The configuration of the core system is minimally configured with base station, ASN, VoIP gateway and file server to enable the features as IP phone, file share and TV phone.

The Apply of WiMAX for establishing new Communication Channel

between CKCPH and each Destination.

WiMAX Core Center (ASN , BS , AS , CME)

7. Mobile Terminal

Notebook PC+ Camera, Softphone



6 Mobile Terminal
Notebook PC+ Camera, Softphone

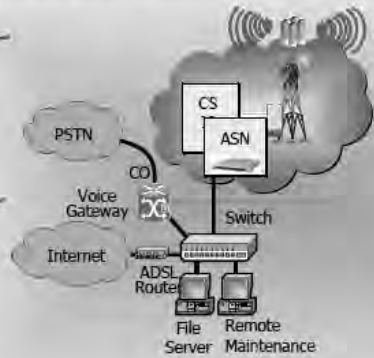


8. Mobile Terminal

Notebook PC+ Camera, Softphone



5. Mobile Terminal
Notebook PC+ Camera, Softphone



Fix WiMAX Access Station # 1 (Center)
PC+ Camera, IP Phone, IP-Camera



Fix WiMAX Access Station # 2 (Satarn PCU)
PC+ Camera, IP Phone, IP-Camera



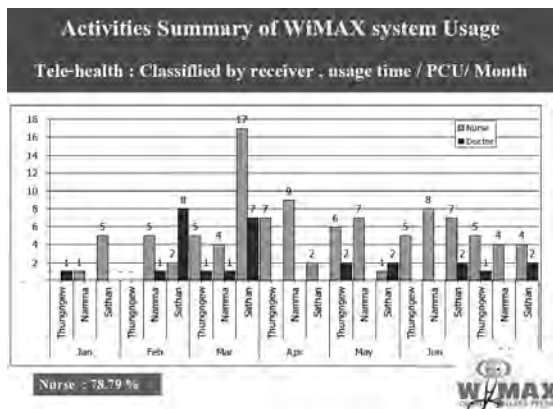
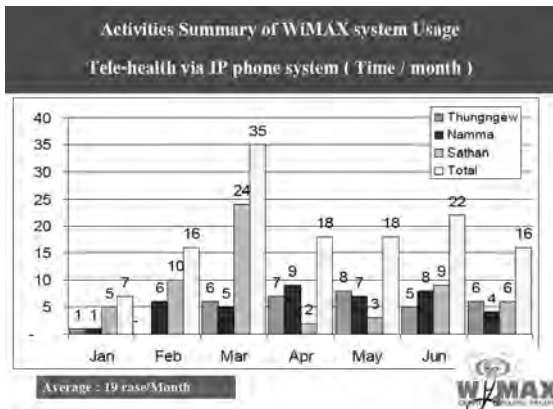
Fix WiMAX Access Station # 3 (Thung Ngwe PCU)
PC+ Camera, IP Phone, IP-Camera



Fix WiMAX Access Station # 4 (Lao's BorKaew or Numma PCU)
PC+ Camera, IP Phone, IP-Camera

Impact and perception of the users

CKCPH measures the impact of the project achievement through setting indicators such as IP phone system usage by times/month and by usage time/PCU/ Month and also tele-health system usage by times/month by 5 major disorders.



As for the ftp usage file size transferred in kbps is taken as the indicator for the impact measurement.

**Activities Summary of WiMAX system Usage
Communication & File Transfer service**

	FTP	Communication	
	Freq	Size (MB)	Freq
Namma	9	106.80	38
Sathan	5	59.20	41
Thunggew	13	62.40	96
Total	27	169.40	175
	Upload	Download	
FTP	1,798.11 Kbps	12,184.72 Kbps	
IP Phone	224 Kbps	224 Kbps	

Remark : There is many cases that not be recored

Resolution : Investigate data from Log file.



As seen in results of the measurement in usage above, the tele-health system usage is at average of 19 cases per month, and despite the fact of such short time period of implementation, the impact has been already seen in numbers. Even though there is a deviation in the results depended on the PCUs, as shown in the number, it looks like well utilized.

There seems to be some technical difficulties seen in the practical use of the VOIP system, such troubles as the First –Call of each day always need 2 times restarting, Call Manager (CME) will not re-connect by automatically when connection is loss, or Voice condition of VoIP call is delay. Also, instability of power source was pointed out as an issue for system operation.

From the perspective of the CKCPH, there are impacts in two major areas, one for dramatic reduction of patients visiting the hospital by the use of Tele-health service and the other for better communication by the best use of VOIP.

The above are the notable impacts seen by the simple TV-phone application provided by Cisco. It is important to note and have learned that there is not a always a necessity of complicated applications to meet user demand. A quite

simple application such as TV-phone can bring maximum impact as long as it suites local user demand.

⑰ Sathern PCU(Primary care unit)

About Sathernl PCU, one of PCU site connected to the WiMAX system



Satern PCU is a one of the 3 PCU sites connected to WiMAX and located at about 20 minutes away from the CKCPH. It is considered to be one of the typical user sites of Tele-health services.

Impact and perception of the users

Through an interview of one patient frequently takes advantage of the Tele-health service provided in Sathern PCU, a great impact have already been seen even within such a short time after the implementation. First, the transportation time with her child to CKCPH used to be about 20 minutes one way, with the Tele-health service, since the patient does not have to come all the way to CKCPH, it now only takes about 5 minutes. This patient is a child and as we interview patient's mother, especially the great impact in saving transportation and waiting time were well recognized. When the mother was taking her son to the hospital, it used to take from 7:00am to at least 17:00pm usually just to get to meet doctor for 3~4 minutes diagnosis and one more hour to get prescribed medicine. With the tele-health system facilitated in PCU, the waiting time became less than 5~10 minutes versus 11 hours when visiting hospital physically. The interviewee strongly requested to increase the number of Tele-health services enabled PCUs in near future. Therefore, the merits were brought to patient users already by not having to come to the hospital every time for such simple transactions as blood test and/or prescriptions.

⑱ Chiangkhong Crown Prince Hospital(CCKPH) base station site

About CCKPH base station site



CCKPH project has its base station located in the back side of the hospital. WiMAX base station system at the site is all equipped with NEC brand products. The NEC base station products installed in the period of project implementation may not have been the mass production units. By taking look at the base station equipments, it gave the experts an impression that looked like prototype units without any brand. The antenna and tower set ups seemed to have built solid and robust, and comparing with other antennas facility typically seen in Thailand, it is obvious this facility is sturdier at a glance.

About technical findings in the use of the WiMAX network infrastructure

Network configuration seems very simple. Lesser equipments results lesser troubles; therefore, the features rarely being used shall be eliminated as much as possible and make the system as simple as possible to reduce the chance of any future troubles, especially, for the system operating in the mission critical medical environment. The team leaned from this case that system design should be deliberated with taken the above into account.

(7) Others

Through the series of interviews, the case study team found that, compared to Mae Hong Song area, there are not many power outage issues arisen in Chaingrai. The supply of electricity in Chaingrai seems very stable since the school has not encountered any power outage in past 5 months. The

geographical and weather characteristics may be similar between Chaingrai and Maehongson which is NECTEC's HRD-WiMAX project site, but the base infrastructural condition such as electricity supply to utilize IT between these two areas is different and incomparable.

4. Summary of findings and conclusion of the case study

(1) Conclusion

From this time of case study, the team learned from ongoing WiMAX related projects in Chaingrai the key success factors and ideas that could apply to HRD-WiMAX project at NECTEC. The team concludes the key success factors and some applicable ideas learnt from the study as follows.

1. Trainings for HRD is critical for the utilization of the WiMAX network infrastructure

The MFU project manager points out that HRD is more difficult task compared to developing the network infrastructure. Through the series of interviews the team conducted against the end users of the systems, the team learned that the user's appreciation for MFU's effort in training users accelerates the usage of the system and make users motivated. With the advantages of MFU holding its own IT school, MFU seems to be successful in the HRD process taking advantage of its existing management capability of lecturer resource and learning material development. Also, the scheme of the training and types of curriculums being trained at MFU can be beneficial in further proceedings of training plan of HRD-WiMAX project in MHS.

2. Teachers Workgroup to retain trainers locally is valid to retain the instructor resource and its knowledge.

MFU project may be a fortunate case for that the participating schools are very aggressive and sustainable as to their knowledge retention. Through the interviews to MHS teacher participants in HRD-WiMAX project, there were many voices heard concerning periodical transfers of trained teachers to comply with MOE's reorganization orders. That would be resulted as an obstacle to retain the trained instructors in the future. Learning from MFU's project case, establishing a workgroup or teachers' association to found a mutual trained resource pool, so that if any transfer occurs, the workgroup (or association) can share the resource and self nurture the

instructors within the group. This also is one of the key success factor proven by MFU.

3. Impact measurement and indicators, methods

The team had findings in the measurement of impact of the project. In the MFU case for the training phase, the project defined important indicators for impact measurement on training such as the number of trainings conducted, number of trainees trained, trainee's popularity for the training classes and also importantly, the selection of target teachers, target community and the information to be provided to these targets were recognized valid by the team, and these indicators can further be referenced to HRD-WiMAX project in MHS for future impact surveys.

In case of CCKPH project, numbers of the system users, outpatients reduced by the system, ftp file size seems to be set as indicators. The team was expecting not only for the indicators to measure the impact, but also the hypothesis that later will contribute to consider the design of future impact survey. Unfortunately, any referable example of impact survey and its method could not be found from this time of case study.

4. Simple Application based on the demand

Amazing impact within a short period was actually recognized by the users of Tele-health system implemented by the CCKPH project. The team analyzes the cause of the impact comes from the system that is exactly meeting the local demand. The hospital intended to reduce outpatient's numbers while patients demanded to reduce the time of having to be at the hospital. In this case, the system and the wireless technology have actually met the local needs and when the system fit to the demands, the dissemination of the system use goes rather smooth. The amazing point is that the system is not such complicated software and is just a simple off-the-shelf TV phone system was the key to meet the demands. There, the team realizes the application must comply with the local demands such for the local service vender and the users from both ends.

5. Stable operation of the network is keen to the motivation of the users

As seen in the case at one of the schools of MFU project, once the system

goes down for a certain period and continued unmaintained, the user behaves and tends to abandon from using the system. Learning from this past problem in other project, maintenance of the system, both infrastructure and application is a key issue considering encountering problem in operation every daily basis. In order to maintain the system stably, considering the scheme of training and raising the technical skill set of the local maintenance resource is strongly demanded.

6. Establishment of a workgroup to mutually study and share project related information within an alliance of NTC, MFU, CCKPH and HRD-WiMAX were proposed to NTC by MFU.

At last, the team would like sincerely extend its appreciation in cooperation in presenting each project at MFU and CCKPH, and also, NTC for the arrangement of the case study tour this time. The HRD-WiMAX team is looking forward to meet with the related project members in near future and kindly request NTC for its cooperation in forming a workgroup among of the WiMAX related projects in The Kingdom of Thailand.

EOF

National Electric and Computer Technology Center (NECTEC)

Wireless Innovation and Security Laboratory (WIS)

WiMAX System Operation

Version 3.0

February 10, 2012

National Electric and Computer Technology Center (NECTEC)

[Revision History]

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1.0	2010/10/06	The first edition	Komate J.	Dr. Kitti
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3.0	2012/10/02	The third edition	Worawath P.	Dr. Kitti

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Definition

MHS = แม่ฮ่องสอน (Mae Hong Sorn)

MSR = แม่สะเรียง (Mae Sa Riang)

PAI = ปาย (Pai)

HD = Help Desk

SD = Support Desk

SC1 = Support Center 1

SC2 = Support Center 2

NECTEC = National Electric and Computer Technology Center

GOV = หน่วยงานของรัฐ (Government)

SCH = โรงเรียน (School)

COM = ชุมชน (Community)

VOIP = Voice Over IP

BS = สถานีข่าย Base Station

CPE= อุปกรณ์ลูกข่าย Customer Premises Equipment

GPS= ระบบบอกตำแหน่งบนพื้นผิวโลก Global Positioning System

UPS= เครื่องสำรองไฟฟ้าและปรับแรงดันไฟฟ้าอัตโนมัติ Uninterruptible Power Supply

1. โครงสร้างการบริหารจัดการ (Organization) (HD , SD , SC)

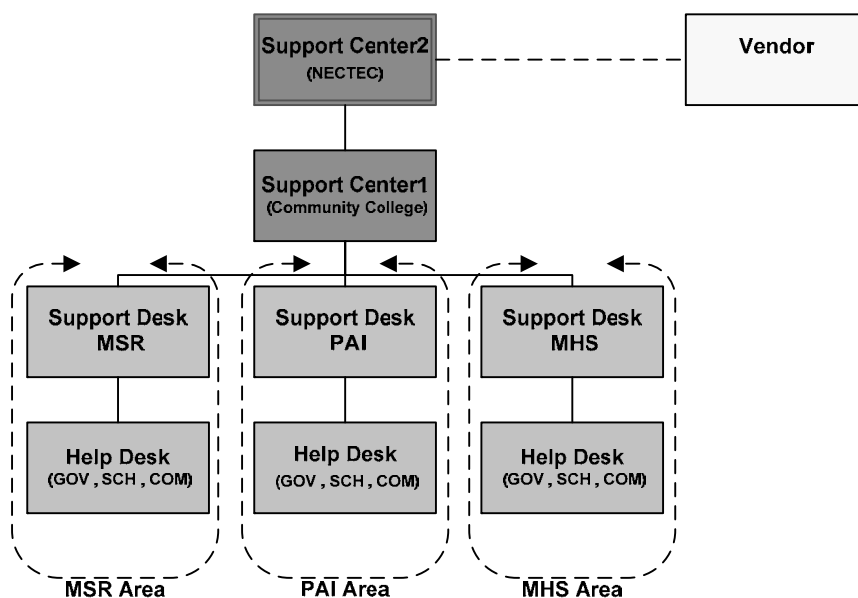
1. ผู้ดูแลระบบของหน่วยงาน (Helpdesk) ได้แก่
 - GOV (Government)
 - SCH (School)
 - COM (Community)

2. ผู้ดูแลระบบพื้นที่ (Support Desk) ได้แก่
 - PAI
 - MHS
 - MSR

3. ผู้ดูแลระบบแม่ฮ่องสอน (Support Center)
 - MHS

4. Vendor
 - Yamato (UPS)
 - Hatari (Tower)
 - Alavarion (WiMAX)
 - HP (Server)
 - Blue Coat (L7 Firewall)
 - Dell (Desktop PC)
 - D-Link (SW L2, L3)
 - Garmin (GPS)
 - Power Metric (UPS)
 - TELCOM (ADSL router)
 - Well Tech Taiwan (VoIP Phone)
 - ECS Thailand (Storage Unit)

HELPDESK ORGANIZATION CHART



2. บทบาทและหน้าที่ (Role) (HD , SD , SC)

1. ผู้ดูแลระบบของหน่วยงาน (Helpdesk)

- ดูแลรักษาอุปกรณ์ระบบ WiMAX ให้อยู่ในสภาพพร้อมใช้และครบถ้วน
 - ตัวอย่างเช่น การจัดเก็บอุปกรณ์ การนับจำนวนอุปกรณ์ การใช้งานอย่างถูกต้องเหมาะสม การดูแลสายสัญญาณ สายไฟต่างๆ
- ดูแล Software ที่ติดตั้งบนเครื่อง PC
 - ตัวอย่างเช่น การ Update Antivirus, การ Patch OS
- การสร้างและดูแล Account ของผู้ใช้งานระบบ WiMAX
- ให้การสนับสนุนผู้ใช้งานผ่านระบบ WiMAX เช่น การใช้งาน Videoconference การใช้งาน VoIP การใช้งาน eLearning เป็นต้น
- แก้ไขปัญหาเบื้องต้นกับอุปกรณ์ระบบ WiMAX
- แจ้งเหตุขัดข้องแก่ผู้ดูแลระบบของพื้นที่

2. ผู้ดูแลระบบพื้นที่ (Support Desk)

- สนับสนุนและดูแลระบบในพื้นที่
- สนับสนุนดูแลสถานีฐานในพื้นที่
 - ประสานงานกับผู้ดูแลระบบแม่ฮ่องสอนในการดูแลสถานีฐาน
- แจ้งเหตุขัดข้องกับผู้ดูแลระบบแม่ฮ่องสอน

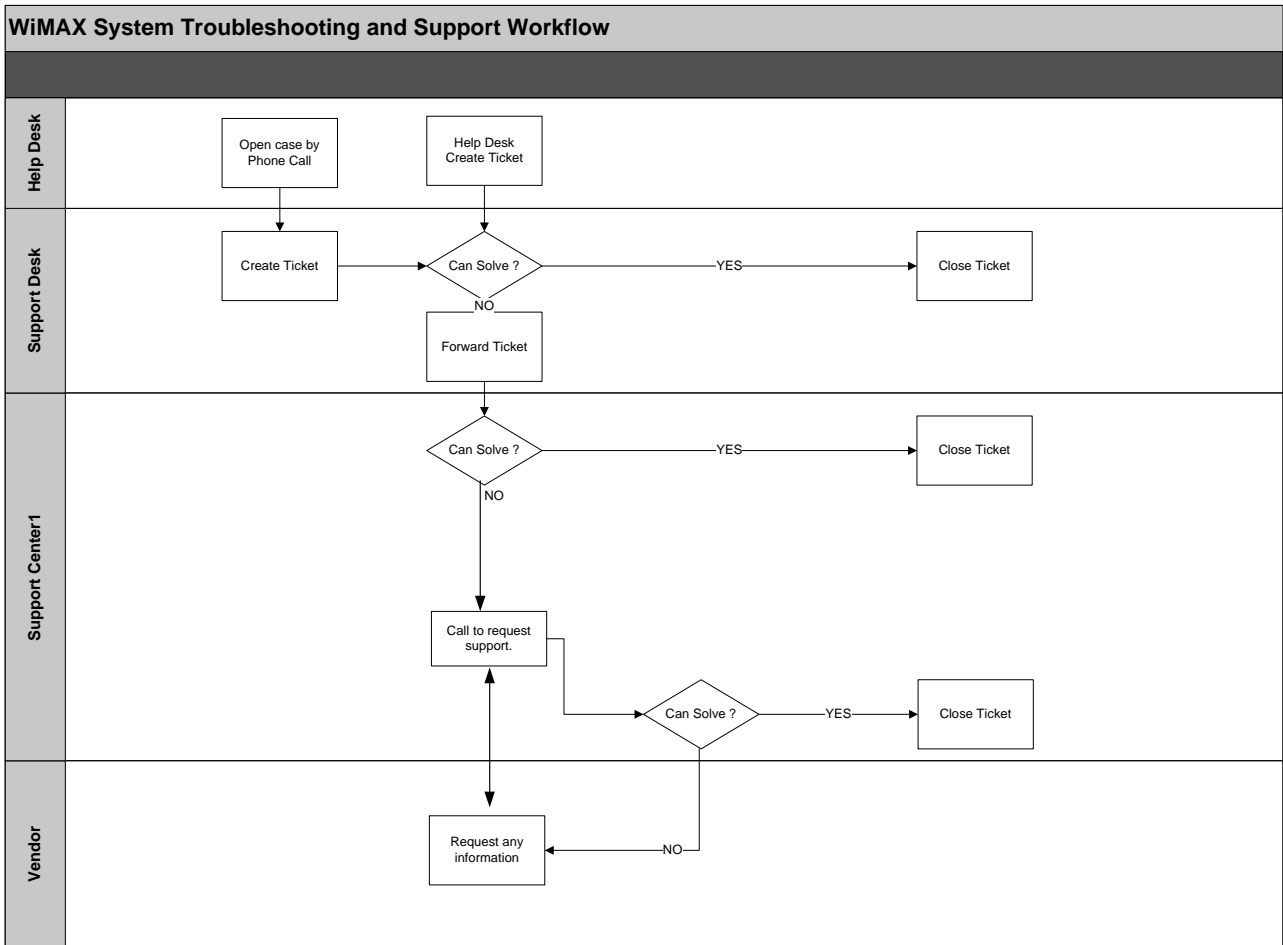
3. ผู้ดูแลระบบแม่ฮ่องสอน (Support Center1)

- ประจำอยู่ที่อำเภอเมือง
- สนับสนุนดูแลผู้ดูแลระบบพื้นที่ และผู้ดูแลระบบหน่วยงาน
- ประสานงานกับ Vendor ในกรณีที่ไม่สามารถแก้ไขปัญหาได้

4. Vendor

- เป็นผู้เชี่ยวชาญเกี่ยวกับอุปกรณ์ต่างๆหรือเป็นผู้เชี่ยวชาญเกี่ยวกับระบบ WiMAX
- ให้คำปรึกษาหรือแก้ไขปัญหาที่เกิดขึ้นต่างๆ จากผู้ดูแลระบบของแม่ฮ่องสอน

3. WiMAX System Troubleshooting and Support Workflow (HD , SD , SC)

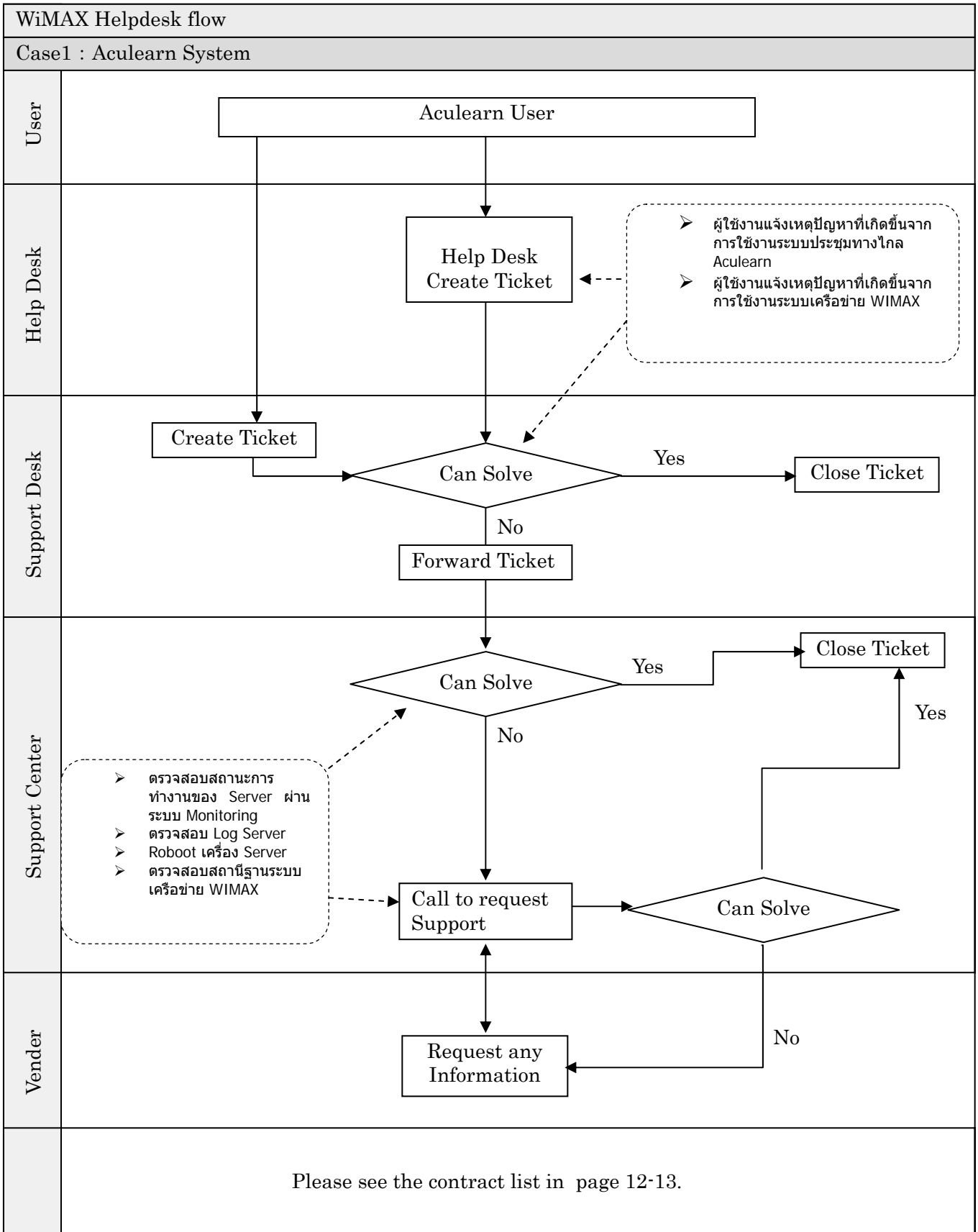


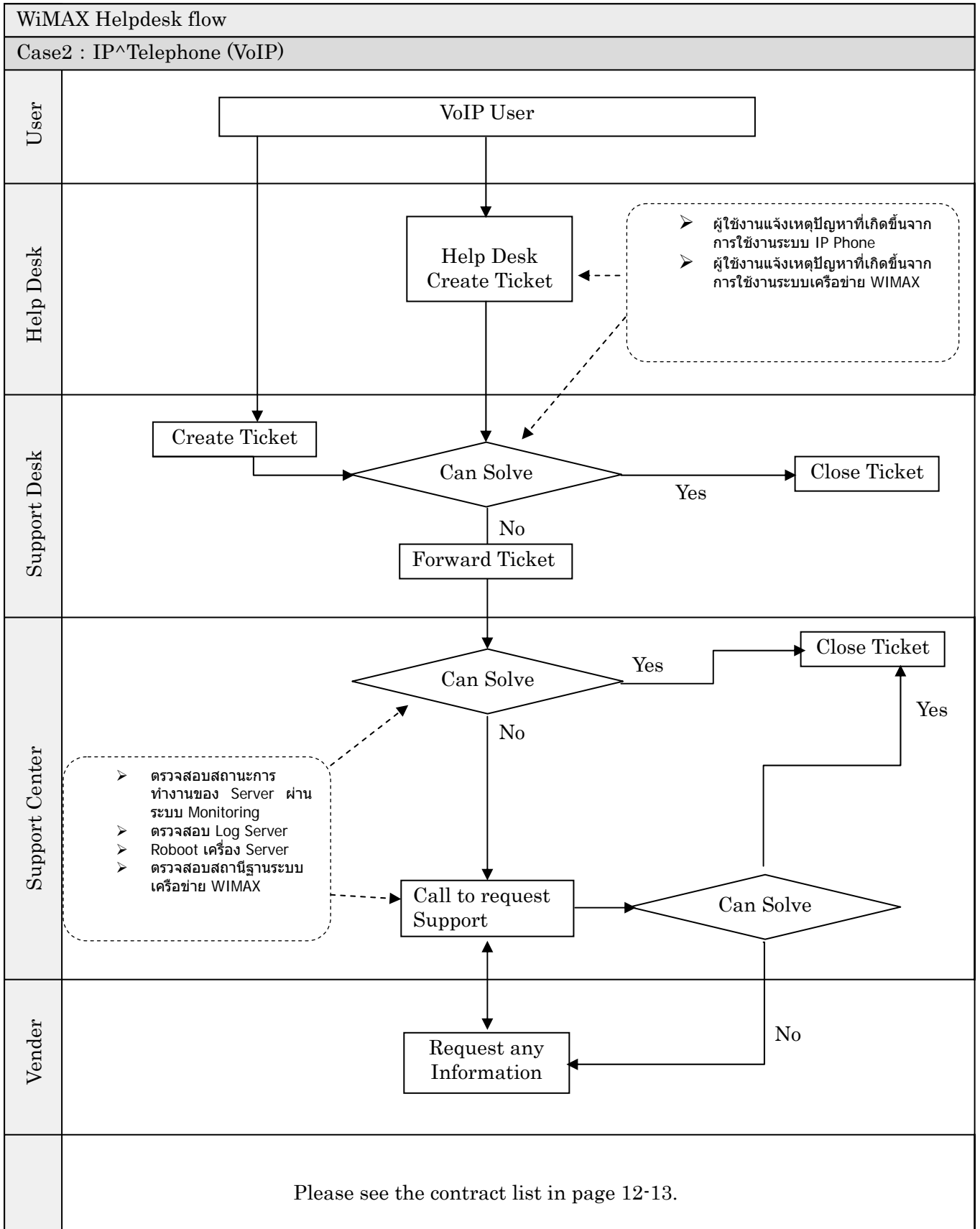
Workflow Description

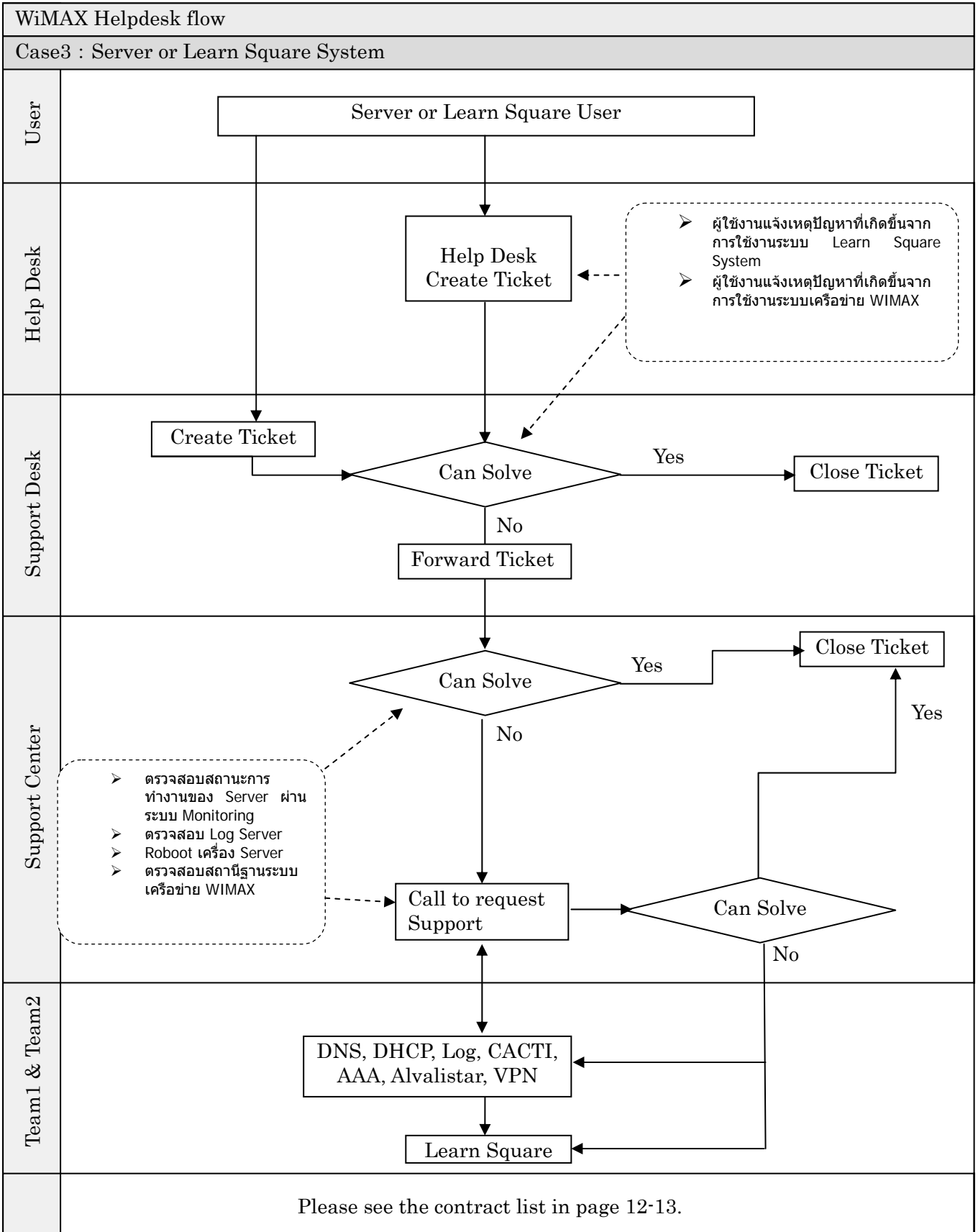
- ผู้ใช้งานระบบสามารถแจ้งขอรับการแก้ไขปัญหาได้ 2 ทางคือ
 1. ทางระบบ WiMAX Helpdesk System

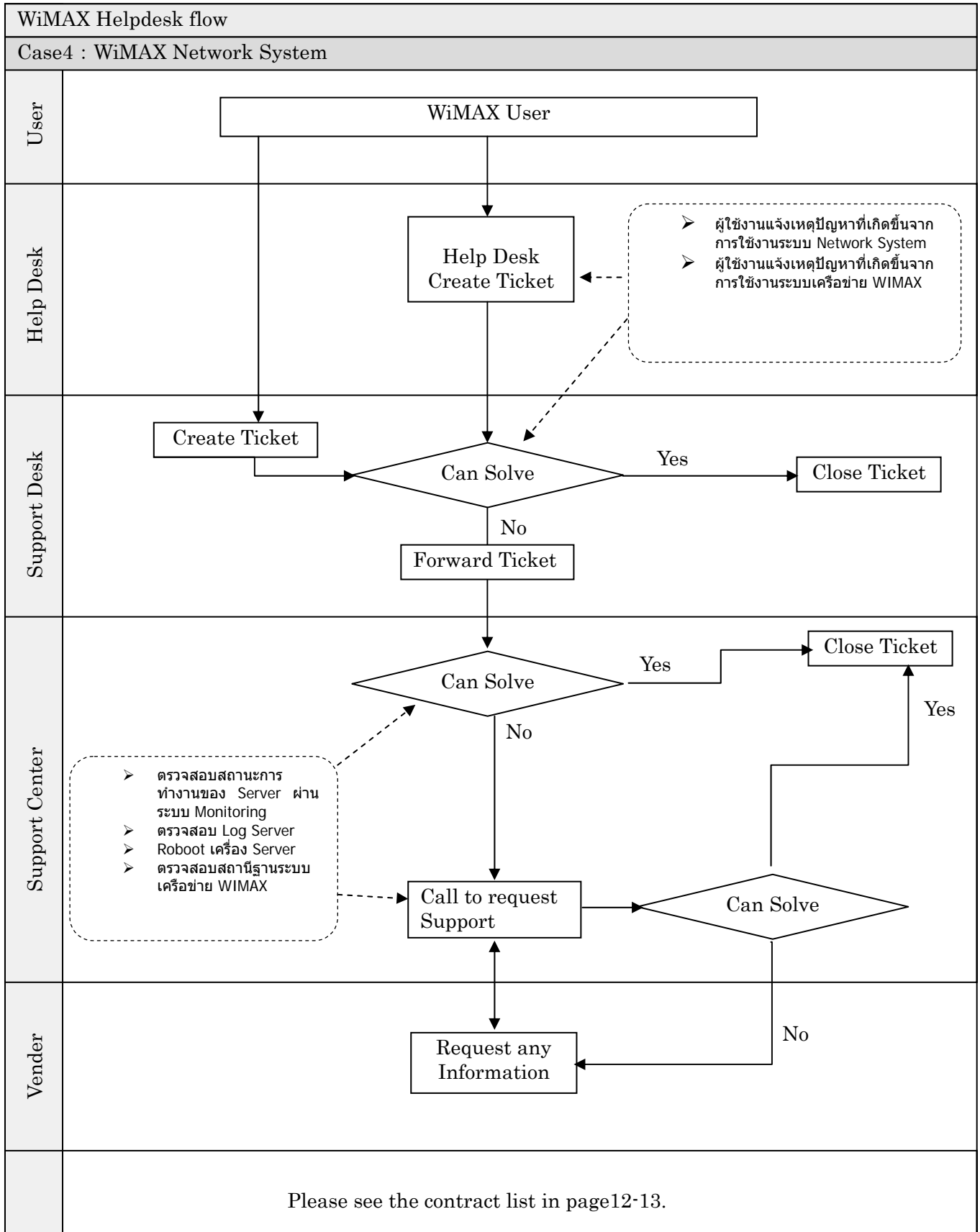
โดยแจ้งปัญหาโดยกรอกข้อมูลเข้าสู่ระบบ **WiMAX Helpdesk System** ทาง URL <http://wimaxitvalley.org/wimaxrt/index.php>
 2. ทางโทรศัพท์

โดยสามารถติดต่อขอความช่วยเหลือจากทาง Support Desk ของแต่ละพื้นที่ หรือติดต่อ Support Center1 หรือ Support Center 2 โดยเมื่อผู้ดูแลระบบรับเรื่องแล้วให้ทำการบันทึกข้อมูลที่ได้รับแจ้งลงระบบ WiMAX Helpdesk system ทุกครั้ง หากผู้รับแจ้งปัญหาระดับใดก็ตามไม่สามารถแก้ไขปัญหาได้ให้ทำการส่งต่อปัญหาให้แก่ผู้ดูแลระบบในระดับที่สูงกว่าต่อไป









No	Equipment list	Manufacturing	Vendor name	Contact person	Warranty	Maintenance cost	Remark
1	WiMAX ASN Gateway System	Alvarion	Alvarion	02-574-6409/ 0811707503	12/30/2009		
2	WiMAX Base Station System	Alvarion	Alvarion	02-574-6409/ 0811707503	12/30/2009		
3	WIMAX CPE	Alvarion	Alvarion	02-574-6409/ 0811707503	12/30/2009		
4	WiMAX Modem USB	Alvarion	Alvarion	02-574-6409/ 0811707503	12/30/2009		
5	Wireless System Point to Point	Alvarion	Alvarion	02-574-6409/ 0811707503	12/30/2009		
6	Rack Server Type 1 (WiMAX Management System)	Alvarion	Alvarion	02-574-6409/ 0811707503	12/30/2009		
7	Firewall L7	Blue Coat	Blue Coat	02-2596930	12/30/2009		
8	Storage Unit	Buffalo	ECS Thailand	02-6616666 / 02-2612900	12/30/2009		
9	Computer Desktop	Dell	Dell	1800 006 007	12/30/2009		
10	Monitor of Computer Desktop	Dell	Dell	1800 006 007	12/30/2009		
11	Notebook Model:Vostro 1520, WiMAX USB	Dell	Dell	1800 006 007	12/30/2009		
12	Firewall L3	D-Link	D-Link	02-6617997	12/30/2009		
13	KVM Switcher	D-Link	D-Link	02-6617997	12/30/2009		
14	Switching Hub L2	D-Link	D-Link	02-6617997	12/30/2009		
15	Switching Hub L3	D-Link	D-Link	02-6617997	12/30/2009		
16	Wi-Fi Router	D-Link	D-Link	02-6617997	12/30/2009		
17	GPS	Garmin	Garmin	02-6368421	12/30/2009		
18	Computer Desktop Server Model:DX7510MT, Display Monitor, LinuxSIS	HP	HP	HP Customer support 02-3539000	12/30/2009		
19	Display Monitor Model:LV156W	HP	HP	HP Customer support 02-3539000	12/30/2009		

20	Monitor of Computer Desktop Server Model:L1710	HP	HP	HP Customer support 02-3539000	12/30/2009		
21	Rack Server Type 1 (AAA + Database)	HP	HP	HP Customer support 02-3539000	12/30/2009		
22	Rack Server Type 1 (AAA and Database)	HP	HP	HP Customer support 02-3539000	12/30/2009		
23	Rack Server Type 1 (AcuLearn)	HP	HP	HP Customer support 02-3539000	12/30/2009		
24	Rack Server Type 1 (LearnSquare + Web server)	HP	HP	HP Customer support 02-3539000	12/30/2009		
25	Rack Server Type 1 (LearnSquare)	HP	HP	HP Customer support 02-3539000	12/30/2009		
26	Rack Server Type 2 (DHCP + Performance Testing)	HP	HP	HP Customer support 02-3539000	12/30/2009		
27	Rack Server Type 2 (DHCP)	HP	HP	HP Customer support 02-3539000	12/30/2009		
28	Rack Server Type 2 (Log Server)	HP	HP	HP Customer support 02-3539000	12/30/2009		
29	Rack Server Type 2 (Network Monitoring)	HP	HP	HP Customer support 02-3539000	12/30/2009		
30	UPS Model:VGD-700RM	PCM	PowerMetric	0-2952-4400	12/30/2009		
31	UPS for Server Model:VGD-5000RM Server connection cable set	PCM	PowerMetric	0-2952-4400	12/30/2009		
32	UPS Model:VGD-700	PCM	PowerMetric	0-2952-4400	12/30/2009		
33	Broadband ADSL Router Model:AR4031C	TECOM	TECOM	886-2-2655-1000	12/30/2009		
34	VoIP Telephone Model:LP-201	WellTech	Welltech Taiwan	886 2 82265699	12/30/2009		

4. Support Center and Helpdesk Site List (HD , SD , SC)

4.1 Support Center

Site Code	Unit	Name-Surname	E-mail	Telephone
A-CORE-01	ประสานงาน WIMAX / สามหมอกทิวี	สุดเขต พุมวารี	sudkhet23@hotmail.com	0856159803

4.2 Support Desk

4.2.1 Mae Hong Sorn Region

Site Code	Unit	Name-Surname	E-mail	Telephone
A-GOV-01	สำนักงานจังหวัดแม่ฮ่องสอน	สุดเขต พุมวารี	sudkhet23@hotmail.com	0856159803
A-GOV-05	สำนักงานเขตพื้นที่ทางการศึกษาแม่ฮ่องสอน เขต1	อนุเดช ปุระวิทย์	moggymdf@hotmail.com	0857115026

4.2.2 Mae Sa Rieng Region

Site Code	Unit	Name-Surname	E-mail	Telephone
B-SCH-01	โรงเรียนแม่สะเรียง (บริพัตรศึกษา)	สุรพล ศรีศิลป์	suraphols@gmail.com	0897059617
B-SCH-01	โรงเรียนแม่สะเรียง (บริพัตรศึกษา)	อนุสิทธิ์ ปิตุรัตน์	a_piturat@hotmail.com	0813668705

4.2.3 Pai Region

Site Code	Unit	Name-Surname	E-mail	Telephone
C-GOV-02	โรงพยาบาลปาย	วີธี เทอดบุษกุลรัมย์	witee@hotmail.com	0857138938 , 053699031 ต่อ187

4.3 Help Desk

4.3.1 Mae Hong Sorn Region

Site Code	Unit	Name-Surname	E-mail	Telephone
A-CORE-01	ประสานงาน IT Valley	บัณฑิต นิลอุดมศักดิ์	koonohm@yahoo.com	0813075377
A-CORE-01	วิทยาลัยชุมชนแม่ฮ่องสอน	ปรีชา ศรีบุญมา	admin_mcc@hoymail.com	0869112550
A-CORE-01	ศูนย์พัฒนาทักษะการเรียนรู้ ICT แม่ฮ่องสอน	พุดิพรรณ บุญจันทร์		0815942596
A-CORE-01	วิทยาลัยชุมชนแม่ฮ่องสอน	มนตรี วงษ์รบ	montriwong@hotmail.com	0847773300
A-CORE-01	ศูนย์พัฒนาทักษะการเรียนรู้ ICT แม่ฮ่องสอน	เอมอร ลัมวัฒนา	mphapet@hotmail.com	0867311905
A-SCH-01	โรงเรียนห้องสอนศึกษา	ประกิจ ผาดิจิโรชาติ	charman_pk@hotmail.com	0861862772
A-SCH-01	โรงเรียนห้องสอนศึกษา	ยิ่งยศ จันทร์ชิต	yingyot@hotmail.com	0845037196

A-SCH-02	โรงเรียนอนุบาลแม่ฮ่องสอน	ปิ่นเทพ กิติเลิศ	kitilert@hotmail.com	0871736800
A-SCH-02	โรงเรียนอนุบาลแม่ฮ่องสอน	พรรณทิพา ทิพกนก	gtxmhs2@yahoo.com	
A-SCH-02	โรงเรียนอนุบาลแม่ฮ่องสอน	พูนศรี ฮ่องสอน	phongso@hotmail.com	0899540211
A-SCH-03	โรงเรียนบ้านสบป่อง	คารม สิงห์ลุน	k_singlun@hotmail.com	0895533839
A-SCH-03	โรงเรียนบ้านสบป่อง	ประยูร เจริญผล		0871856872
A-SCH-03	โรงเรียนบ้านสบป่อง	ศศิประภา ชมถิ่น	kwandaw-sasi@hotmail.com	0819529159
A-SCH-04	โรงเรียนบ้านใหม่	ลลิตา สระสังข์	mam4450@hotmail.com	0894352298
A-SCH-04	โรงเรียนบ้านใหม่	วิทยา สารีขิต		0821066389/0898557455
A-SCH-05	โรงเรียน อบจ.บ้านจองคำ	วรัญญา อุন্নันกาศ	moowhan_wr20@hotmail.com	0801305464
A-SCH-05	โรงเรียน อบจ.บ้านจองคำ.	สุพัตรา ไชยพรหม	nanogj_jeed@hotmail.com	0817678833
A-SCH-06	โรงเรียนเทศบาลเมืองแม่ฮ่องสอน	จรรยา วงศ์ไชย	pankulaoy@hotmail.com	0843780143
A-SCH-06	โรงเรียนเทศบาลเมืองแม่ฮ่องสอน	ประจวบ ลังกา	prachuab_ms@hotmail.com	0843780143
A-SCH-07	วิทยาลัยการอาชีพพวนมินทรราชินีแม่ฮ่องสอน	จักรพงษ์ เบี้ยปลุก	eakyu1@hotmail.com	0895586871
A-SCH-07	วิทยาลัยการอาชีพพวนมินทรราชินีแม่ฮ่องสอน	รุจิรัตน์ เสมเปี้ย	Krunok.nok@hotmail.com	0815775597
A-SCH-07	วิทยาลัยการอาชีพพวนมินทรราชินีแม่ฮ่องสอน	วิทยา ภิญโญฤทธิ	p_wittaya@hotmail.com	0817831242
A-SCH-08	โรงเรียนศึกษาสงเคราะห์แม่ฮ่องสอน	กนกศรี สายสอด	kanoksri.ss@hotmail.com	0818845061
A-SCH-08	โรงเรียนศึกษาสงเคราะห์แม่ฮ่องสอน	พิพัฒน์ อารี	a_pipat@hotmail.com	0898516639
A-SCH-08	โรงเรียนศึกษาสงเคราะห์แม่ฮ่องสอน	ศุภชัย นาคเนียม	yai08@yahoo.com	0871740080
A-SCH-09	โรงเรียนขุนยวมวิทยา	ธนมล สุวรรณทอง	ked_kung@hotmail.com	0818851421

Site Code	Unit	Name-Surname	E-mail	Telephone
A-GOV-01	สำนักงานจังหวัดแม่ฮ่องสอน	วัลลภา สุนคณ์	wanlapa_suk@moi.go.th , maehongson@moi.go.th	0875758974
A-GOV-01	สำนักงานจังหวัดแม่ฮ่องสอน	สุดเขต พุ่มวารี	sudkhet23@hotmail.com	0856159803
A-GOV-02	สำนักงานสาธารณสุข จังหวัดแม่ฮ่องสอน	ศุภชัย ธรรมวงศ์	jufr69@hotmail.com	053611281 ต่อ 127
A-GOV-02	สำนักงานสาธารณสุข จังหวัดแม่ฮ่องสอน	อรรถพล รุ่งกมลวิจาย	redarmy_att@hotmail.com	0898547175
A-GOV-03	โรงพยาบาลศรีสังวาลย์	เกรียงศักดิ์ ศรีกอนติ	paper_enter@hotmail.com	053611378 ต่อ 5001
A-GOV-03	โรงพยาบาลศรีสังวาลย์	สุรศักดิ์ กันหาแปง	mhs_natib@hotmail.com	0891692699
A-GOV-04	สำนักงานป้องกันและบรรเทาสาธารณภัย	ฤกษ์ ผดุงกิ		0895562960
A-GOV-04	สำนักงานป้องกันและบรรเทาสาธารณภัย	ศิวมัญญา ทอดเสียง	ss-wk111513@hotmail.com, CYBER_WHARN@hotmail.com	0817063183
A-GOV-04	สำนักงานป้องกันและบรรเทาสาธารณภัย	อัจฉรา วุฒานนท์		053614313
A-GOV-05	สำนักงานเขตพื้นที่ทางการศึกษาแม่ฮ่องสอน เขต1	อนเดช ปุระณะวิทย์	moggymdf@hotmail.com	0857115026
A-GOV-06	สถานีตำรวจภูธรจังหวัดแม่ฮ่องสอน	ไตรสิทธิ์ วสุวัฒน์ศรี	trisit_pud@hotmail.com	0846080909
A-GOV-06	สถานีตำรวจภูธรจังหวัดแม่ฮ่องสอน	อดิศักดิ์ ยอดวีระพงษ์	Rider_Tum@hotmail.com	0819524510

	แม่ฮ่องสอน			
A-GOV-07	ศูนย์บำบัดรักษาเยาเสพติด แม่ฮ่องสอน	ชวานากร เงินใส	pookan_na@hotmail.com, arp- ersand_note@msn.com, comsci_mdte@hotmail.co m	0806733744
A-GOV-07	ศูนย์บำบัดรักษาเยาเสพติด แม่ฮ่องสอน	สุรียา สวัสดิ์	suriya_02@hotmail.com	0860188771
A-COM-02	กศน/. ห้องสมุดประชาชน เมืองแม่ฮ่องสอน	เจริญชัย ปิตตอุทิศชัย กุล	m_charoenchai@hotmail.c om	0818843922
A-COM-02	ห้องสมุดประชาชนแม่ฮ่องสอน	ชลดา เรืองแสง	mmlada_lib@hotmail.com	0843701365
A-COM-02	ห้องสมุดประชาชนแม่ฮ่องสอน	ธนวัฒน์ อ้นอยู่	taiza03@hotmail.com	0848106444
A-COM-02	ห้องสมุดประชาชนแม่ฮ่องสอน	ไพลิน เฉลิมเมธีวงศ์	Library611317@hotmail.c om, numta_ache@hotmail.com	0847411891

4.3.2 Mae Sa Rieng Region

Site Code	Unit	Name-Surname	E-mail	Telephone
B-SCH-01	โรงเรียนแม่สะเรียง (บริพัตร ศึกษา)	ธนรัฐ จันทรขาว	chankhao@gmail.com	0869229377
B-SCH-01	โรงเรียนแม่สะเรียง (บริพัตร ศึกษา)	นิคม สิงห์สูตร		053681250
B-SCH-01	โรงเรียนแม่สะเรียง (บริพัตร ศึกษา)	สุชิตร์ ุริ		0835764731
B-SCH-02	โรงเรียนทองสวัสดิ์วิทยาคาร	ไกรรัชต์ ปันติสวัสดิ์	porott2502@hotmail.com	0841746656
B-SCH-02	โรงเรียนทองสวัสดิ์วิทยาคาร	ลิขิต ไหวดี	tanenmai@hotmail.com	0864319619
B-SCH-03	โรงเรียนอนุบาลแม่สะเรียงบ้าน) (โป่ง	ชัยวัฒน์ มีบุญ	andureal_ch@hotmail.com	0819983141
B-SCH-04	โรงเรียนบ้านจอมแจ่มมิตรภาพที่ 193	เกตสุดา วรรณวินิจ	wanwinid_nim1976@hot mail.com	0870329676
B-SCH-04	โรงเรียนบ้านจอมแจ่มมิตรภาพที่ 193	สுகานดา ประยูร	view_vca@hotmail.com	0833231139
B-SCH-05	โรงเรียนไทยรัฐวิทยา 33 (บ้าน ทุ่งพร้าว)	ประหยัด นิรมล	kroocomp@gmail.com	0871722637
B-SCH-06	โรงเรียนบ้านไร่วิทยา	จินตนา ปิตร์ตัน	bd_school@hotmail.com	0892657855
B-SCH-06	โรงเรียนบ้านไร่วิทยา	พิมพ์ประไพ วิริยภาค	khumpim_1@hotmail.com	0817648834
B-SCH-06	โรงเรียนบ้านไร่วิทยา	วีรยา ปวงคำคง	veeraya_24@hotmail.com	0871530812
B-SCH-06	โรงเรียนบ้านไร่วิทยา	ศศิกันต์ แสนจันทร์	tansasikarn@hotmail.com	0897587822
B-SCH-07	วิทยาลัยการอาชีพแม่สะเรียง	รณกร วิกรรัตน์		053681576
B-SCH-07	วิทยาลัยการอาชีพแม่สะเรียง	อนชิต ศิริรัตน์		053681576
B-SCH-08	โรงเรียนบ้านห้วยทราย	สมคิด สิงห์สูตร	Tant.c@hotmail.com	0815683752
B-SCH-09	โรงเรียนชุมชนบ้านน้ำดิบ	อมลวรรณ จำปาทอง	srijum.jumpatong@gmail. com	0819515388
B-SCH-10	โรงเรียนบ้านศรีมูลเมือง	ประกาศิต วรรณกุล ชัย		0806751642
B-SCH-10	โรงเรียนบ้านศรีมูลเมือง	ศารทูล สมาศิลปี	srimoonmuang@gmail.co m, nick_aggie@chaiyo.com	0897599261
B-SCH-10	โรงเรียนบ้านศรีมูลเมือง	สงกรานต์ ต้วน่า		0817657212
B-SCH-11	โรงเรียนแม่ลาน้อยตรุลสิกข์	सनาน คงอ้าย	ganggpark@gmail.com	0871850959
B-SCH-11	โรงเรียนแม่ลาน้อยตรุลสิกข์	สมชาติ มิ่งศรีสุข	somchart007@hotmail.co m	0899997195
B-SCH-12	โรงเรียนราชประชานุเคราะห์ 21	ปนัดดา	poro.p@hotmail.com	0848062083

B-SCH-12	โรงเรียนราชประชานุเคราะห์ 21	สราวุธ ปิ่นทวัง	noa2519@hotmail.com	0848045079
B-SCH-12	โรงเรียนราชประชานุเคราะห์ 21	สายัน โยริยะ		0818849017
B-GOV-01	สำนักงานเขตพื้นที่การศึกษา แม่ฮ่องสอน เขต 2	จันทร์ วัลย์กลยา	vungkullaya@yahoo.com	0819610264
B-GOV-01	สำนักงานเขตพื้นที่การศึกษา แม่ฮ่องสอน เขต 2	ชุตติพงษ์ โพธิ์หล้า	tuenoon_just@hotmail.com	0828949529

4.3.3 Pai Region

Site Code	Unit	Name-Surname	E-mail	Telephone
C-SCH-01	โรงเรียนชุมชนบ้านแม่ฮี้	นิภาวรรณ ปิระภรณ์	peeragan17_whan@hotmail.com	0871902079
C-SCH-01	โรงเรียนชุมชนบ้านแม่ฮี้	ประจักษ์ สิทธิเชียว	Prajuk_s@hotmail.com	0819504249
C-SCH-01	โรงเรียนชุมชนบ้านแม่ฮี้	ประยุทธ์ ปิ่นทนา		0861801467
C-SCH-01	โรงเรียนปายวิทยาคาร	พรเทพ ศุภภรณ์	porntheepsupa@gmail.com	0861853923
C-SCH-01	โรงเรียนปายวิทยาคาร	วิสุทธิชาติ บุญคำ	wisutthichat7@hotmail.com	0857064988
C-SCH-01	โรงเรียนปายวิทยาคาร	สมชาย ขอแสบ		
C-SCH-02	โรงเรียนอนุบาลปาย (เวียงใต้)	ดำรง ปิ่นทวงศ์	anubanpai53@hotmail.com	0810308309
C-SCH-02	โรงเรียนอนุบาลปาย (เวียงใต้)	ธาดา กาญจนโนพงษ์	tan_moto@hotmail.com	0852559022
C-SCH-04	โรงเรียนบ้านเวียงเหนือ	ทวี ชัยวุฒิ		0819511682
C-SCH-04	โรงเรียนบ้านเวียงเหนือ	สุภัทติษฐ์ ชมภู	Nu_mho@hotmail.com	0899997527
C-SCH-05	โรงเรียนราชประชานุ เคราะห์ 22	กัจจายน์ อ่ำพันธ์	Rpk22_pai@hotmail.com	053065141 ต่อ 11
C-SCH-05	โรงเรียนราชประชานุ เคราะห์ 22	ปรีชา โหลแจ	preecha_karen@hotmail.com	0819517872
C-SCH-05	โรงเรียนราชประชานุเคราะห์ 22	รุ่งระวี เลิศอิสราลักษณ์		0819602583
C-SCH-06	โรงเรียนราชประชานุ เคราะห์ 34	กิตติศักดิ์ ตำระ	comhang2010@hotmail.com	0827723005
C-SCH-06	โรงเรียนราชประชานุ เคราะห์ 34	จิราพร กรณาวีเชียร		0894303102
C-SCH-06	โรงเรียนราชประชานุ เคราะห์ 34	ณัฐวัฒน์ แสงสิทธิ์	sangsit_2004@yahoo.com	0835753907
C-SCH-06	โรงเรียนราชประชานุ เคราะห์ 34	สมพงษ์ อุ่นใจ		0850345499
C-GOV-01	ที่ว่าการอำเภอปาย	เอกรินทร์ ชมภูศรี	hcm16720@hotmail.com	0896347427
C-GOV-02	โรงพยาบาลปาย	ธนพัฒน์ มาลาวัลย์	hospitalos_pai@yahoo.com	0805001942

5. Security Management (HD, SD, SC)

Security Software

- มีการติดตั้ง Kaspersky Antivirus Software ที่เครื่อง Dell , HP และ Server ทุกเครื่อง
- มีการตั้งตารางการ Update Antivirus Definition โดยอัตโนมัติ
- มีการตั้งเวลาในการ Scan เครื่องโดยอัตโนมัติ
- มีการเปิดใช้งาน Auto protect ไว้ตลอดเวลา

Backup Policy

Mon	Tue	Wed	Thu	Fry	Sat	Sun
Differential	Differential	Differential	Differential	Differential	Full	Incremental
Differential	Differential	Differential	Differential	Differential	Full	Incremental
Differential	Differential	Differential	Differential	Differential	Full	Incremental
Differential	Differential	Differential	Differential	Differential	Full	Incremental
Differential	Differential	Differential	Differential	Differential	Full	Incremental
AM12:00 Backup start	AM12:00 Backup start	AM12:00 Backup start	AM12:00 Backup start	AM12:00 Backup start	AM12:00 Backup start	AM12:00 Backup start

Password Security Policy

- ตั้งรหัสผ่านอย่างน้อย 6 ตัวอักษร
- รหัสผ่านที่ควรประกอบด้วยตัวอักษร (ตัวใหญ่ ตัวเล็ก) , อักขระ และตัวเลข
- ไม่ควรตั้งรหัสผ่านด้วยคำที่คาดเดาได้ง่าย เช่น วัน เดือน ปีเกิด , บ้านเลขที่ , เลขบัตรประชาชน เป็นต้น
- ไม่ควรตั้งรหัสผ่านด้วยคำที่มีอยู่ในพจนานุกรม
- ไม่ควรตั้งรหัสผ่านซ้ำกับรหัสผ่านที่เคยใช้มาแล้วในอดีต
- ไม่ควรจดรหัสผ่านใส่กระดาษไว้
- ควรมีการเปลี่ยนรหัสผ่านทุกๆ 6 เดือน
- ทำการเปลี่ยนรหัสผ่านทันทีที่ข้อมูลรั่วไหล
- ไม่บอกรหัสผ่านแก่ใครแม้กระทั่งผู้ดูแลระบบ

6. Basic Support and Operation Hours (HD, SD, SC)

ข้อกำหนดเกี่ยวกับเวลาทำงานของผู้ดูแลระบบและเวลาที่สามารถใช้งานระบบ WiMAX มีรายละเอียดดังต่อไปนี้

1. ระยะเวลาทำงานของผู้ดูแลระบบ ซึ่งได้แก่บุคคลดังต่อไปนี้ (สามารถรายละเอียดการติดต่อได้จากหัวข้อที่ 4 Support Center and Helpdesk Site List)
 - 1) Support Desk
 - 2) Support Center

เวลาทำการ วันจันทร์ – ศุกร์ เวลา 9:00 - 17:00 น.

ขอบเขตของการให้บริการในการ Support ของผู้ดูแลระบบมีดังนี้

1. ระบบเครือข่ายคอมพิวเตอร์ของระบบ WiMAX
2. โปรแกรมใดๆที่เกี่ยวข้องกับระบบ WiMAX ได้แก่ Aculearn Conference , Learning management system VDO on demand , เว็บไซต์ Learnsquare , ระบบปฏิบัติการ Windows XP , Windows Server 2003,2008 หรือ Linux ที่ถูกติดตั้งกับเครื่อง PC หรือ Server ระบบ WiMAX

*** หมายเหตุ เมื่อการใช้งานระบบมีปัญหาสามารถแจ้งปัญหาในเวลาทำการ 09.00-17.00 แต่จะสามารถทำการแก้ไขปัญหาในวันทำการถัดไป

2. ระยะเวลาทำงานของระบบ WiMAX ผู้ใช้ระบบสามารถเข้าใช้ระบบ WiMAX ได้ดังรายละเอียดด้านล่าง

เวลาทำการ เปิดให้ใช้งานได้ตลอด 24 ชั่วโมง ทุกวัน

7. Service Monitoring (SC1 , SC2)

1. Service Availability

ผู้ดูแลระบบต้องมีการตรวจสอบ Service Availability เพื่อตรวจสอบว่าระบบสามารถทำงานเป็นปกติหรือไม่โดยใช้โปรแกรม Cacti



ซึ่งจะทำการตรวจสอบอุปกรณ์ต่างๆในหัวข้อต่อไปนี้

1. WAN Link ได้แก่
 - Backbone Network (CAT Telecom link)
2. WiMAX Network ได้แก่อุปกรณ์ดังต่อไปนี้
 - Coe1 L3 Firewall
 - Core1 L3 Switch
 - Core1 L2 Switch
 - Point to point
3. Core1 Server

AAA , LMS , Aculearn , DHCP , DNS , SIP , Cacti , Log , AlvariSTAR , Storage

4. Base Station

5. CPE Site ได้แก่อุปกรณ์ดังต่อไปนี้

- IDU(Indoor Unit) , ODU(Outdoor Unit) , L2 Switch , WiFi Router , VoIP Telephone , Linux SiS , Dell Desktop PC , HP Desktop PC

6. ADSL Site

- L2 Switch , WiFi Router , VoIP Telephone , Linux SiS , Dell Desktop PC , HP Desktop PC

2. Performance Monitoring. (Discuss Later)

Delay monitoring (100 ms from CPE sit to core 1).

Daily monitoring (VOIP and VDO Conference)

- Connectivity
- Quality
- Stability

8. Preventive Maintenance (SD, SC)

การจัดทำ Preventive maintenance เพื่อตรวจสอบระบบ WiMAX ว่าสามารถใช้งานได้อยู่หรือไม่ โดยจะมีการถูกกำหนดตามช่วงเวลาของแต่ละหัวข้อ ได้แก่

- Software แบ่งออกเป็น
 - License เป็นการตรวจสอบการหมดอายุและจำนวนที่สามารถใช้ได้ของ Software License ได้แก่ Kaspersky Antivirus Software , Windows License , VoIP , Aculearn เป็นต้น
 - Version เป็นการตรวจสอบการ update ของ Software เพื่อให้โปรแกรมมีทันสมัยอยู่เสมอ ได้แก่ Kaspersky Antivirus Software , Windows License , VoIP , Aculearn เป็นต้น โดย
 - Kaspersky Antivirus Software จะทำการ update virus definition ทุกๆ 1 อาทิตย์
 - Windows Update จะทำทุกครั้งที่มีการแจ้งเตือนเมื่อมีการ update patch ใหม่
 - VoIP จะทำการ update version เมื่อได้รับแจ้งจากผู้ผลิตซอฟต์แวร์
 - Aculearn ทำการ update software ทุกครั้งเมื่อระบบแจ้งโดยอัตโนมัติว่ามี version ใหม่
- WiMAX Equipment เป็นการดูแลความสะอาดของอุปกรณ์ของระบบ WiMAX ให้สะอาดอยู่เสมอ โดยมีการกำหนดให้มีการทำความสะอาดทุกๆ 1 ครั้ง/เดือน
- Tower Maintenance เป็นการดูแลความสะอาดของหอคอยสัญญาณให้มีความสะอาดอยู่เสมอโดยมีการกำหนดให้มีการทำความสะอาดทุกๆ 1 ครั้ง/ปี
- Base Station Maintenance เป็นการดูแลความสะอาดของสถานีฐานให้มีความสะอาดอยู่เสมอโดยมีการกำหนดให้มีการทำความสะอาดทุกๆ 1 ครั้ง/ปี

9. WiMAX System and Network Diagram

CPE Site Network Diagram

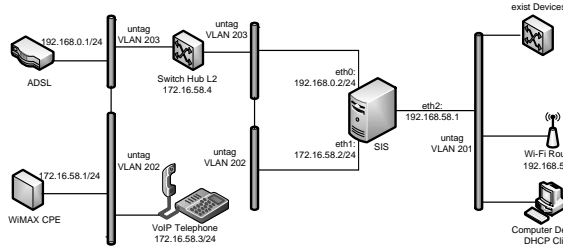


Figure 1 Network Logical Diagram

Order	Name of Equipment	Manufacturer	Specification	Original Quantity	S/N	Status
1	WIMAX CPE	Alcatel	Model:BreezeMax PRO-S	1		
2	Switching Hub L2	D-Link	Model:DGS-3426P	1		
3	Computer Desktop Server	HP	Model:DX7510MT, Display Monitor, LinuxSIS	1		
4	Computer Desktop	DELL	Model:VOSTRO-2205, WindowsXP, Kaspersky, WellTech Web camera, Display Monitor, Logitech Mic & Speaker	1		
5	VoIP Telephone	WellTech	Model:LP-201	1		
6	Wi-Fi Router	D-Link	Model:DIR-300	1		
7	UPS	PCM	Model:VGD-700	1		
8	UPS	PCM	Model:VGD-700	1		
9	LAN Cable set	Kansai Denson	Model:NIL LAN cable set L100 cat5e	1		

Figure 3 Equipment List

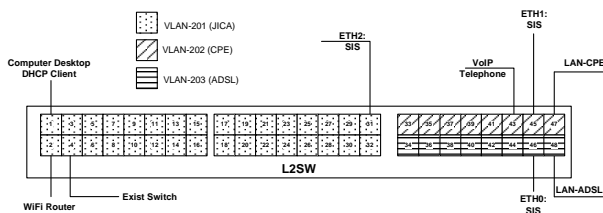


Figure 2 Physical Diagram

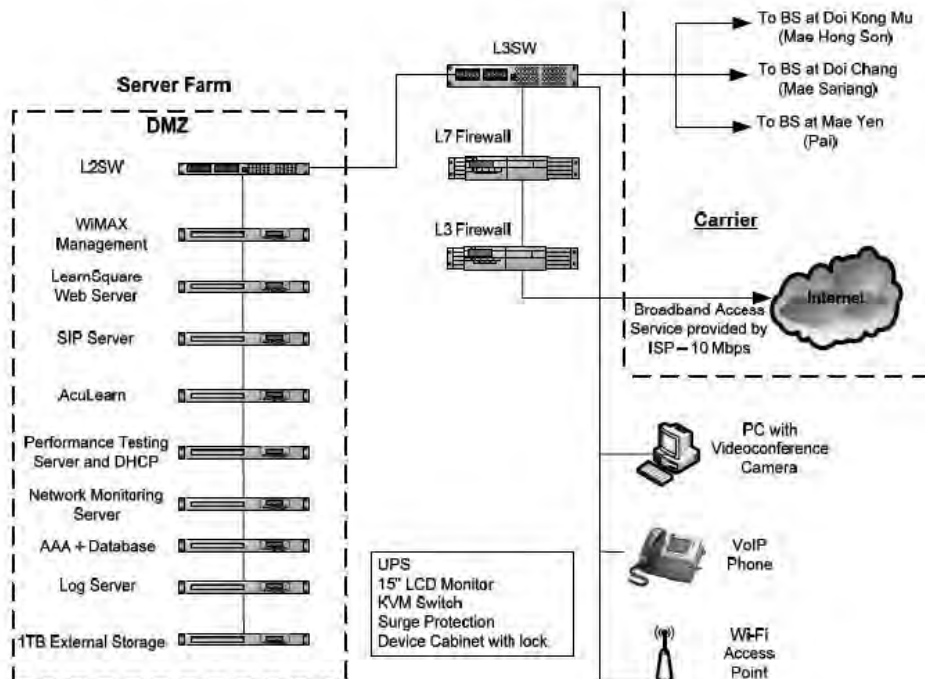
Devices	IP	Login	Password
ADSL			
BreezeMax PRO-S	192.168.254.251	<blank>	installer
LinuxSIS	192.168.212.1	root	123456
WellTech LP-201	10.1.1.3	root	<blank>
D-Link DGS-3100-48P	10.90.90.90	<blank>	<blank>
D-Link DIR-300	192.168.0.1	admin	<blank>

Figure 4 Factory Default

Devices	IP	Login	Password
ADSL	192.168.0.1	admin	
WIMAX-CPE	172.16.58.1	admin	wimax123456
LinuxSIS	192.168.58.1	admin	123456
VoIP Telephone	172.16.58.3	root	wimax123456
Switch Hub L2	172.16.58.4	admin	wimax123456
Wi-Fi Router	192.168.58.2	admin	wimax123456

Figure 5 After finish Configuration

Core Site Network Diagram



Configuration Manual

1. การเซตอัพ Access Point D-Link DIR-300

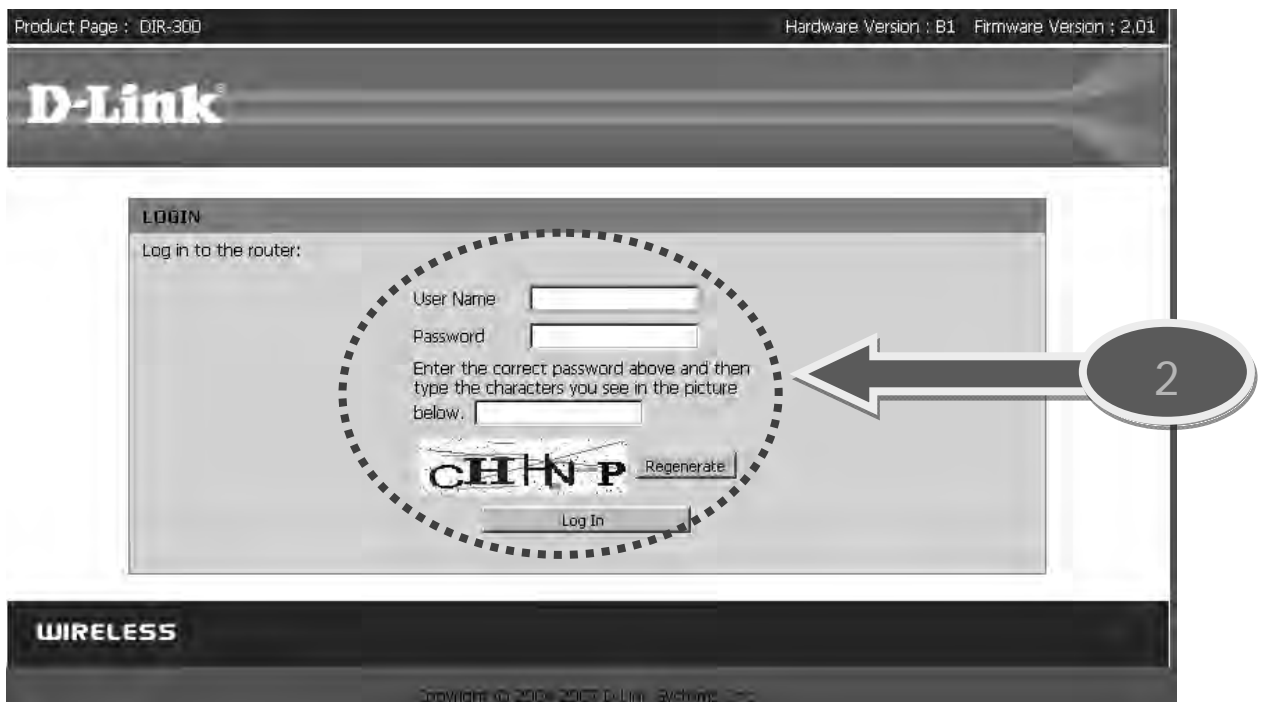


ขั้นตอนการใช้งาน Access Point D-Link DIR-300

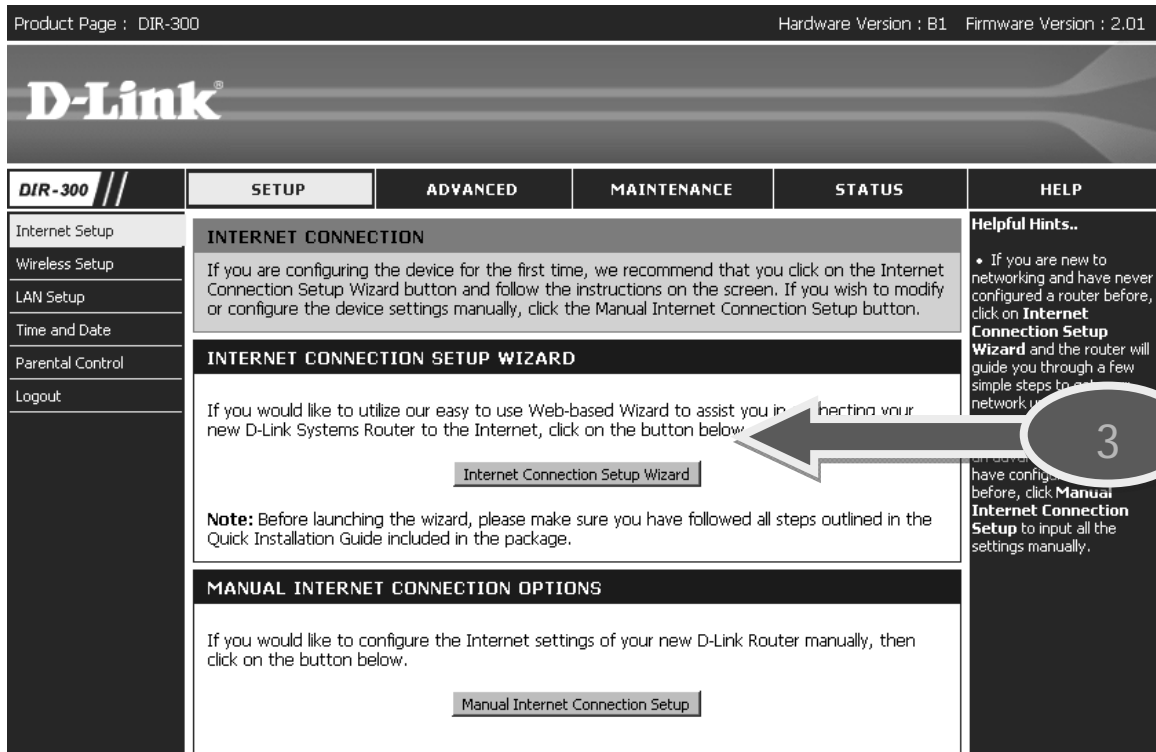
1. ผู้ใช้ที่ทำการเชื่อมต่อเข้ากับระบบเครือข่าย WIMAX จะได้รับไอพีแอสเดรสเป็นวง 192.168.58.1/24 ซึ่งจะสามารถเข้าถึงตัว Access Point D-Link DIR-300 ผ่านทางเบราว์เซอร์จากคอมพิวเตอร์ที่ทำการเชื่อมต่อได้
2. เปิดเบราว์เซอร์ที่คอมพิวเตอร์แล้วกรอกไอพีแอสเดรส 192.168.58.2



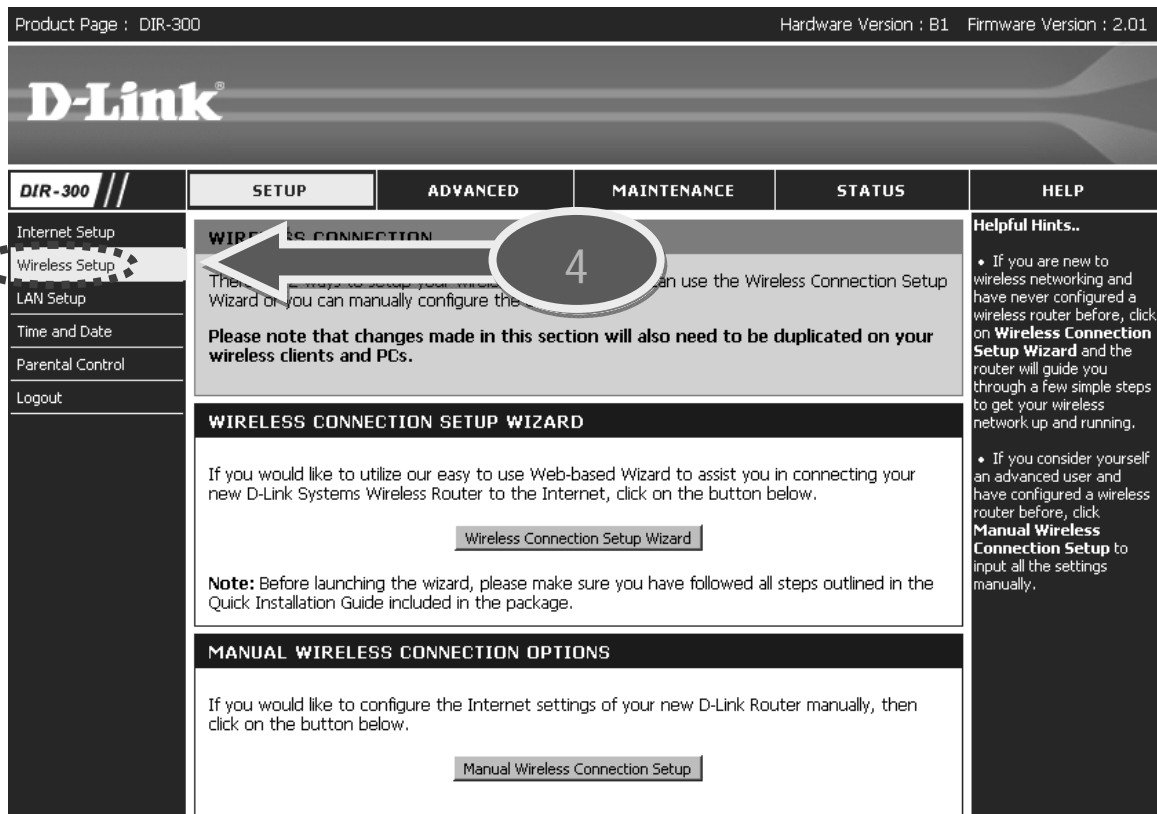
3. ใส่ User Name และ Password ผ่านทางหน้าจอล็อกอิน



4. เข้าสู่หน้าจอหลักของการเซตอัพ Access Point D-Link DIR-300



5. คลิกที่ Wireless Setup เพื่อเข้าไปดูค่าการเซตอัพเพื่อกระจายสัญญาณไร้สาย WIFI



6. จะแสดงให้เห็นรายละเอียดการเซตอัปเดตดังนี้

WIRELESS NETWORK SETTINGS

Enable Wireless : Always

Wireless Network Name : WIMAX (Also called the SSID)

Enable Auto Channel Selection :

Wireless Channel : 1

Transmission Rate : Best (automatic) (Mbit/s)

WMM Enable : (Wireless QoS)

Enable Hidden Wireless : (Also called the SSID Broadcast)

WIRELESS SECURITY MODE

Security Mode : Enable WPA/WPA2 Wireless Security (enhanced)

WPA/WPA2

WPA/WPA2 requires stations to use high grade encryption and authentication.

Cipher Type : TKIP

PSK / EAP : PSK

Network Key : wimax@123456
(8~63 ASCII or 64 HEX)

WIRELESS

7. คลิกที่ LAN Setup เพื่อเข้าไปดูค่าการเซตอัปเดตเครือข่ายแลน

Product Page : DIR-300 Hardware Version : B1 Firmware Version : 2.01

D-Link

DIR-300 // SETUP ADVANCED MAINTENANCE STATUS HELP

Internet Setup
Wireless Setup
LAN Setup
Time and Date
Parental Control
Logout

NETWORK SETTING

your router and also to configure on your network. The IP address that is configured here is the IP address of the Web-based management interface. If you change the IP address in the network settings to access the network again, you may need to adjust your PC's network settings to access the network again.

Please note that this section is optional and you do not need to change any of the settings here to get your network up and running.

ROUTER SETTINGS

Use this section to configure the internal network settings of your router. The IP address that is configured here is the IP address that you use to access the Web-based management interface. If you change the IP address here, you may need to adjust your PC's network settings to access the network again.

Router IP Address : 192.168.58.2

Default Subnet Mask : 255.255.0.0

Local Domain Name :

Enable DNS Relay :

DHCP SERVER SETTINGS

Use this section to configure the built-in DHCP server to assign IP address to the computers on your network.

Enable DHCP Server :

DHCP IP Address Range : 100 to 199 (addresses within the LAN subnet)

DHCP Lease Time : 1440 (minutes)

Helpful Hints..

- If you already have a DHCP server on your network or are using static IP addresses on all the devices on your network, uncheck **Enable DHCP Server** to disable this feature.

8. คลิกที่ Time and Date เพื่อเข้าไปดูค่าการกำหนดเวลาให้ตรงกับประเทศไทย

Product Page : DIR-300 Hardware Version : B1 Firmware Version : 2.01

DIR-300 // SETUP ADVANCED MAINTENANCE STATUS HELP

Internet Setup
Wireless Setup
LAN Setup
Time and Date
Parental Control
Logout

TIME AND DATE CONFIGURATION

Time : 01/01/2000 00:43:11
Time Zone : (GMT+07:00) Bangkok, Hanoi, Jakarta
Enable Daylight Saving : Sync. your computer's time settings

AUTOMATIC TIME AND DATE CONFIGURATION

Automatically synchronize with D-Link's Internet time server
NTP Server Used : ntp1.dlink.com Update Now

SET THE TIME AND DATE MANUALLY

Year: 2010 Month: Sep Day: 16
Hour: 17 Minute: 12 Second: 2

Save Settings Don't Save Settings

Helpful Hints..

- Either enter the time manually by clicking the **Sync. Your Computers Time Settings** button, or use the **Automatic Time Configuration** option to have your router synchronize with a time server on the Internet.

9. คลิกที่ MAINTENACE เพื่อเข้าไปเปลี่ยนแปลงรหัสผ่าน

Product Page : DIR-300 Hardware Version : B1 Firmware Version : 2.01

DIR-300 // SETUP ADVANCED MAINTENANCE STATUS HELP

Device Administration
Save and Restore
Firmware Update
DDNS Setting
System Check
Schedules
Log Settings
Logout

ADMINISTRATOR SETTINGS

The 'admin' account can access the management interface. The admin has read/write access and can change passwords. By default there is no password configured. It is highly recommended that you create a password to keep your router secure.

Save Settings Don't Save Settings

ADMIN PASSWORD

Please enter the same password into both boxes, for confirmation.

New Password:
Confirm Password:

ADMINISTRATION

Enable Graphical Authentication:
Enable Remote Management:
IP Allowed to Access: 0.0.0.0
Port: 8080

Helpful Hints..

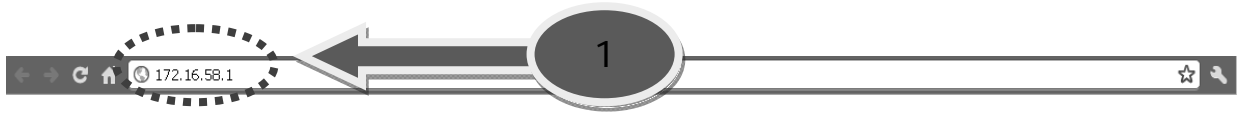
- For security reasons, it is recommended that you change the Password for the Administrator account. Be sure to write down the new Passwords to avoid having to reset the router in the event that they are forgotten.
- When enabling Remote Management, you can specify the IP address of the computer on the Internet that you want to have access to your router, or leave it 0.0.0.0 to allow access to any computer on the Internet.

2. การเซตอัพ BreezeMAX CPE

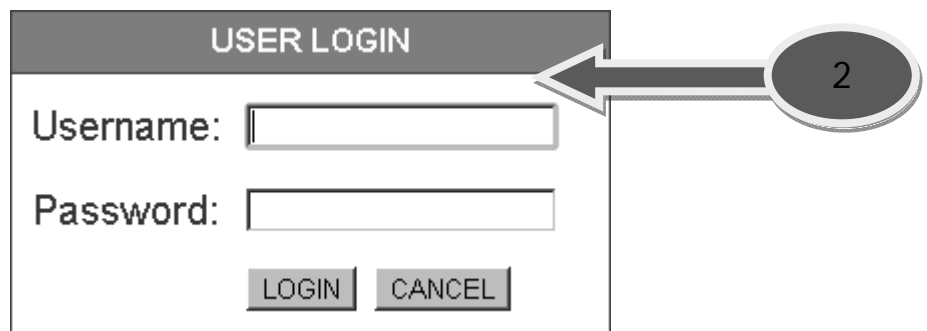


ขั้นตอนการใช้งาน BreezeMAX CPE

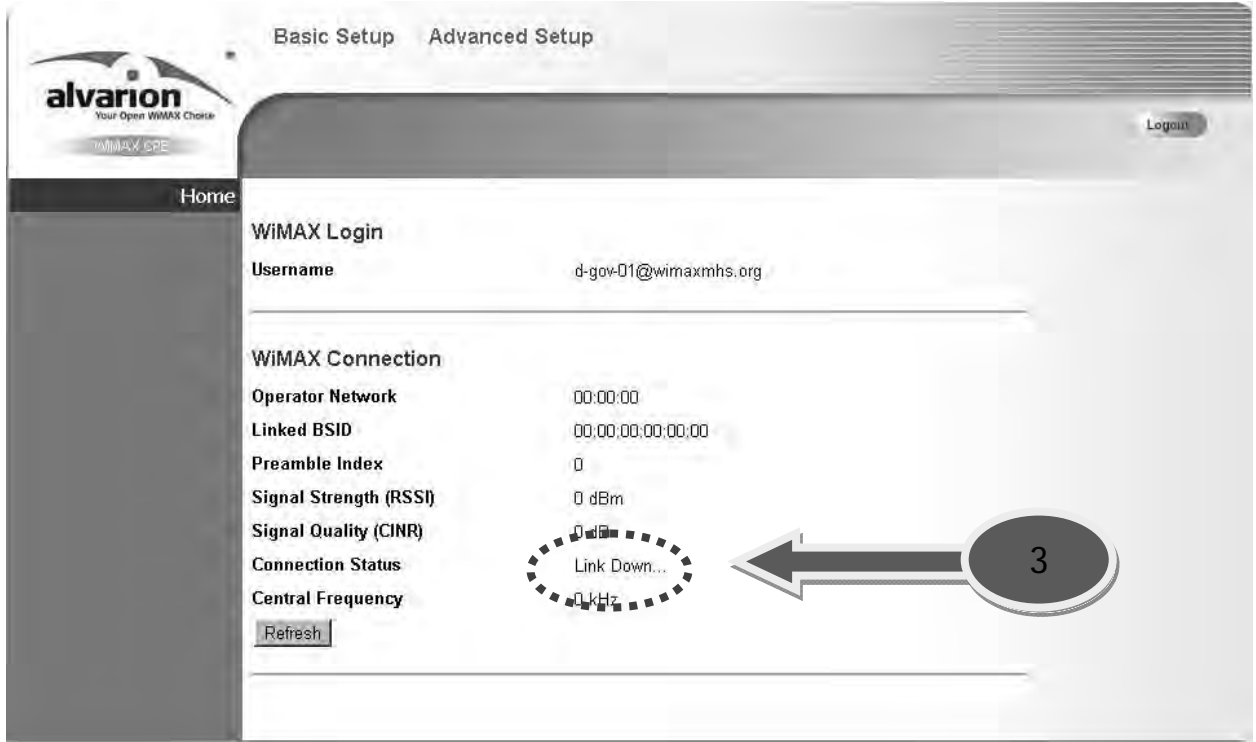
1. ผู้ใช้ที่ทำการเชื่อมต่อเข้ากับระบบเครือข่าย WIMAX จะได้รับไอพีแอสเดรสเป็นวง 192.168.58.1/24 ซึ่งจะสามารถเข้าถึงตัว BreezeMAX CPE ผ่านทางเบราว์เซอร์จากคอมพิวเตอร์ที่ทำการเชื่อมต่อได้
2. เปิดเบราว์เซอร์ที่คอมพิวเตอร์แล้วกรอกไอพีแอสเดรส 172.16.58.1



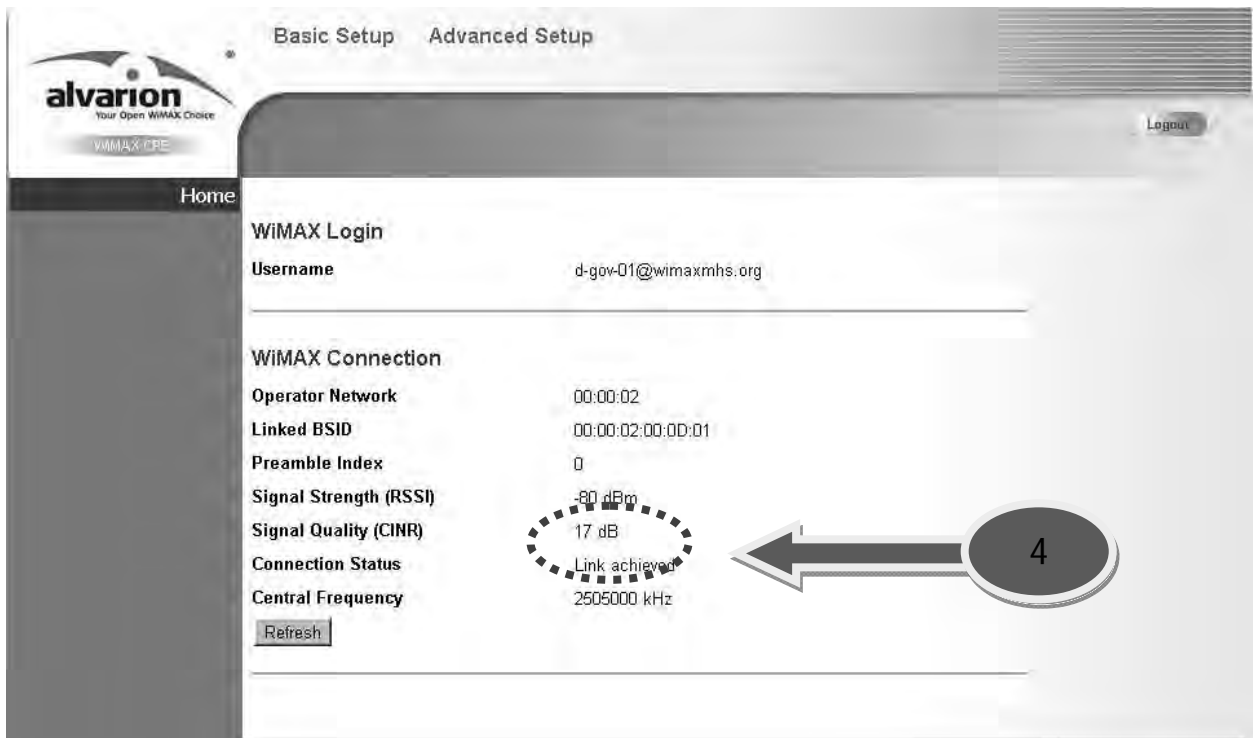
3. ใส่ User Name และ Password ผ่านทางหน้าจอสื่ออีกอัน



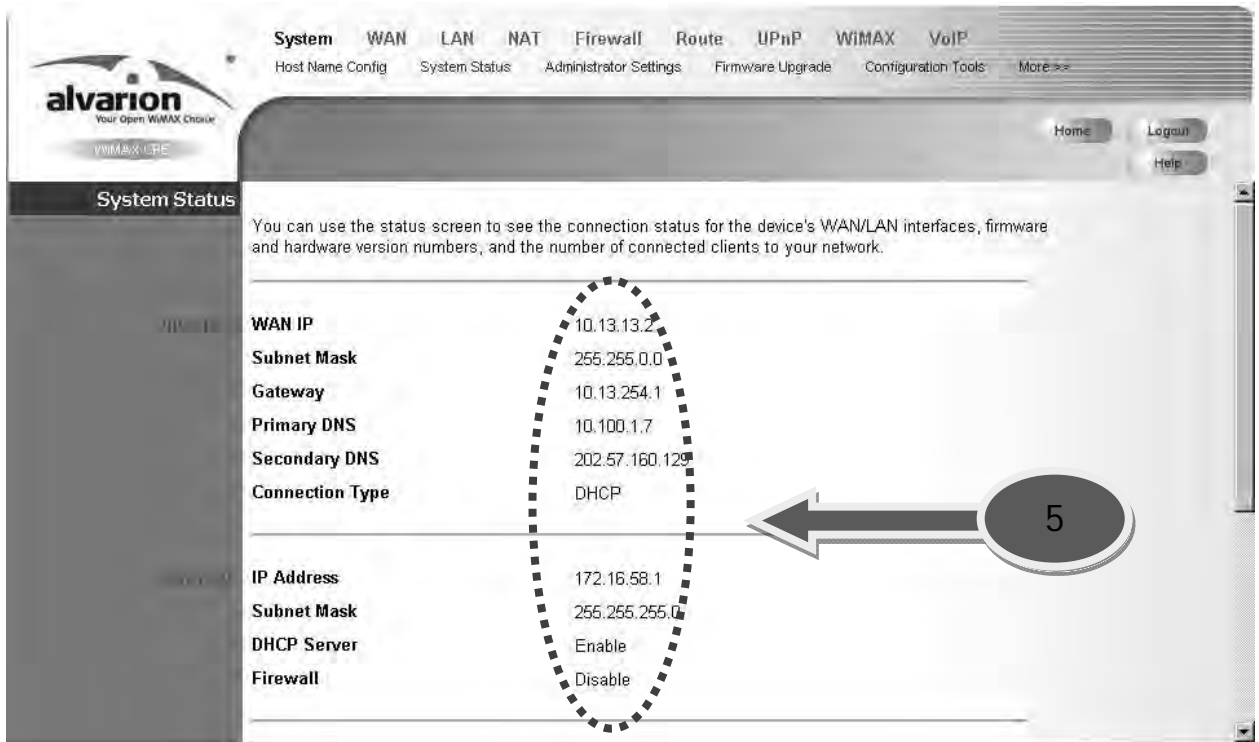
- 4. เข้าสู่หน้าจอแสดงสถานะการเชื่อมต่อเข้ากับระบบเครือข่าย WIMAX ของ BreezeMAX CPE ที่ไม่สามารถเชื่อมต่อได้



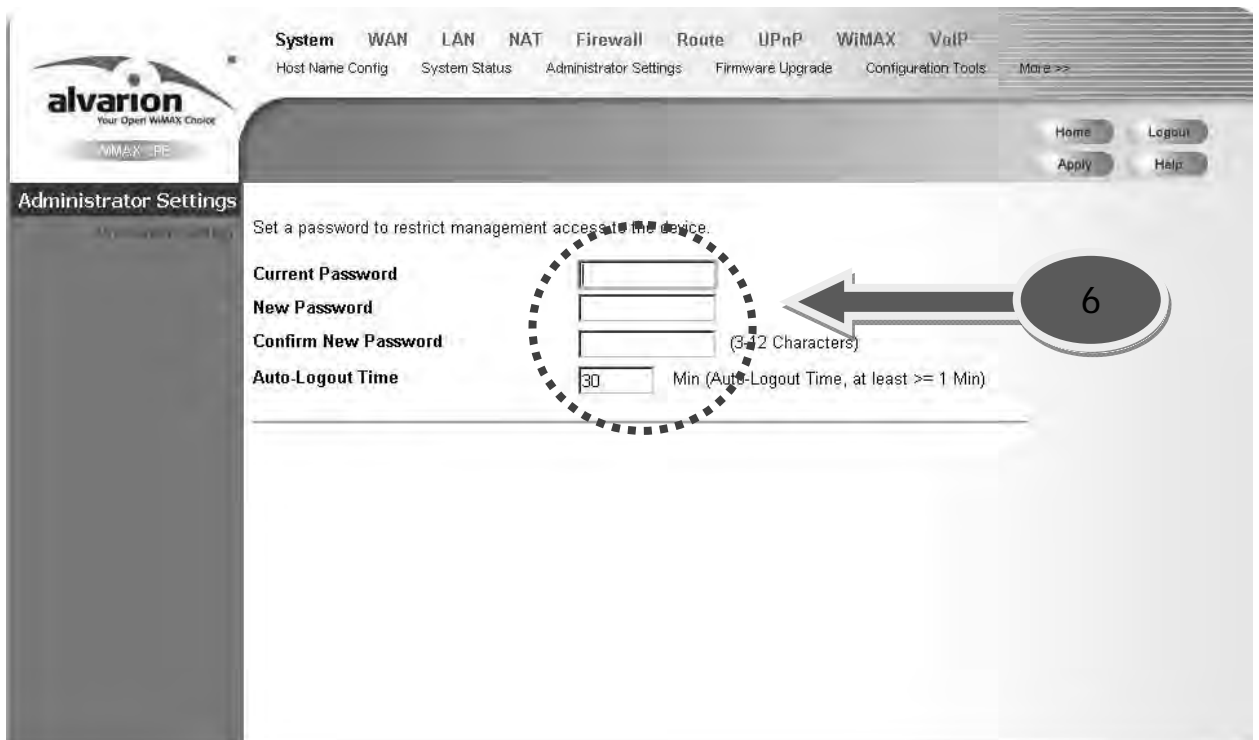
- 5. เข้าสู่หน้าจอแสดงสถานะการเชื่อมต่อเข้ากับระบบเครือข่าย WIMAX ของ BreezeMAX CPE ที่สามารถเชื่อมต่อได้



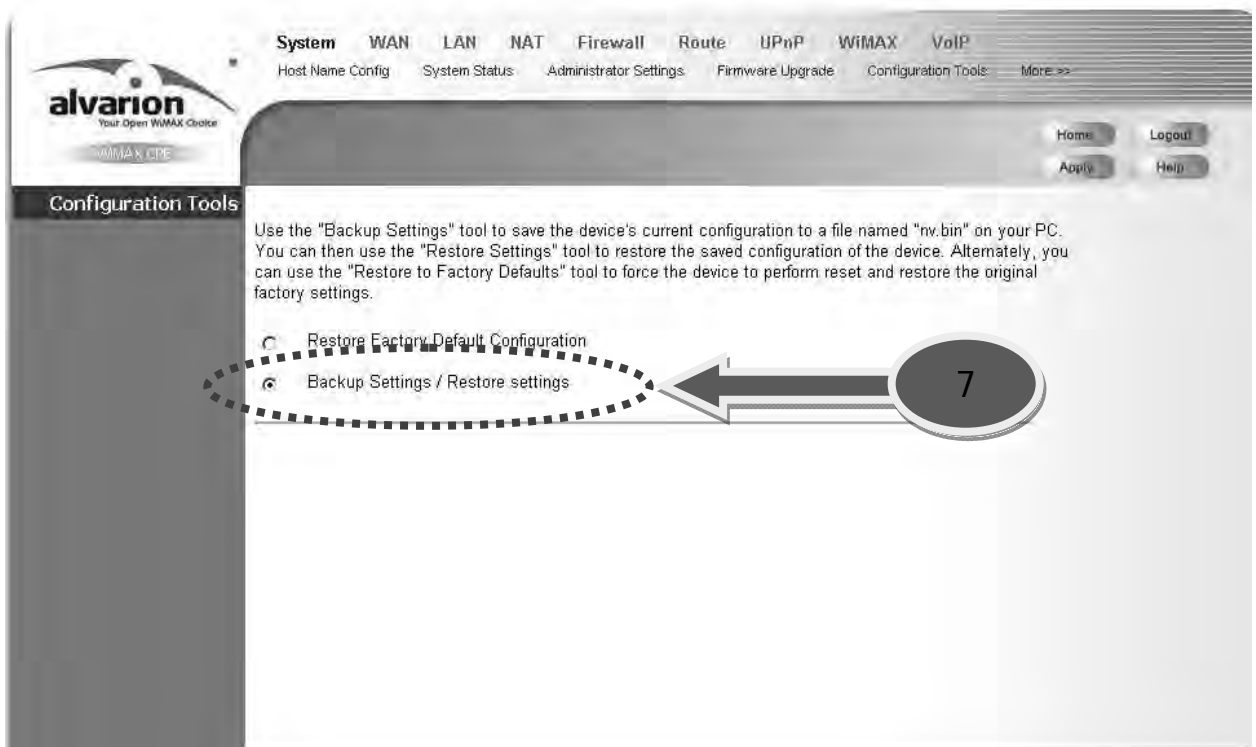
6. แสดงสถานะทั้งหมดของการเชื่อมต่อทั้งขา WAN และ LAN ของ BreezeMAX CPE



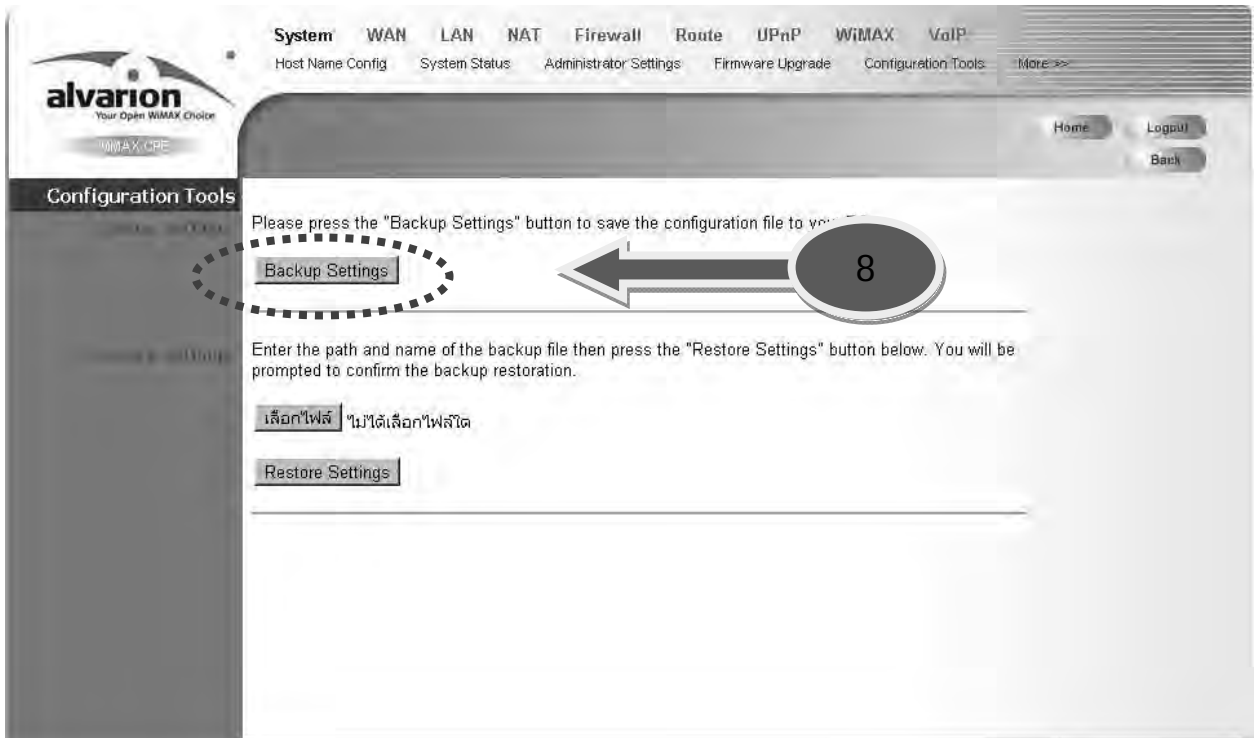
7. คลิกที่ Administrator Settings เพื่อเข้าไปเปลี่ยนแปลงรหัสผ่านของตัวอุปกรณ์ BreezeMAX CPE



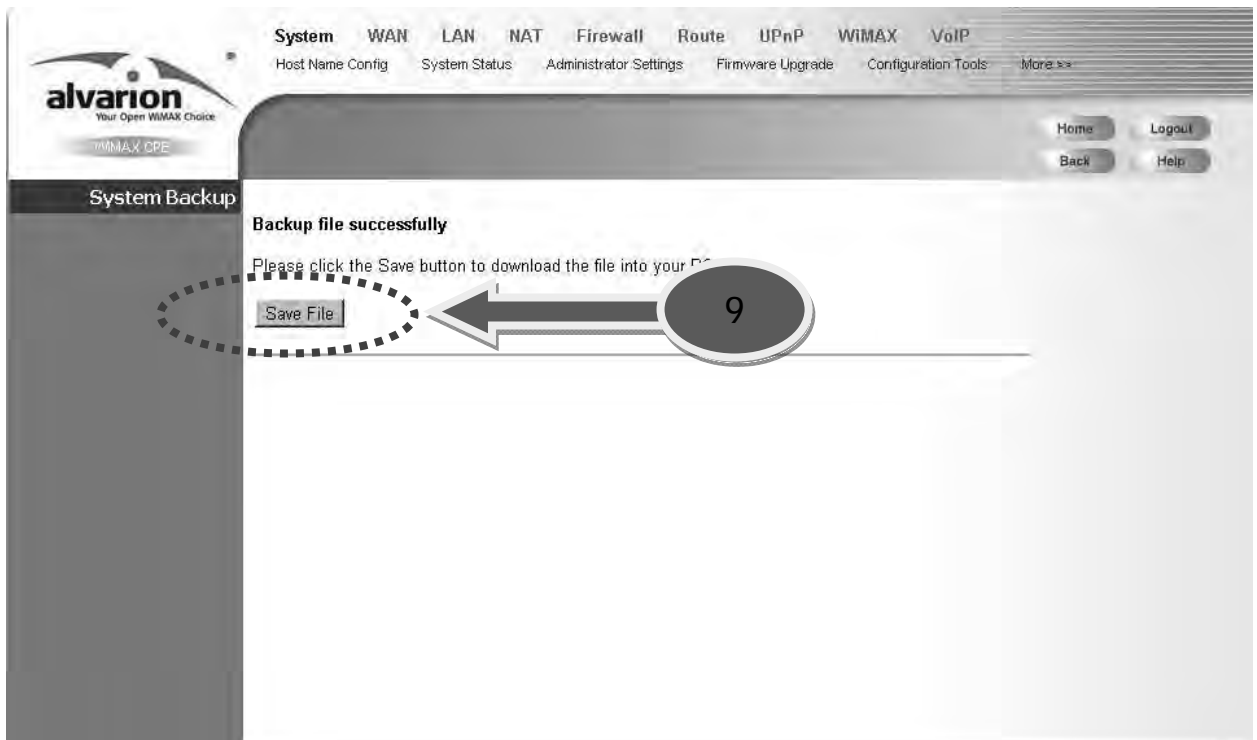
8. คลิกที่ Configuration Tools เพื่อทำการ Backup หรือ Restore ตัวอุปกรณ์ BreezeMAX CPE



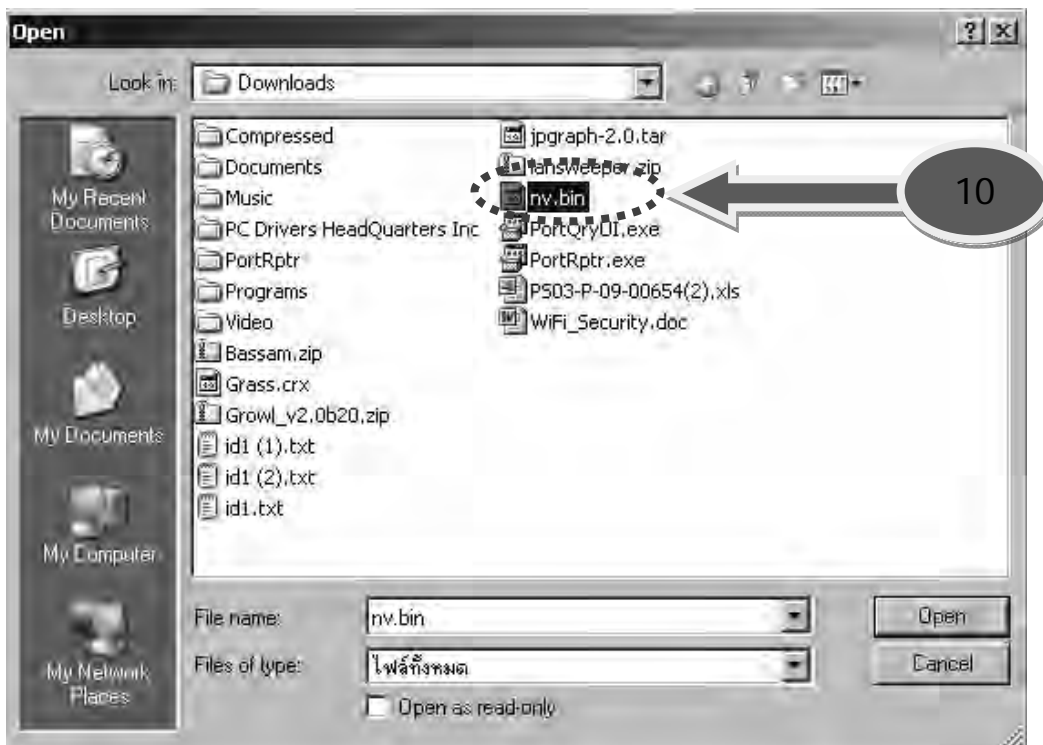
9. คลิกที่ Backup Settings เพื่อทำการ Backup ไฟล์ตัวอุปกรณ์ BreezeMAX CPE เพื่อความปลอดภัย



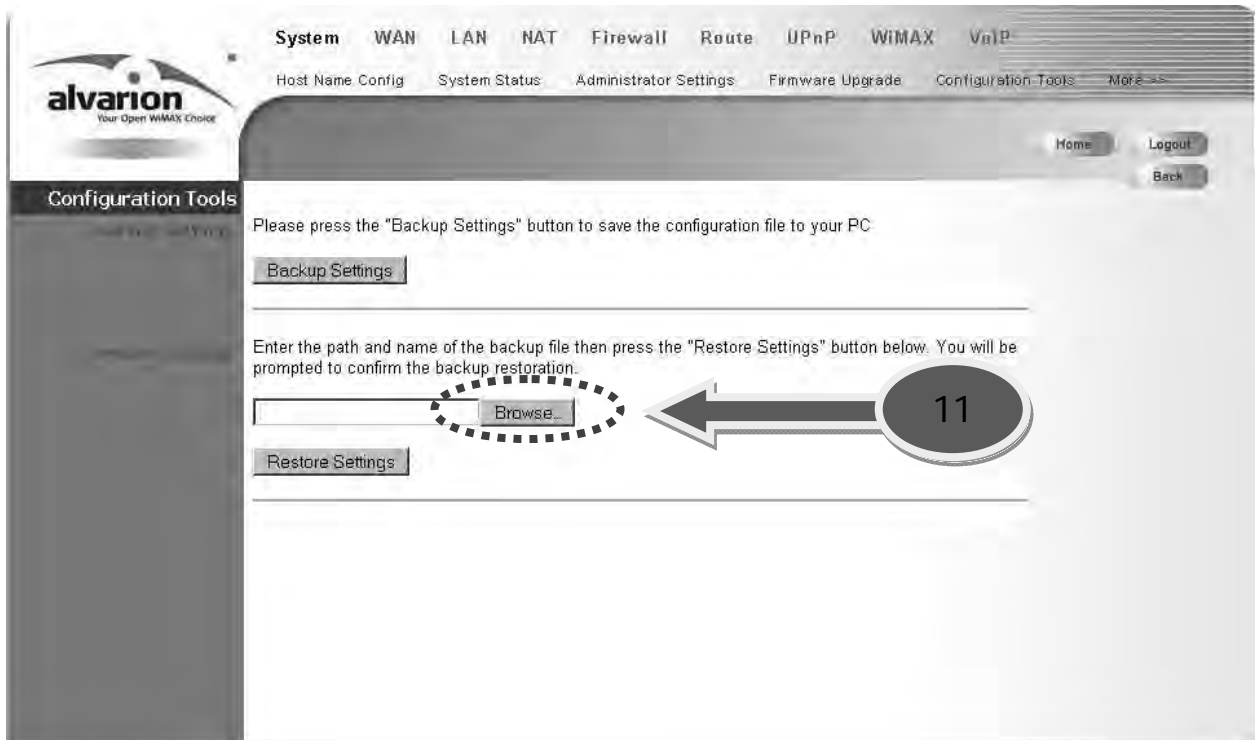
10. คลิกที่ Save File เพื่อทำการ Backup ไฟล์ตัวอุปกรณ์ BreezeMAX CPE



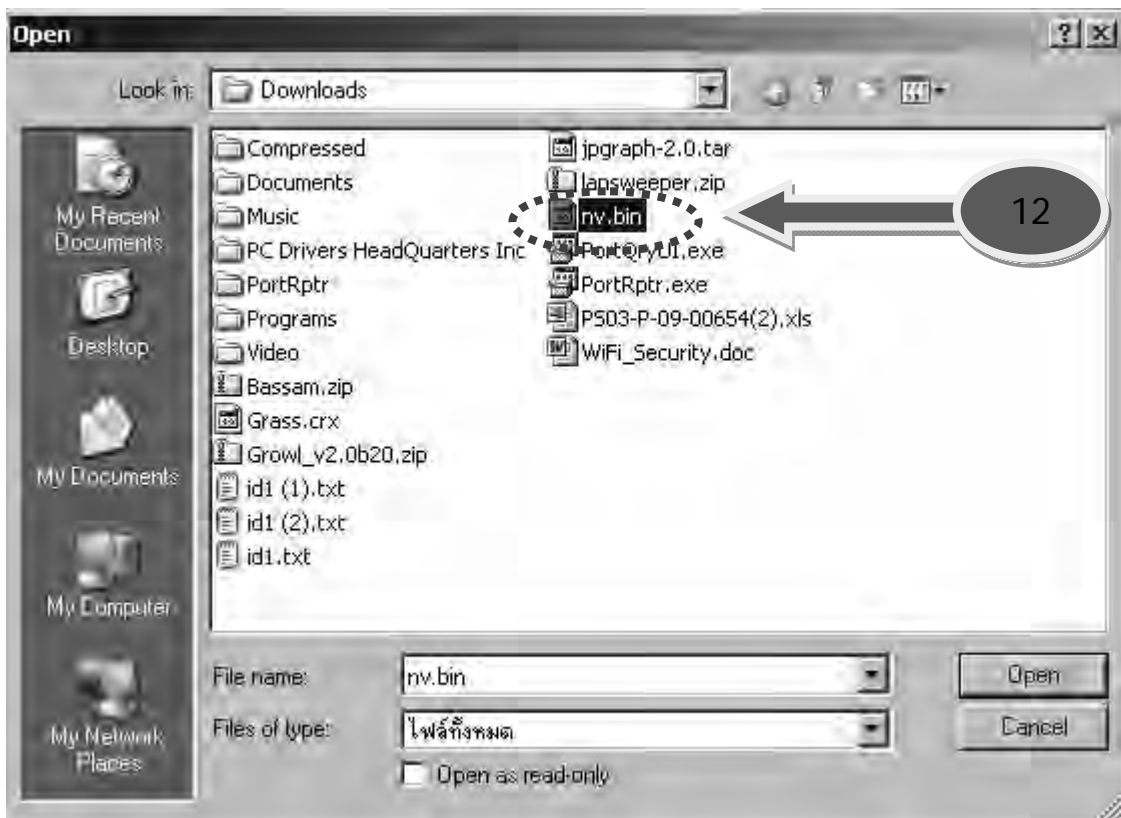
11. ทำการ Backup ไฟล์ตัวอุปกรณ์ BreezeMAX CPE ไปยังโฟลเดอร์ที่เราต้องการ



12. คลิกที่ Browse เพื่อทำการ Restore ไฟล์ตัวอุปกรณ์ BreezeMAX CPE



13. เลือกไฟล์ที่ต้องการทำการ Restore

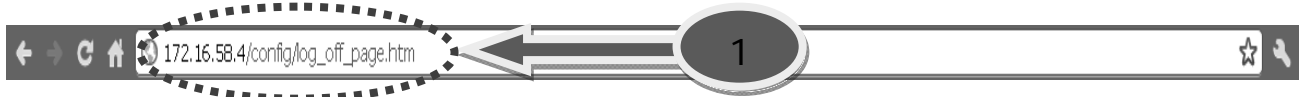


3. การเชื่อมต่อค่าเบื้องต้น Switch D-Link DGS-3100

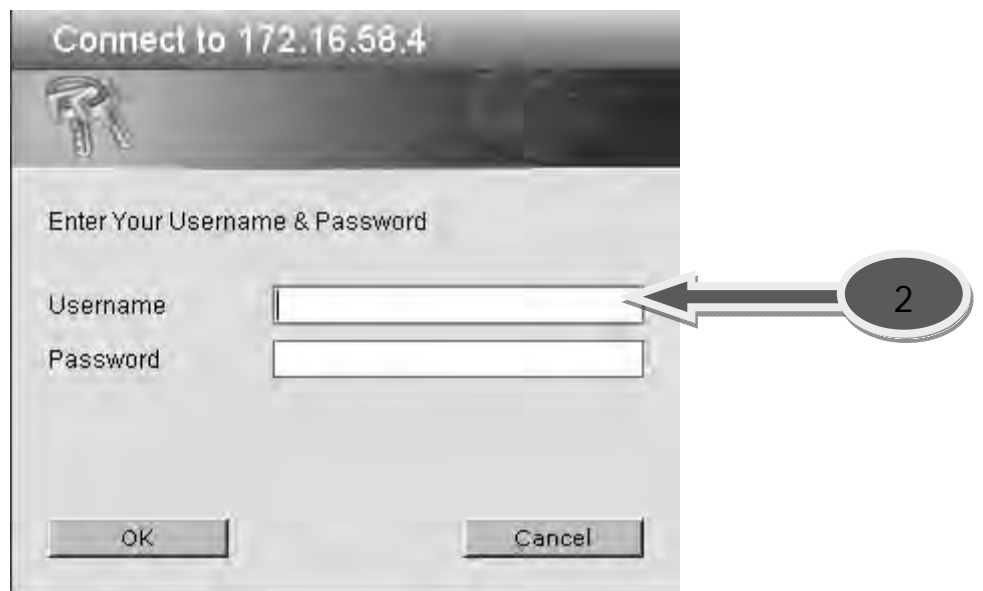


ขั้นตอนการใช้งาน Switch D-Link DGS-3100

1. ผู้ใช้ทำการเชื่อมต่อเข้ากับระบบเครือข่าย WIMAX ที่ VLAN 202 และทำการเซตไอพีแอสเครสให้อยู่ในวง 172.16.58.1/24 ตัวอย่างเช่น IP 192.168.58.5 Netmask 255.255.255.0 ซึ่งจะสามารถเข้าถึงตัว Switch D-Link DGS-3100 ผ่านทางเบราว์เซอร์จากคอมพิวเตอร์ที่ทำการเชื่อมต่อได้
2. เปิดเบราว์เซอร์ที่คอมพิวเตอร์แล้วกรอกไอพีแอสเครส 172.16.58.4



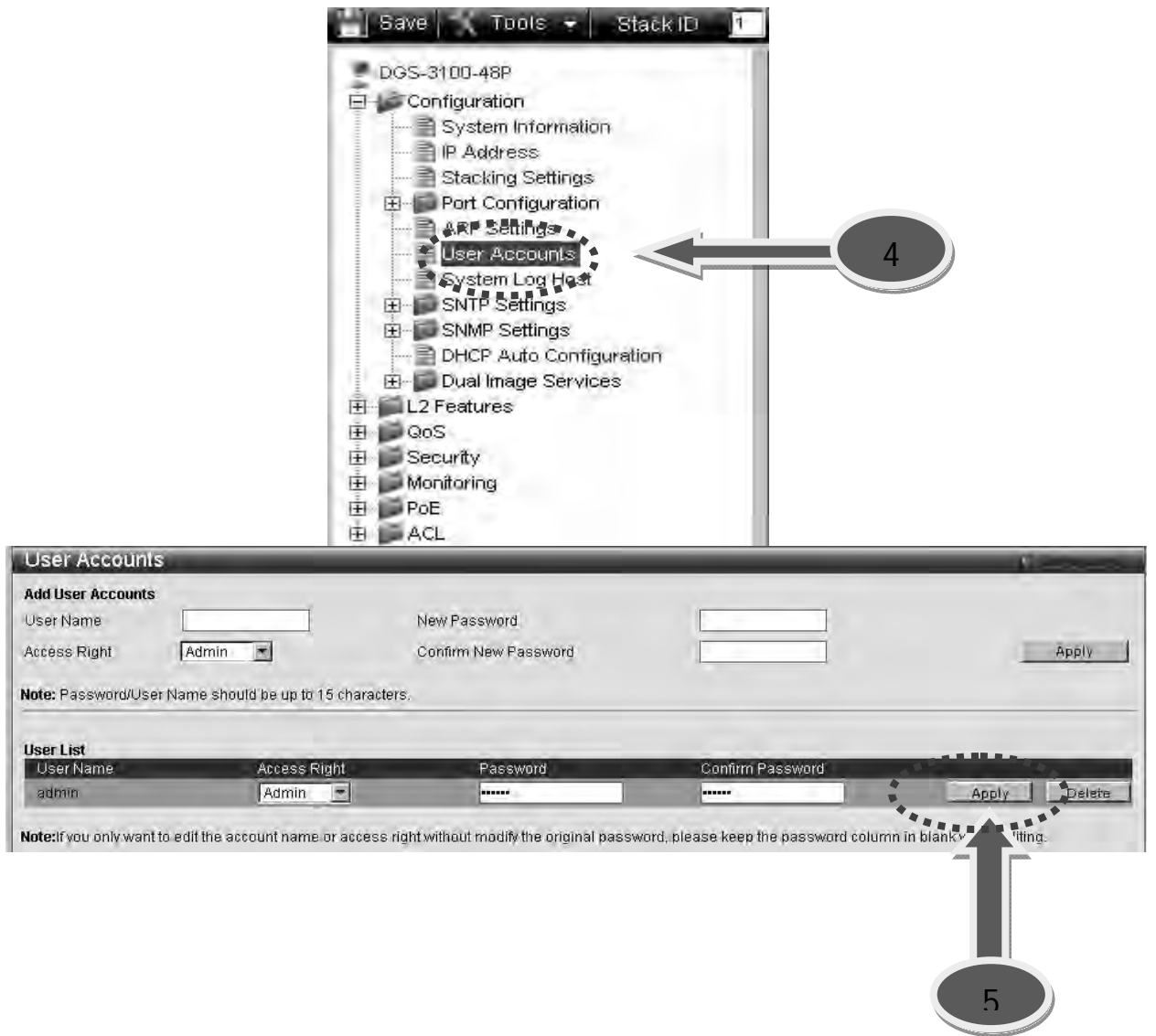
3. ใส่ User Name และ Password ผ่านทางหน้าจอล็อกอิน



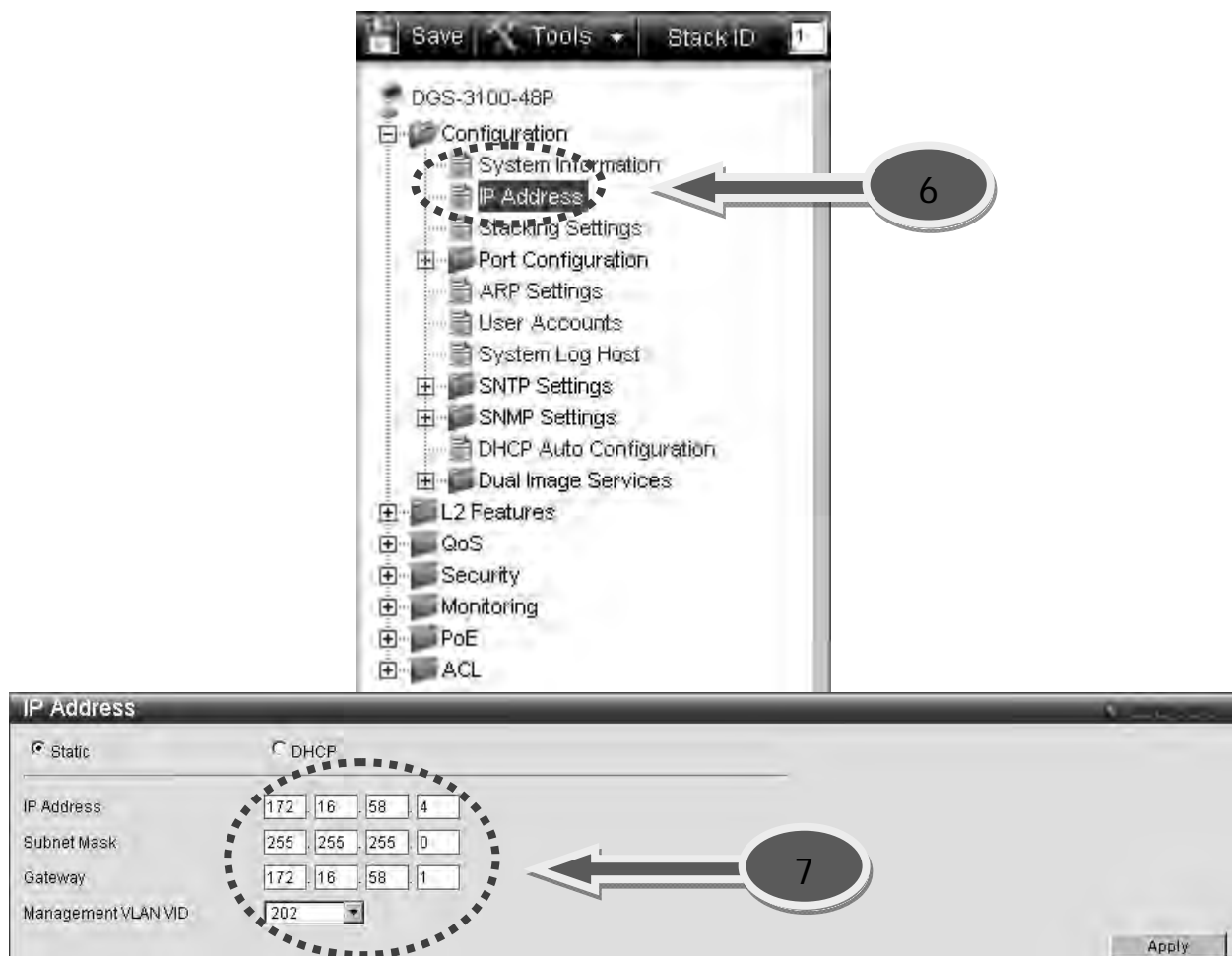
4. เข้าสู่หน้าจอหลักของ Switch D-Link DGS-3100



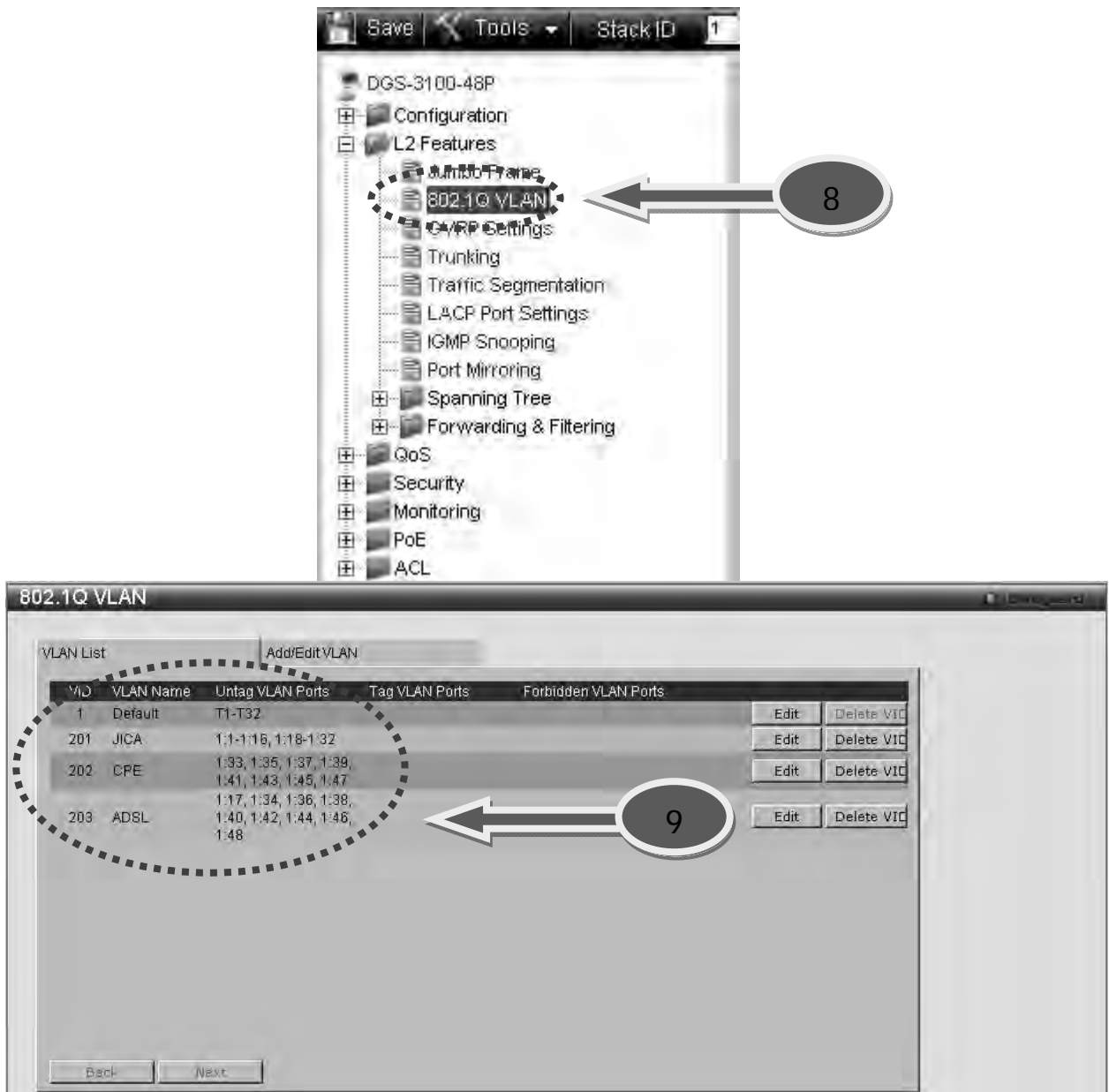
5. คลิกที่ User Accounts เพื่อเข้าไปเปลี่ยนแปลงรหัสผ่าน Switch D-Link DGS-3100 แล้วกด Apply



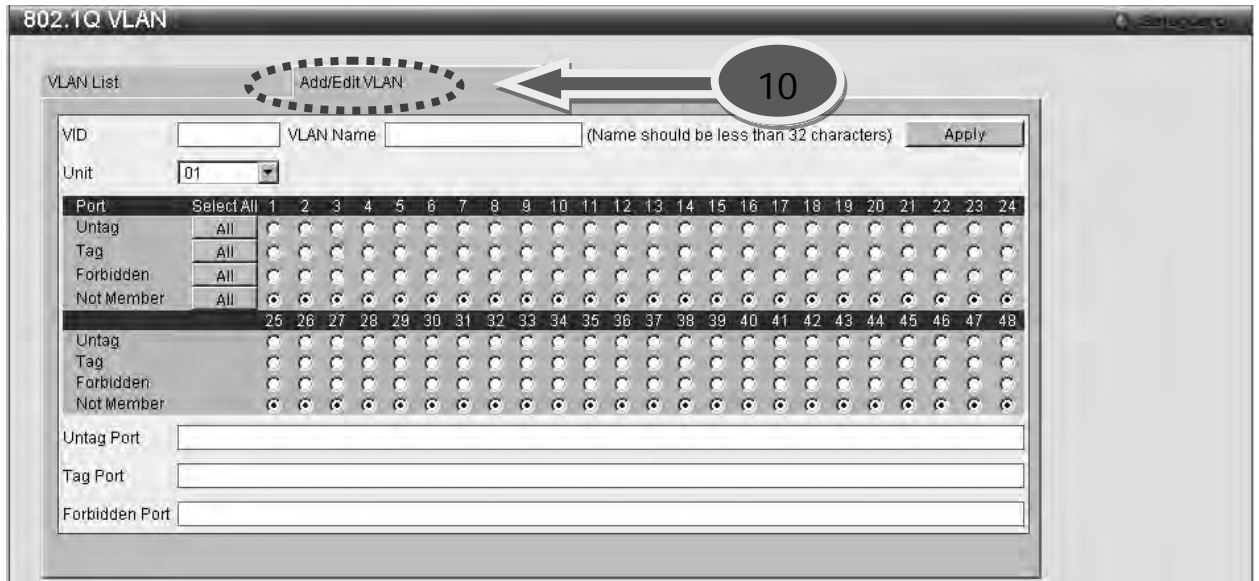
6. คลิกเพื่อเข้าไปเปลี่ยนแปลงไอพีแอสเครสของ Switch D-Link DGS-3100



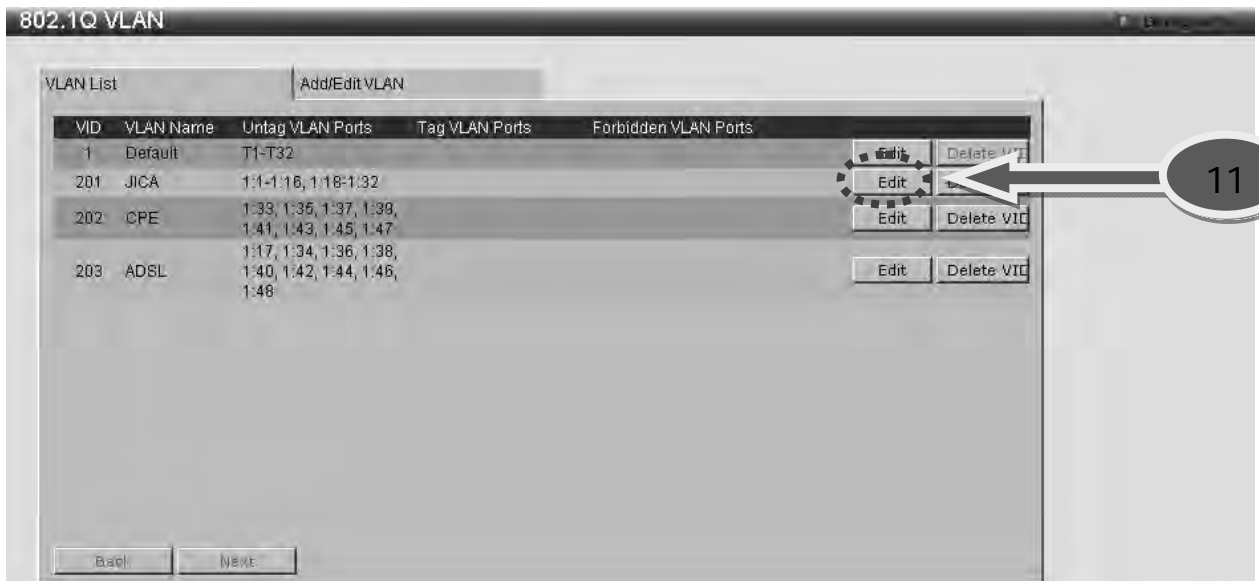
- 7. คลิกที่ L2 Features แล้วเลือก 802.1Q VLAN เพื่อเข้าไปทำการกำหนดค่าต่างๆ ให้กับ Vlan บน Switch D-Link DGS-3100

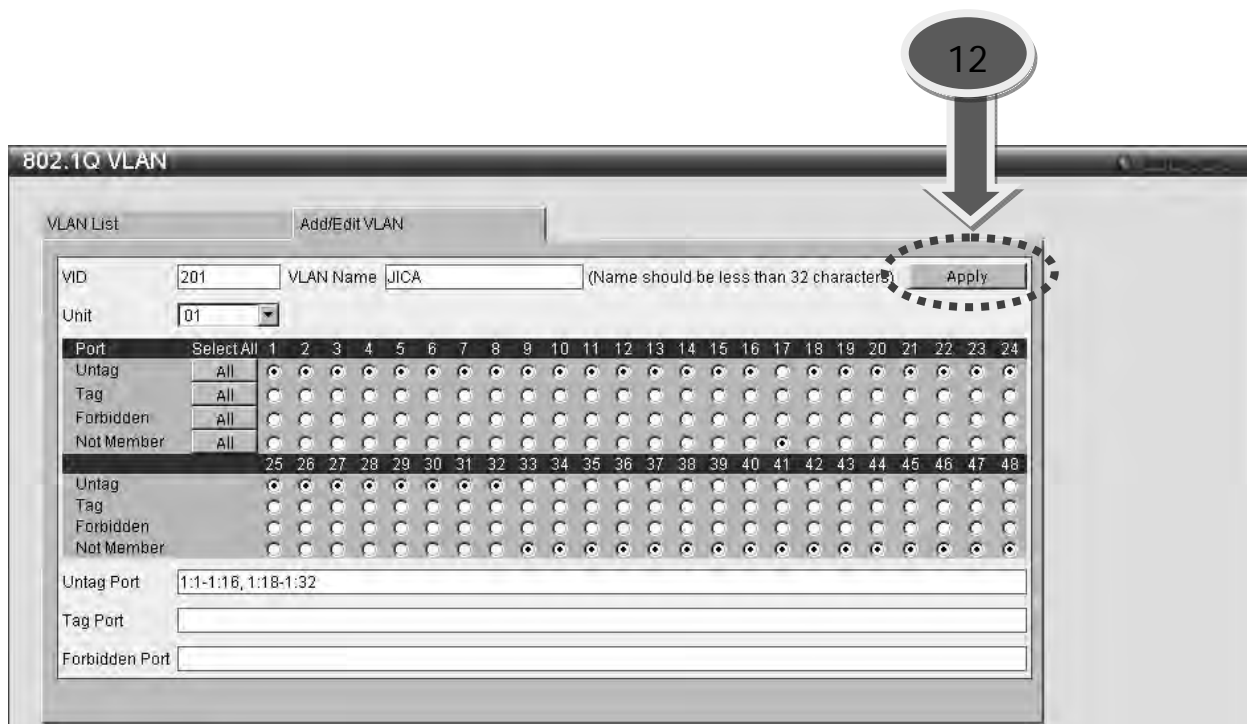


- 8. คลิกที่ Add/Edit VLAN เพื่อทำการสร้าง Vlan ให้กับ Switch D-Link DGS-3100

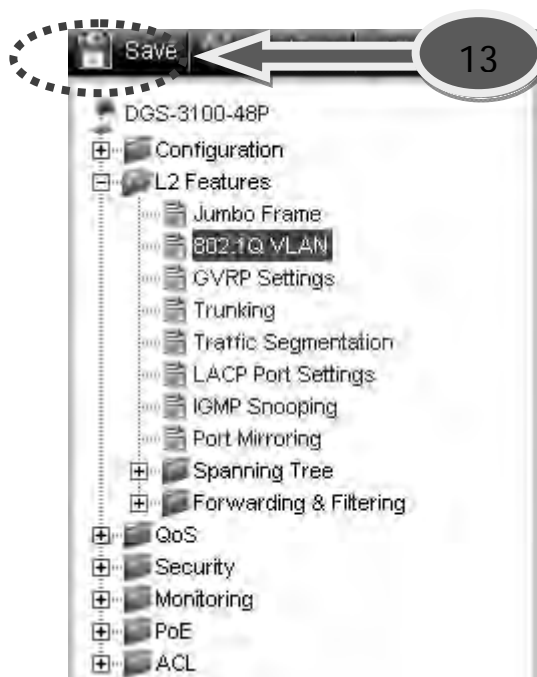


- 9. คลิกที่ Edit เพื่อทำการแก้ไข Vlan ให้กับ Switch D-Link DGS-3100 แล้วกด Apply

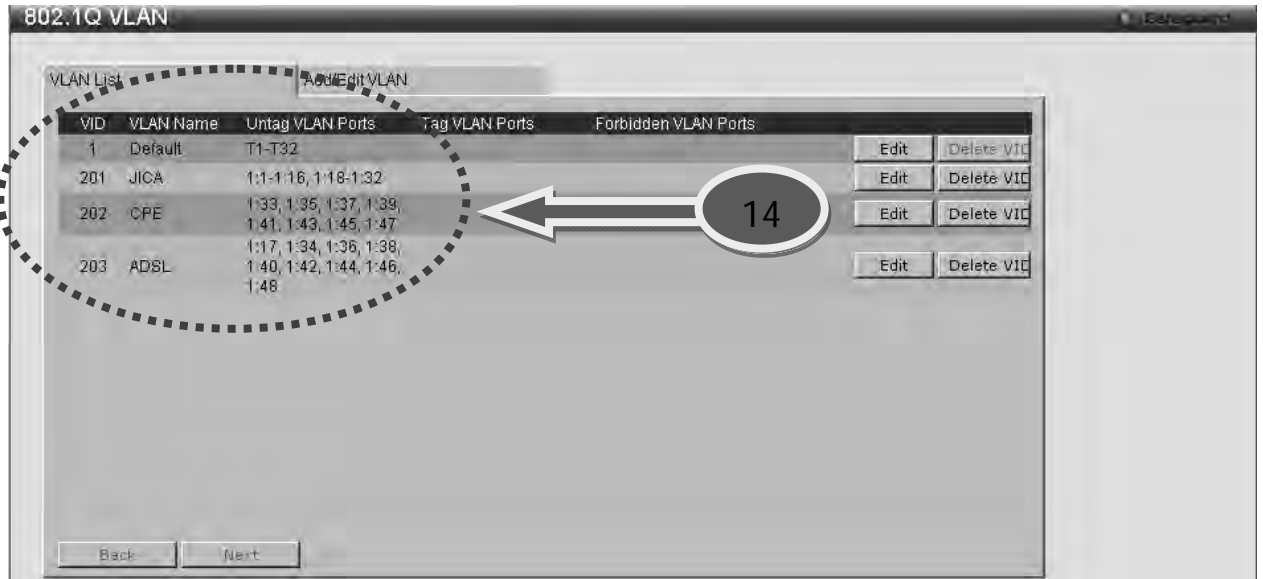




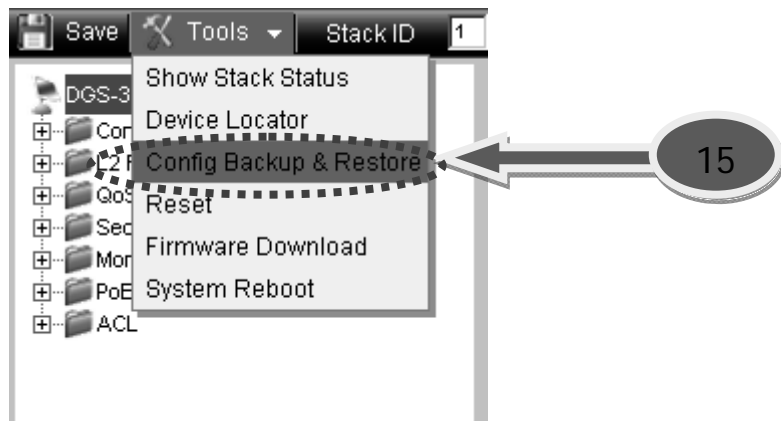
- หลังจากที่ทำการแก้ไข Vlan เรียบร้อยแล้วให้กับ Switch D-Link DGS-3100 ให้กด Save ถ้ามั่นใจแล้วว่าการเซตอัพ ไม่มีอะไรผิดพลาด



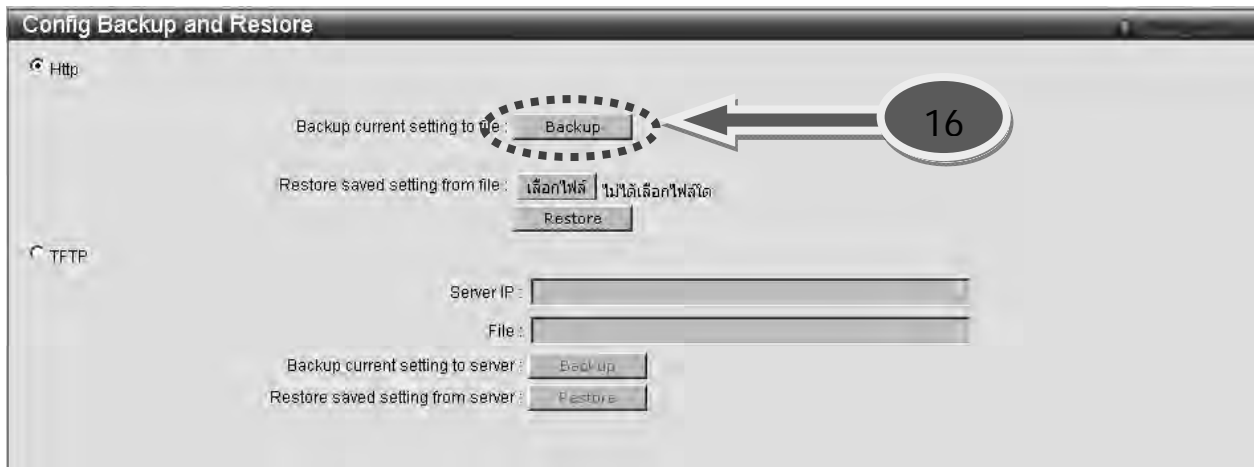
11. คลิกที่ VLANList เพื่อดูการแก้ไข Vlan ให้กับ Switch D-Link DGS-3100 ว่าสำเร็จหรือไม่



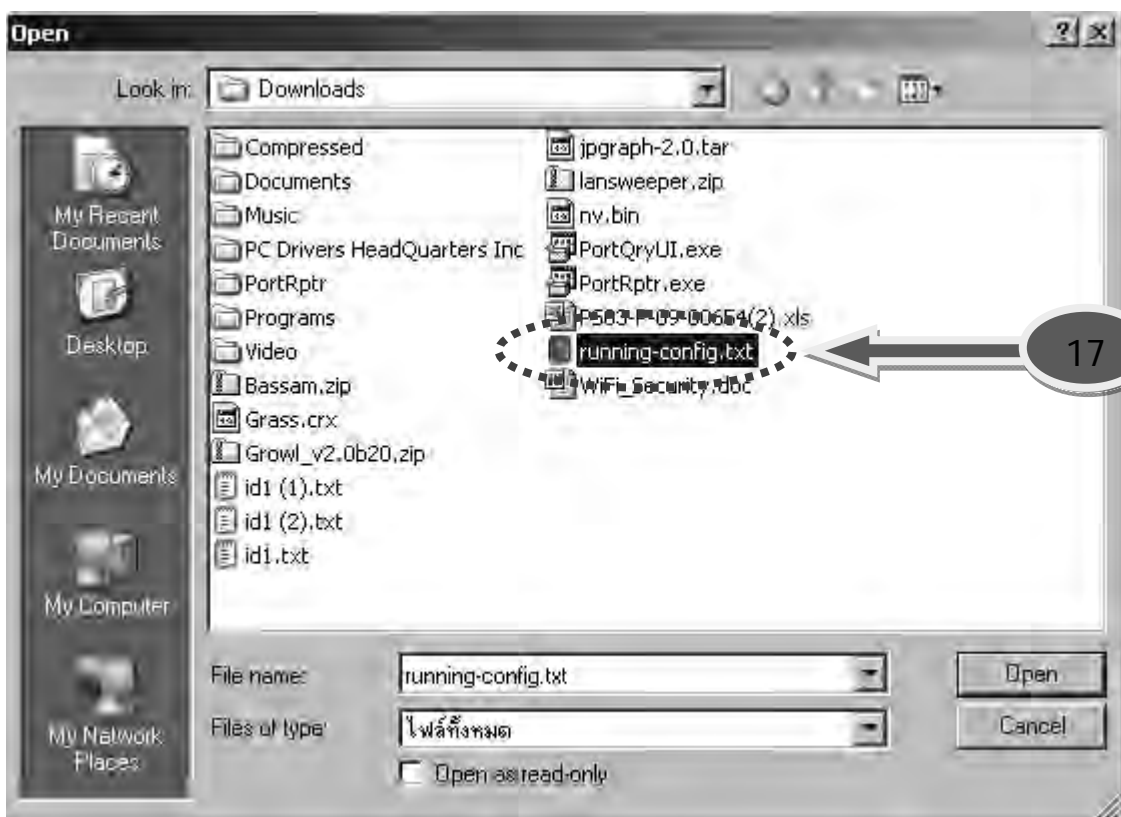
12. คลิกที่ Tools แล้วเลือก Config Backup & Restore



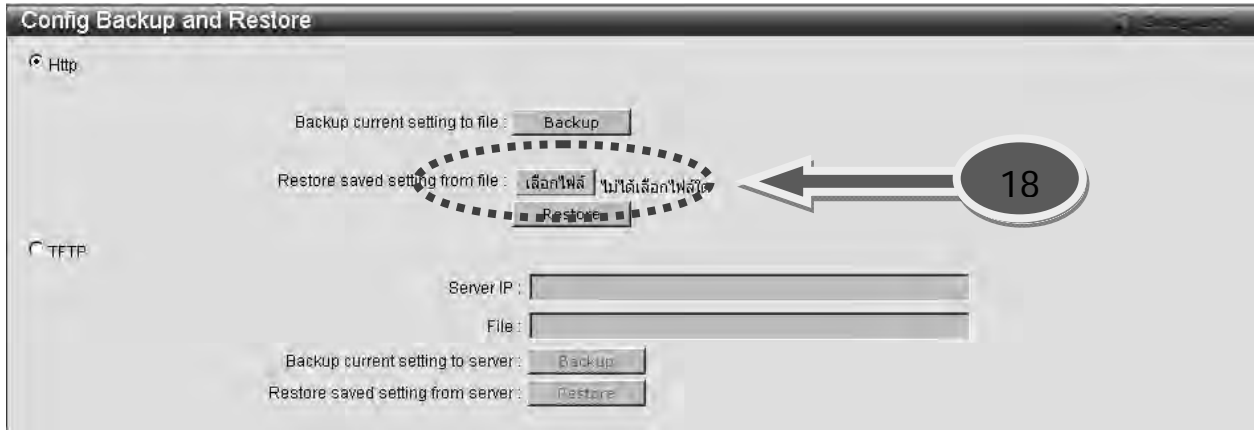
13. คลิกที่ Backup เพื่อทำการ Backup ไฟล์เซตอัปของ Switch D-Link DGS-3100 รวมไปถึงเรื่องของความปลอดภัยก่อนการแก้ไขข้อมูลต่างๆ บนตัว Switch D-Link DGS-3100 ถ้าเกิดความผิดพลาด



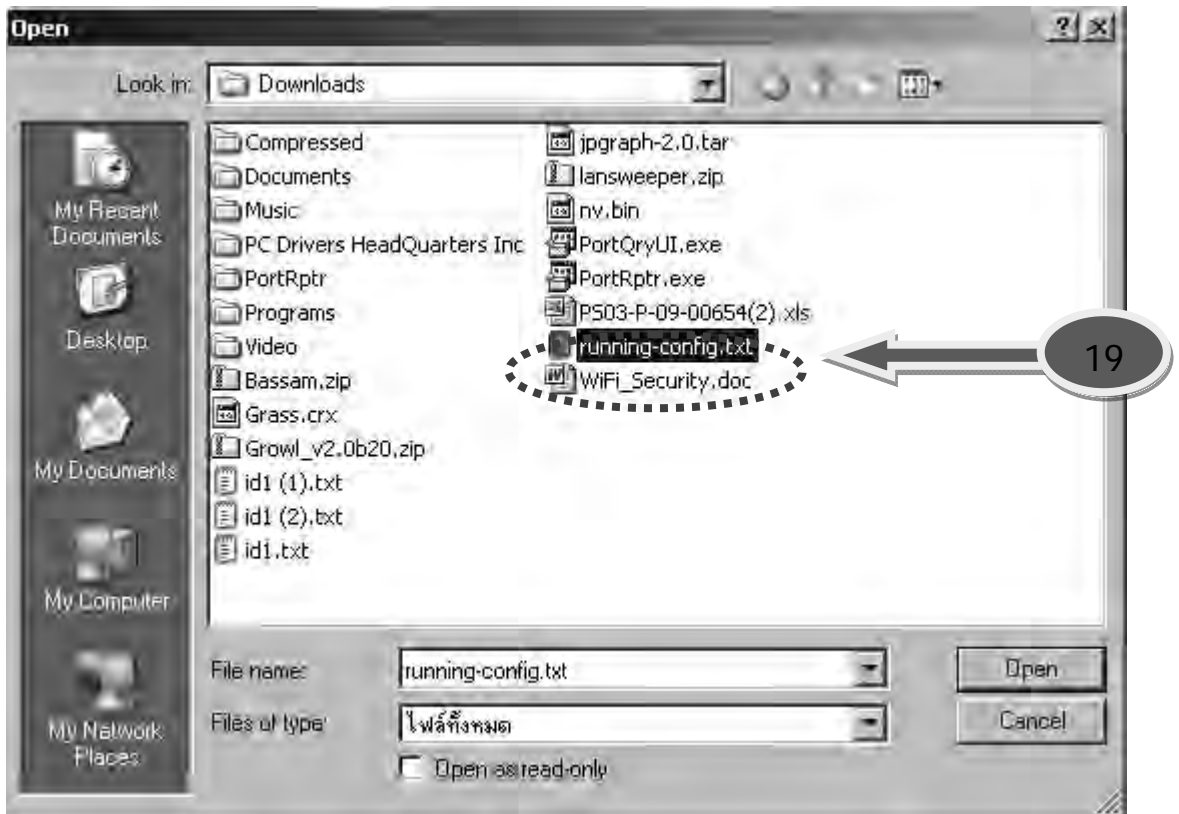
14. เลือกโฟลเดอร์ที่ต้องการจะเก็บไฟล์ Backup พร้อมกับตั้งชื่อให้เหมาะสม



- 15. คลิกที่ เลือกไฟล์ เพื่อนำไฟล์ Backup ที่ต้องการของ Switch D-Link DGS-3100 ในกรณีที่มีการแก้ไขไฟล์ เซตอัฟผิดพลาด



- 16. เลือกไฟล์ที่ Backup ไว้เพื่อทำการ Restore



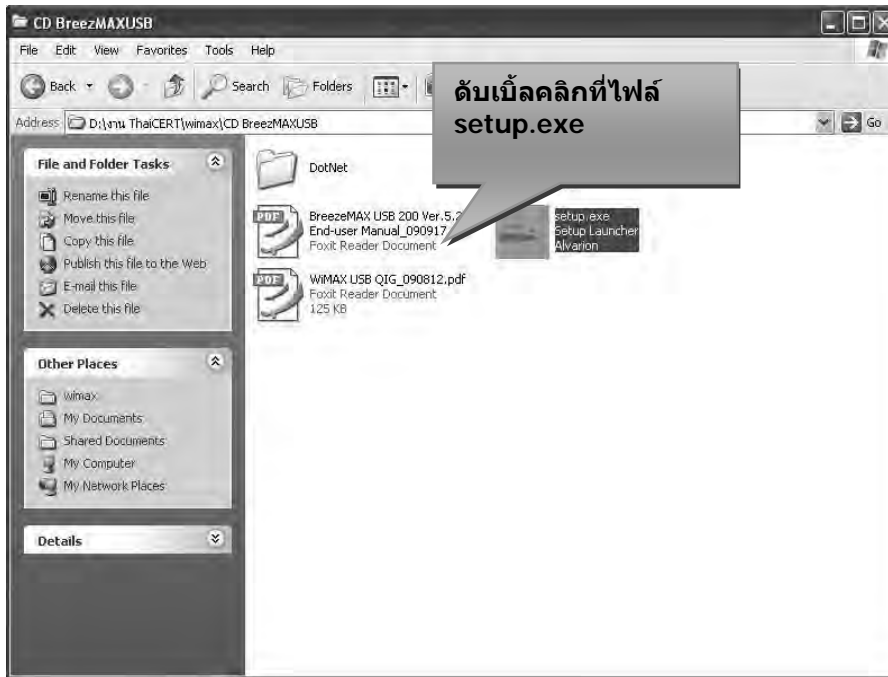
17. หลังจากทำการ Restore ไฟล์เซตอัพเสร็จแล้วก็ทำการ Reboot Switch D-Link DGS-3100



4. การติดตั้ง WIMAX USB

ขั้นตอนการติดตั้ง WIMAX USB มีดังต่อไปนี้

1. ดับเบิลคลิกที่ไฟล์ setup.exe ในแผ่น CD ของ WIMAX USB



2. หลังจากดับเบิลคลิกที่ไฟล์ setup.exe แล้วจะมีหน้าต่างยินดีต่อการติดตั้ง WIMAX USB แล้วคลิกที่ Next เพื่อทำการติดตั้ง



3. คลิกที่ Install เพื่อยืนยันการติดตั้ง



4. เสียบอุปกรณ์ WIMAX USB เข้ากับเครื่องคอมพิวเตอร์ที่เราจะทำการติดตั้ง Dirver และรอกจนกว่าจะติดตั้งเสร็จ



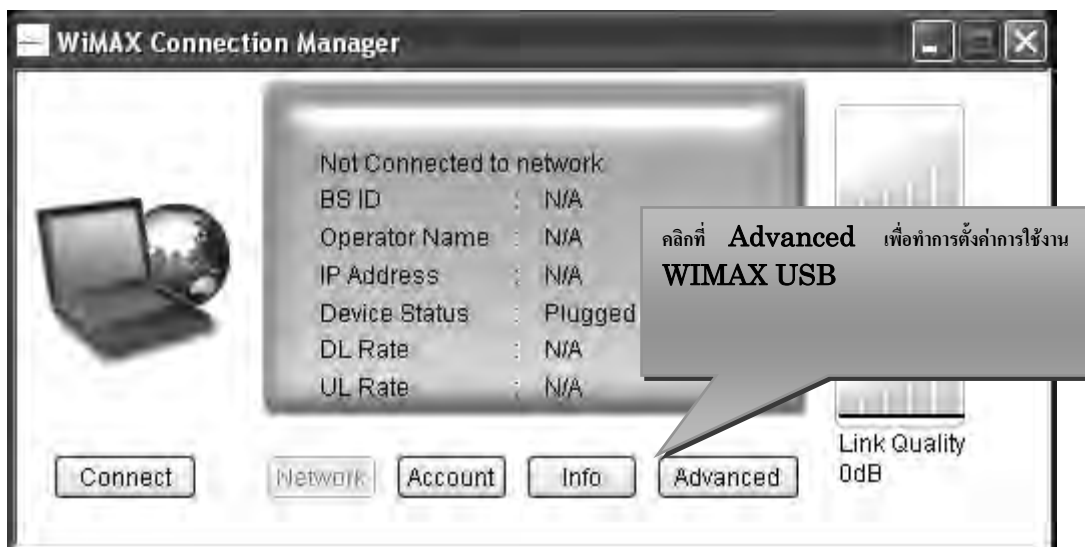
- หลังจากที่ติดตั้งเสร็จจะมีหน้าต่างขึ้นมาบอกว่า InstallShield Wizard Completed แล้วคลิกที่ Finish



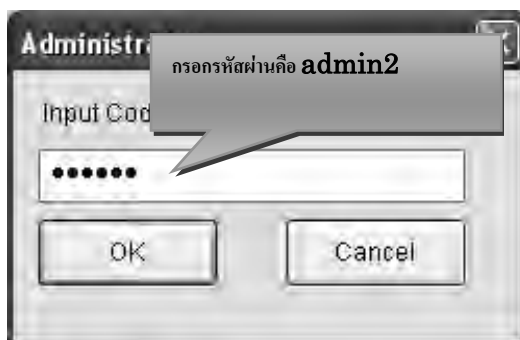
- หลังจากที่คลิก Finish ในขั้นตอนที่ 5 แล้วจะเข้าสู่หน้าแรกของการใช้งานซอฟต์แวร์ WIMAX USB



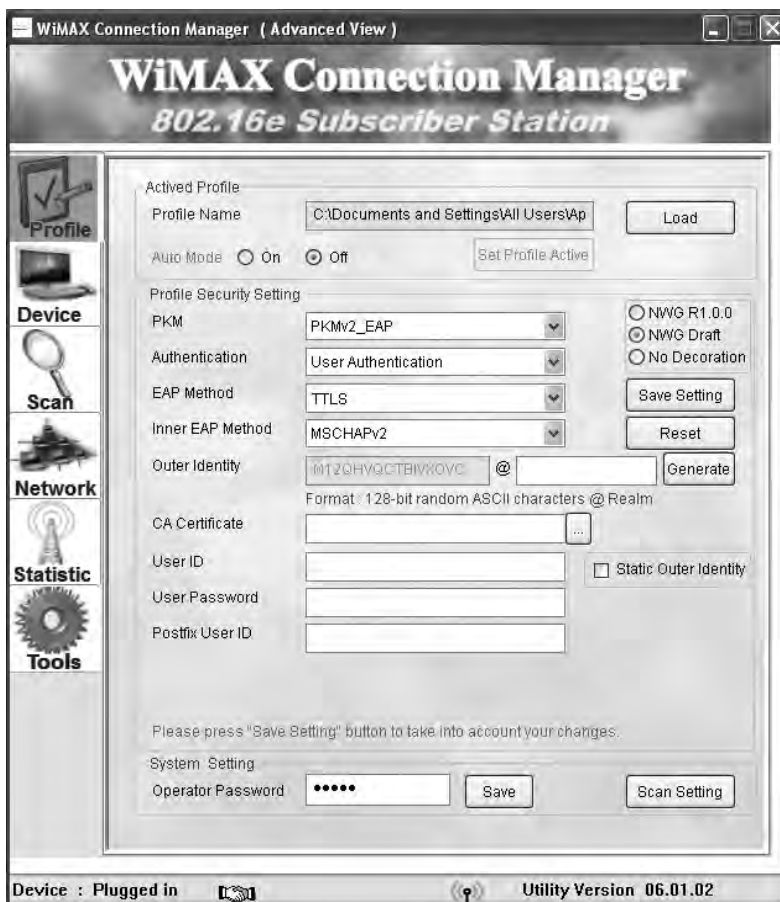
- 7. นำเมาส์ไปคลิกที่ตัวโปรแกรม WIMAX USB แล้วกด Ctrl+Alt+A จะมีปุ่มที่ชื่อว่า Advanced ขึ้นมา เพื่อให้ทำการตั้งค่าการใช้งานบน WIMAX USB



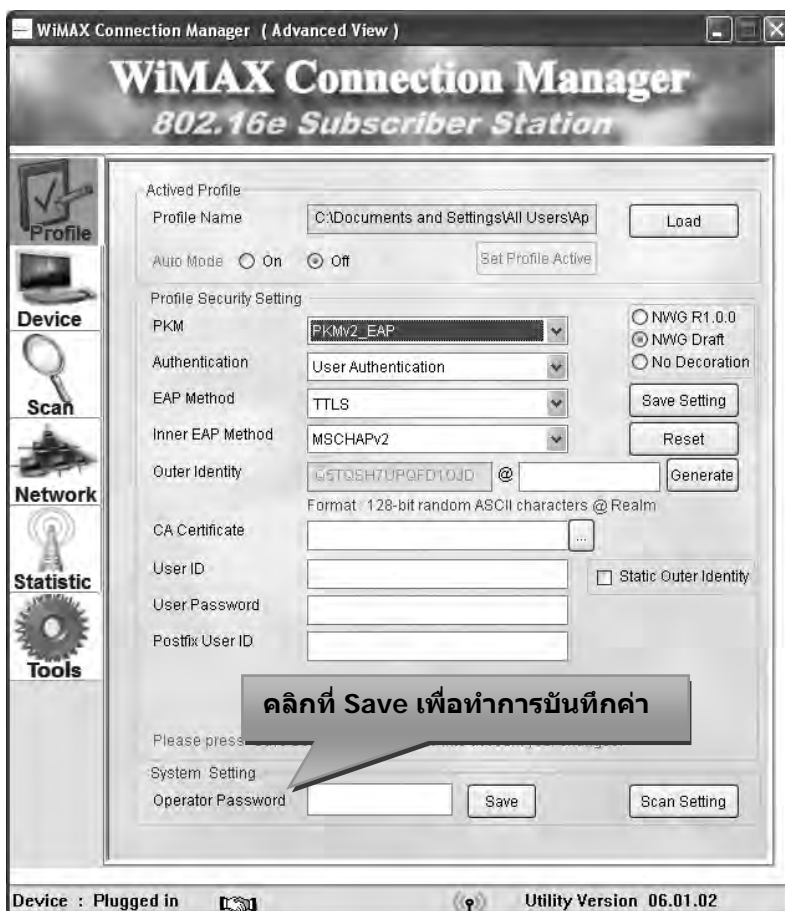
- 8. หลังจากทีคลิกที่ Advanced ในขั้นตอนที่ 7 แล้วจะมีหน้าต่างขึ้นมาให้ใส่รหัสผ่าน



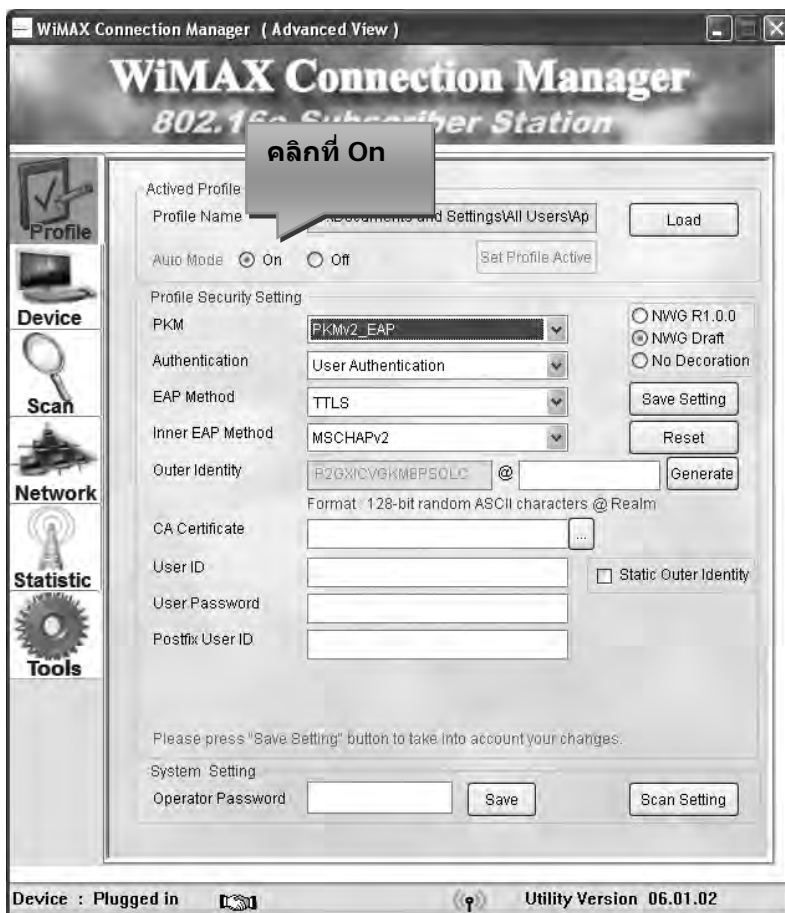
9. หน้าแรกของการตั้งค่า WIMAX USB



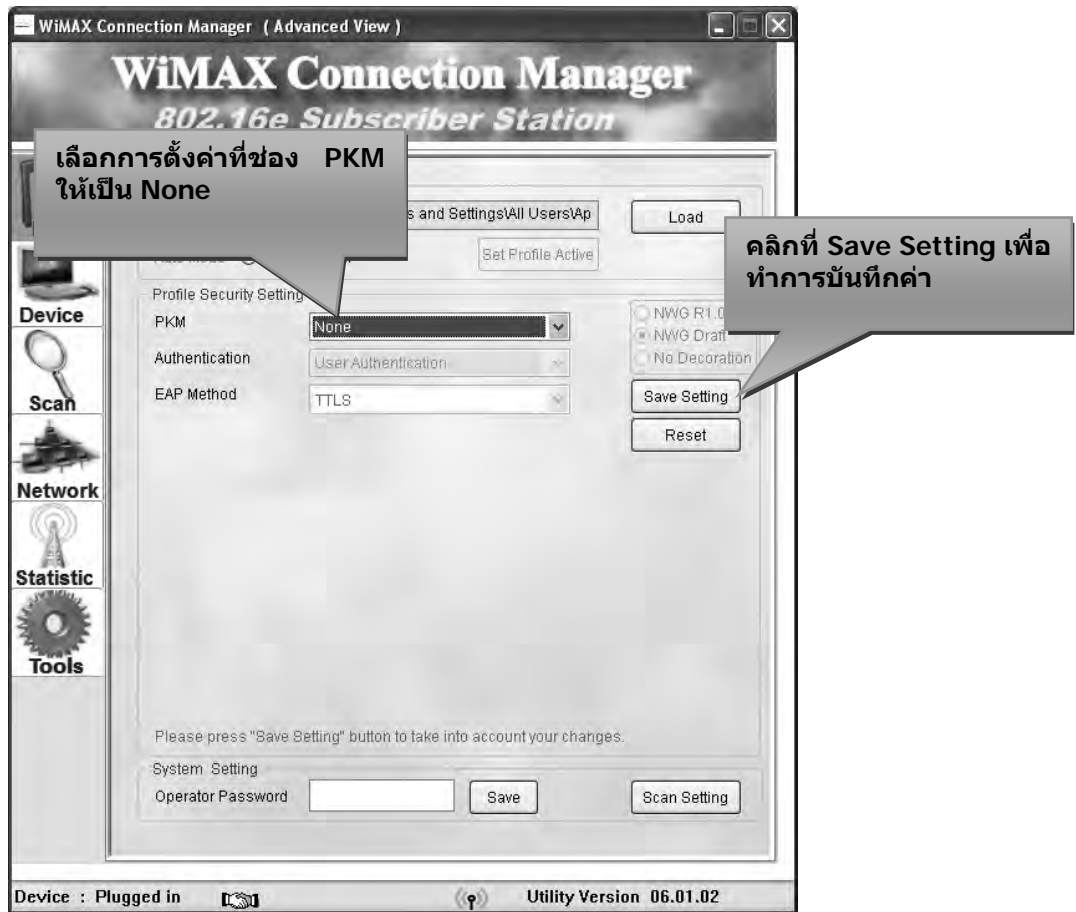
- 10. ทำการลบรหัสผ่านการเข้ามาตั้งค่าโปรแกรม WIMAX USB ที่ช่อง Operator Password แล้วคลิกที่ Save เพื่อทำการบันทึกค่า



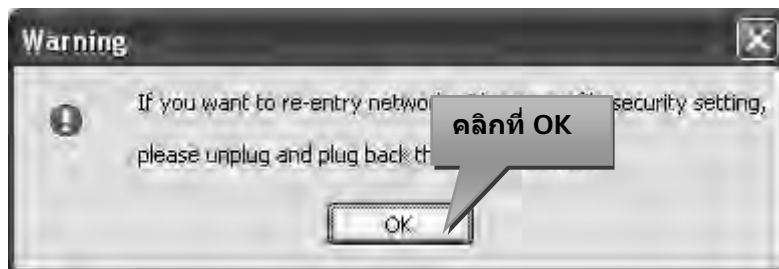
11. เลือกการตั้งค่าที่ Auto Mode แล้วคลิกที่ On เพื่อทำการเชื่อมต่อระบบเครือข่าย WIMAX แบบอัตโนมัติ



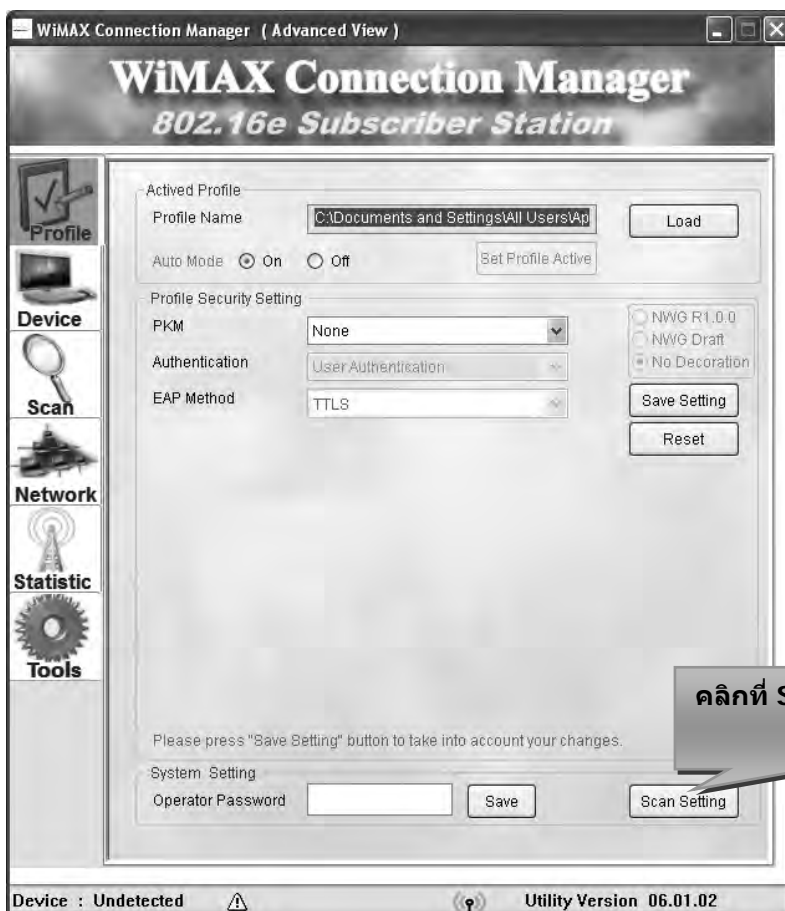
12. เลือกการตั้งค่าที่ช่อง PKM ให้เป็น None เพื่อให้มีการพิสูจน์ตัวตนในการเข้าใช้งานระบบเครือข่าย WIMAX แล้วคลิกที่ Save Setting เพื่อทำการบันทึกค่า



13. ขึ้นคำเตือนให้ถอด WIMAX USB ออกจากคอมพิวเตอร์ก่อนแล้วค่อยเสียบเข้าไปใหม่แล้วคลิกที่ OK



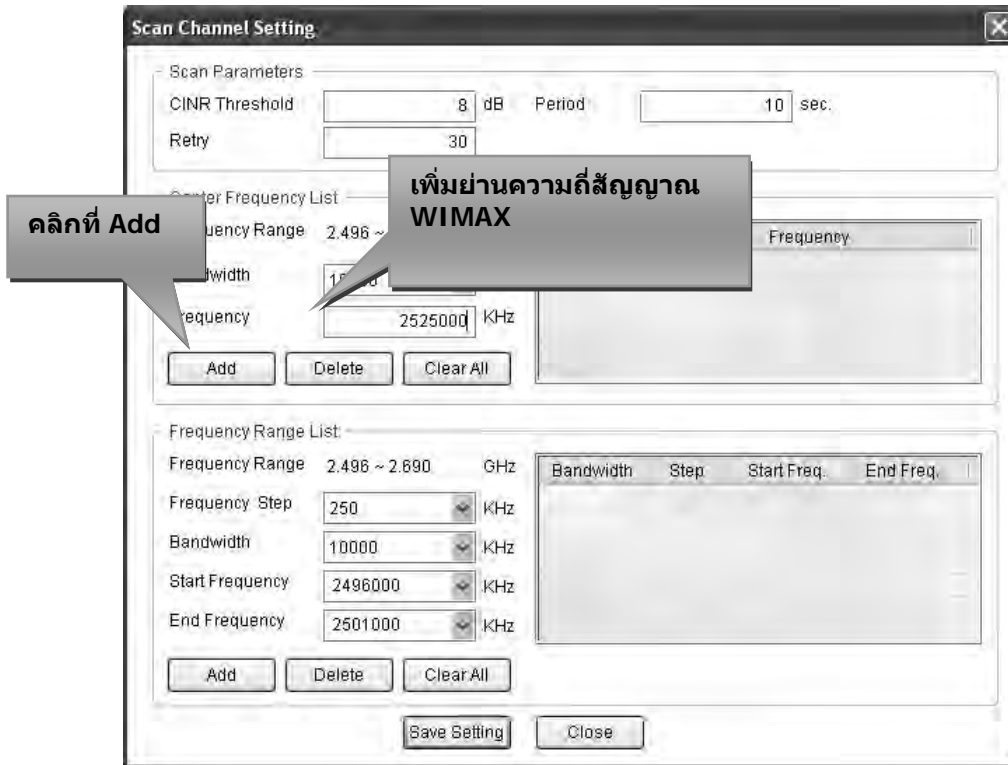
- 14. คลิกที่ Scan Setting เพื่อทำการตั้งค่าย่านความถี่สัญญาณ WIMAX เพื่อใช้งานบนระบบเครือข่าย WIMAX



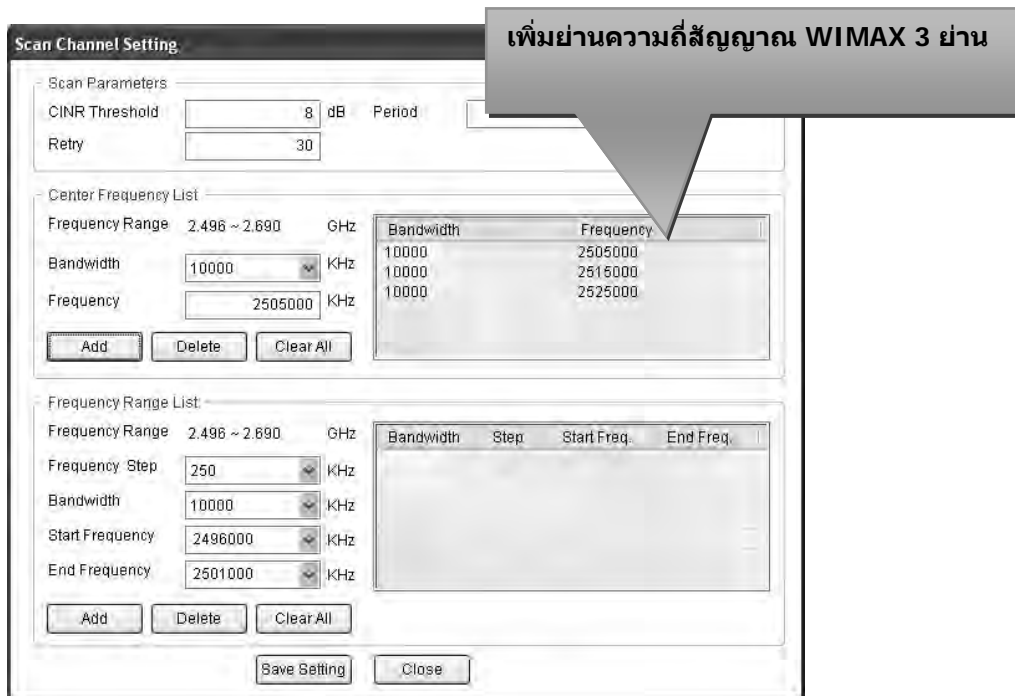
15. เพิ่มย่านความถี่สัญญาณ WIMAX ที่ช่อง Center Frequency List ทั้งหมด 3 ย่านความถี่ ดังนี้

- 10000 - 2525000
- 10000 - 2515000
- 10000 - 2505000

เสร็จแล้วคลิกที่ Add เพื่อเพิ่มความถี่สัญญาณ WIMAX ที่ละย่านความถี่จนครบ



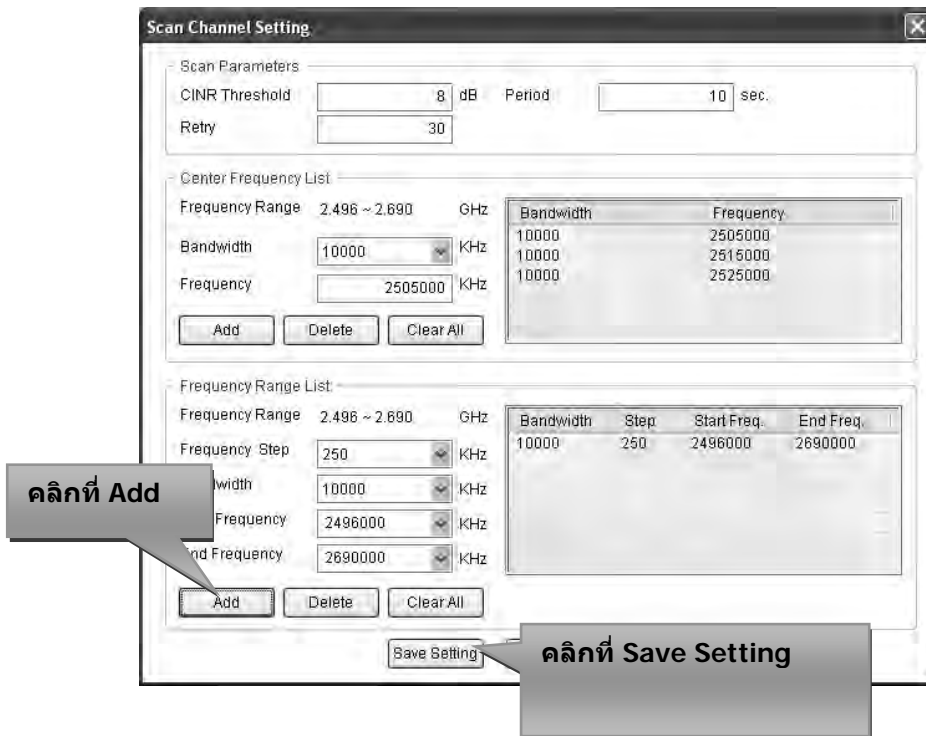
16. หลังจากเพิ่มย่านความถี่สัญญาณ WIMAX ที่ช่อง Center Frequency List ทั้งหมด 3 ย่านความถี่จะ
ได้ดังรูปภาพ



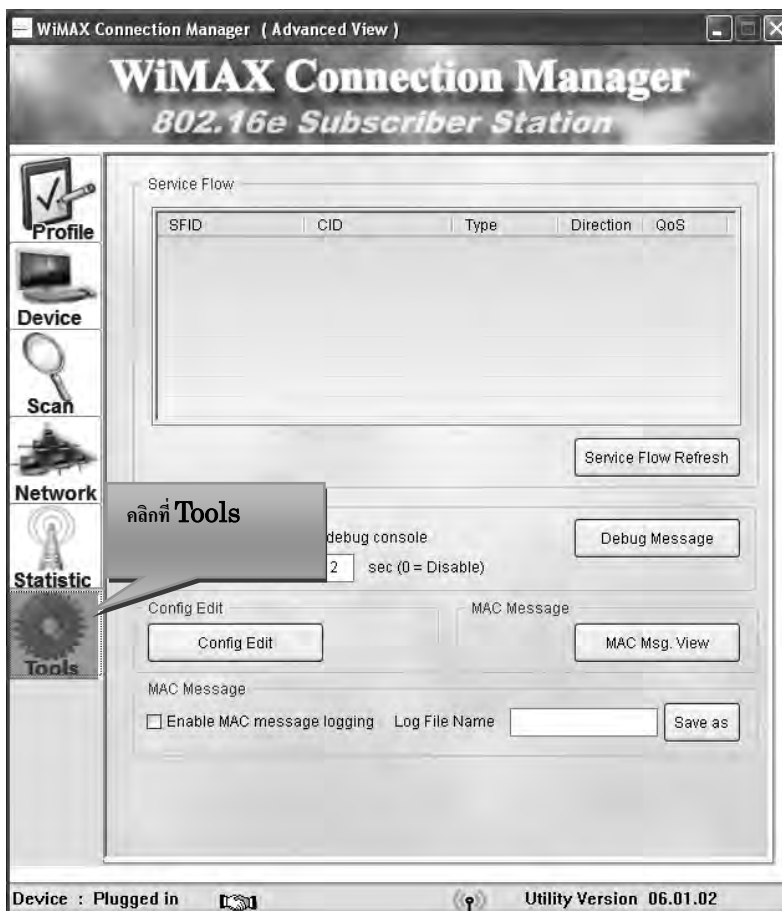
17. เพิ่มช่วงความถี่ของสัญญาณ WIMAX ที่แถบเมนู Frequency Range List ดังนี้

- Frequency Step 250 KHz
- Bandwidth 10000 KHz
- Start Frequency 2496000 KHz
- End Frequency 2690000 KHz

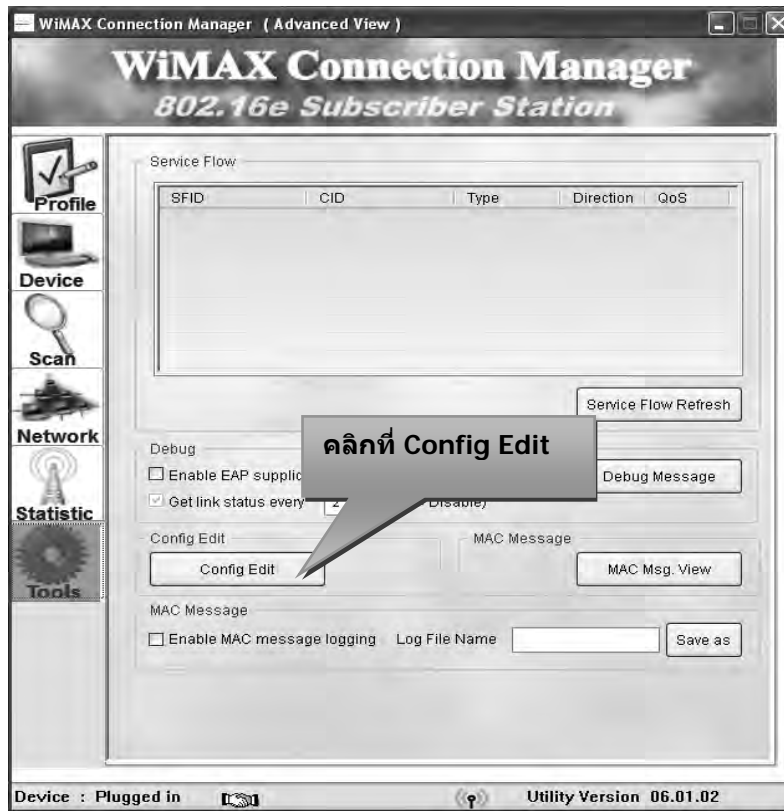
เสร็จแล้วคลิกที่ Add เพื่อทำการเพิ่มค่าแล้วคลิกที่ Save Setting เพื่อทำการบันทึกค่า



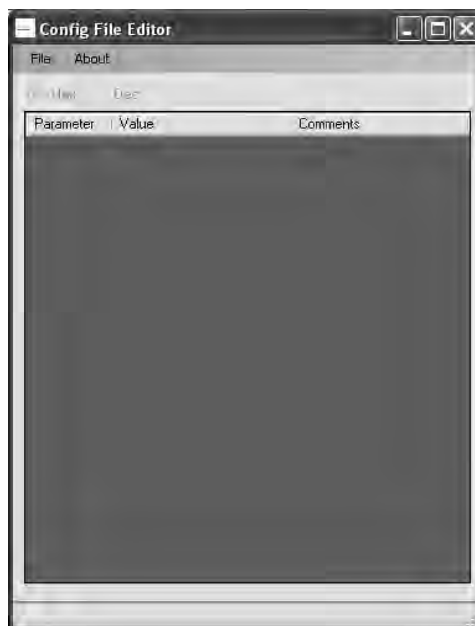
18. คลิกที่แถบด้านซ้ายมือที่เมนู Tools



- 19. คลิกที่ Config Edit ที่เมนู Config Edit เพื่อทำการแก้ไขไฟล์การตั้งค่าการเชื่อมต่อกับระบบเครือข่าย WIMAX



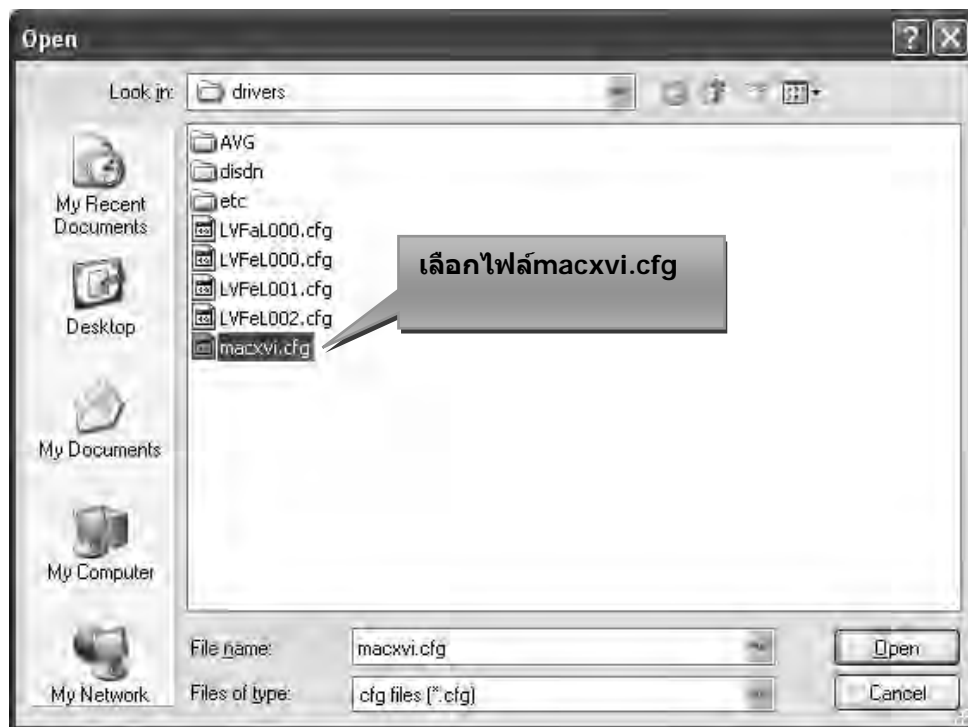
- 20. เมื่อคลิกที่ Config Edit จะมีหน้าต่างขึ้นมาให้ทำการแก้ไขไฟล์การตั้งค่าการเชื่อมต่อกับระบบเครือข่าย WIMAX



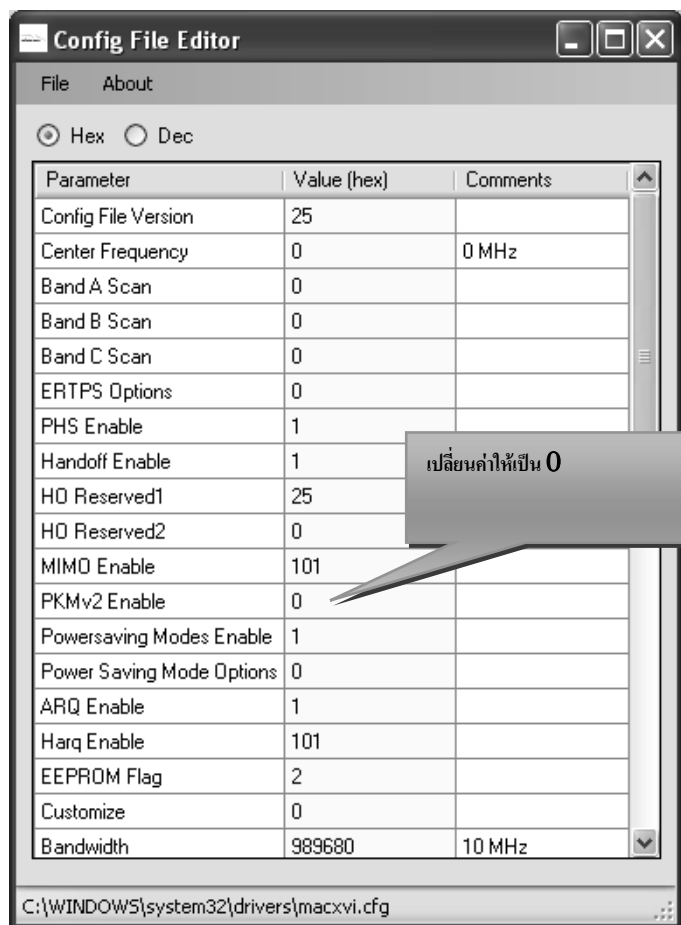
21. คลิกที่เมนู File แล้วเลือก Open เพื่อไปเปิดเอาไฟล์การตั้งค่า



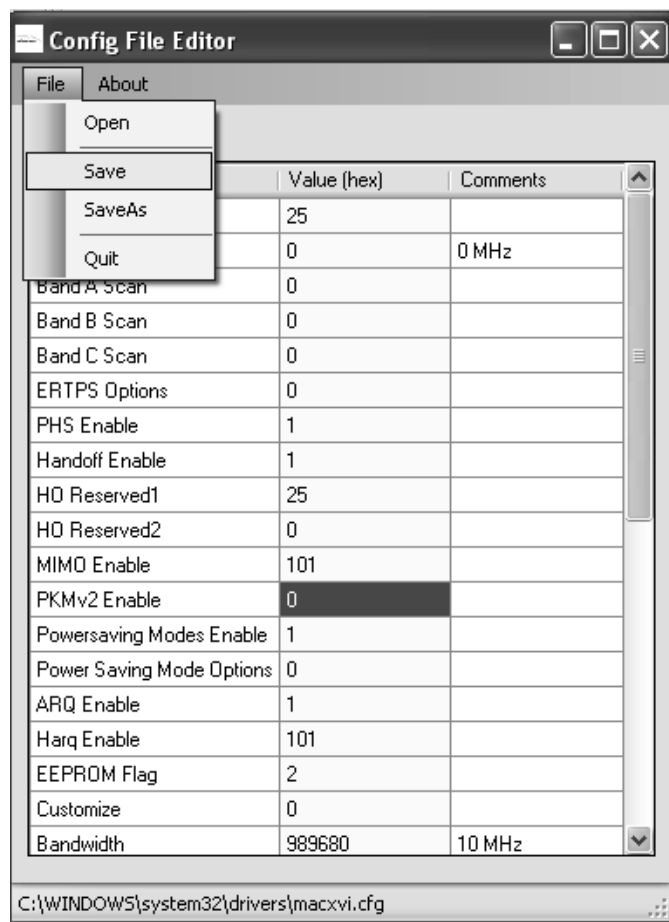
22. เลือกไฟล์ที่ชื่อว่า macxvi.cfg



- 23. ทำการเปลี่ยนค่าที่ช่อง PKM2 Enable ให้เป็น 0 เพราะเราได้เลือกการตั้งค่าแบบไม่มีการพิสูจน์ตัวตนในขั้นตอนที่ 12



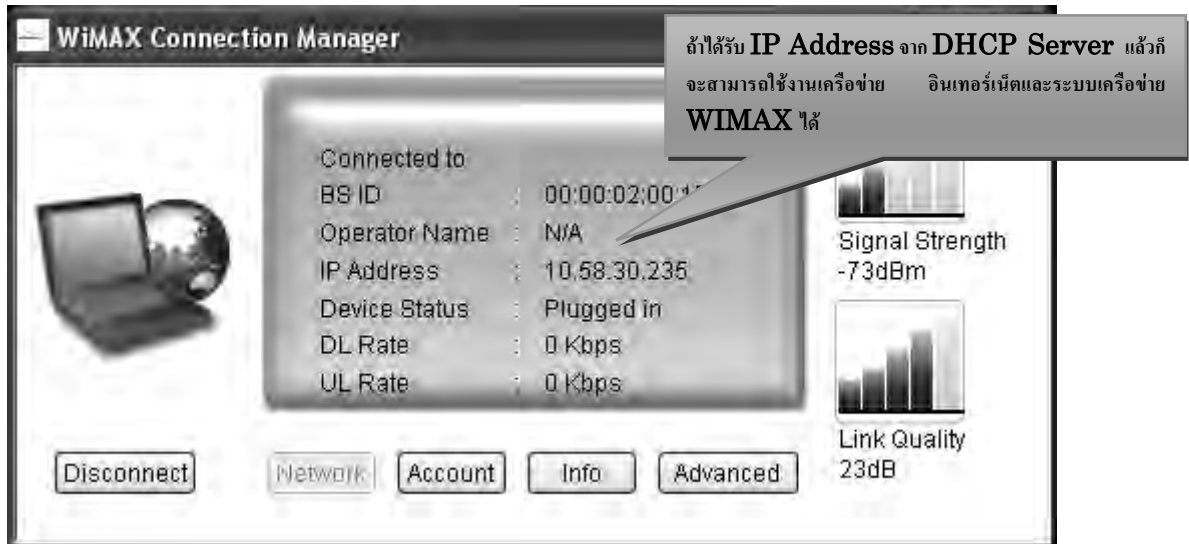
24. คลิกที่ File แล้วเลือก Save เพื่อทำการบันทึกค่า



25. สถานการณ์การเชื่อมต่อระบบเครือข่าย WIMAX จะสังเกตได้จากแถบขวามือที่ Signal Strength ว่า บริเวณที่ใช้งานมีคลื่นสัญญาณ WIMAX หรือไม่



26. สังเกตที่หัวข้อ IP Address ว่าได้รับ IP Address จาก DHCP Server ของระบบเครือข่าย WIMAX หรือไม่



Field Trial Guideline

Team 1 and Team 2

R15



Objective

- (Team 1) To develop RWCS Model
- (Team 2) To measure the APL performance to observe the impact of RWCS implementation





Role Assignment at Testing

- Team 1
 - To conduct the RF measurement in the area with various geographical characteristics
 - To conduct the performance in various weather characteristics
 - To conduct testing on mobility
 - To investigate the WiMAX interference issue and mitigation method
 - To prepare the network infrastructure to support APL performance testing
- Team 2
 - To develop test scenario to validate usability and usage of three major applications (LMS, Video Conf., VOD) and compare before and the after WiMAX implementation. Collect data with cooperation with team 1



Testing

- There are five area of testing
 1. RF testing for geographical characteristics
 2. RF testing for weather characteristics
 3. Application Performance Test
 4. Mobility Test
 5. Interference Test





1. RF testing for geographical characteristics



Objective

- To conduct the RF measurement of BS in different geographical area
- To analyze the relationship between RF measurement and the area
- To support the information for RWCS model



Location

- There are four target types of geographical area
 - City area
 - Flat open field
 - Inside the valley
 - River or lake area
- Measurement distance between BS and Spectrum analyzer → 1 – 2 km with Line of Sight (LOS) location.
- Perform the measurement in each caravan (the total of 7 caravans) with different points in each area

The number of measurement

- MSR area
 - City area (3 Points) x 7 caravan = 21 points
 - Flat open field (3 Points) x 7 caravan = 21 points
 - Inside the valley (3 Points) x 7 caravan = 21 points
- MHS area
 - City area (3 Points) x 7 caravan = 21 points
 - Flat open field (3 Points) x 7 caravan = 21 points
- Pai area
 - City area (3 Points) x 7 caravan = 21 points
 - Flat open field (3 Point) x 7 caravan = 21 points
 - River or lake area (3 Points) x 7 caravan = 21 points

RF Testing Equipment and Procedures

- Equipments
 - Anritsu Spectrum Analyzer with 2.5 GHz rubber antenna
 - Mount rubber antenna on the roof of a Van
 - WiMAX USB dongle mounted on the roof of a Van
- Testing procedures
 - Stand at the selected location
 - Line of sight between BS and Anritsu
 - Turn on Anritsu Spectrum Analyzer and wait until it can detect the stable signal, also connect WiMAX using WiMAX USB dongle
 - Record RSSI, CINR, Channel Frequency, GPS location from both Anritsu and WiMAX USB dongle



2. RF testing for weather characteristics



Objective

- To measure RF signal at various locations (45 project sites) in different season
- To analyze the relationship between RF measurement and the weather



Location and Frequency of measurement

- Measure RF Signal (RSSI and CINR) experienced by WiMAX CPE in each area
- Measure weather condition in 3 districts (MHS, MSR and Pai)





3. Application Performance Test



Application Performance Test

Objective

- To measure the APL performance to observe the impact of RWCS implementation
- There are four applications to be tested
 - VoIP testing (by Team 1)
 - LMS testing (by Team 2)
 - Videoconference testing (by Team 2)
 - Video on Demand or Video streaming (by Team 2)

VoIP Testing (by Team 1)

- Frequency: twice a year, depending on test results
- Data collection schedule
 - 3rd Caravan (Nov., 2010)
 - 5th Caravan (Mar., 2011)
 - Jul., 2011 * Team 1 Japanese experts and C/P (team 2)
 - Oct., 2011 *Team2 to collect data
- Location: The top 2 sites in terms of network performance from each region (MHS, PAI, MSR)
- Tools
 - VoIP phone connected to Berkeke VoIP Server at Core 1



VoIP Testing - Scenario

- Make a VoIP call between two selected sites
- Measurement metrics
 - Connectivity (can make the connection or not)
 - Quality of voice (voice clarity, delay) and record in the Mean Opinion Score (MOS, 1-5)
- MOS criterion

MOS score	Quality	Impairment
5	Excellent	No break, no obstacles for voice communications
4	Good	No breaks, but difficult to listen
3	Fair	Some breaks of voice, but able to converse
2	Poor	Interruptions and breaks of voice, unable to converse
1	Bad	No connection established, unable to converse



VoIP Testing - Procedure

- Check the status of VoIP phone – registered ?
- Site 1 calls Site 2 – Check ringing ?
- Each site starts the conversation
 - Site1: Hello, My name is, How are you?
 - Site2: Yes, I am fine, where are you now?
 - Site1: I am at site 1 performing the voip call, how is the voice ?
 - Site2: Voice is ok, how is weather over there.
 - Site1: Weather is just fine. Ok, talk to you later.
 - Site2: Ok, Bye Bye
- Observe the quality of voice in term of sound clarity and delay



LMS Testing (by Team 2)

- Frequency: twice a year, depending on test results
- Data collection schedule
 - 3rd Caravan (Nov., 2010)
 - 5th Caravan (Mar., 2011)
 - Jul., 2011 * Team 1 Japanese experts and C/P (team 2)
 - Oct., 2011 *Team2 to collect data
- Location: The top site in terms of network performance from each region (MHS, PAI, MSR)
- Tools
 - LMS Server
 - PC to access LMS server (at Core1) and retrieve the content
 - DU meter



LMS Testing Scenario

- Take a lesson using learnsquare server at Core I via WiMAX and Internet routes
- Measurement metrics
 - Connectivity (can make the connection to the server or not)
 - Quality of connection (speed/bandwidth/time)
- Performance matrix

Upload/Download speed (kbps) and duration (sec)	Large file size (20MB)	Medium file size (10MB)	Small file size (1MB)
Download via WiMAX			
Download via Internet			
Upload via WiMAX			
Upload via Internet			



LMS Testing Procedure

1. Connection to the server
2. On WiMAX network, connect to <http://10.100.1.3/>. Learnsquare main page will be shown if connection is successful.
3. On a non-WiMAX network, connect to <http://202.29.94.78> (internet). Learnsquare main page will be shown if connection is successful.
4. Upload and Download and measure the speed and time usage by DU Meter



LMS Testing Procedure - Download

1. Log in as a test user (log in: testuser, passwd: wimaxtest)
2. click menu "รายวิชา"
3. click curriculum "performance test"
4. click tab "สารบัญ"
5. click " download step"
6. <download test file from page's link 3 steps>
7. Repeat for 3 files: 20MB, 10MB, and 1MB.
8. Record speed and duration from DU meter to AllDataCollectionSheet (sheetname: APL-LMS)
9. Add any comment on column AG



LMS Testing Procedure - Upload

1. Rename the downloaded files by adding "-up" in the filenames.
2. Log in as a test user (log in: testuser, passwd: wimaxtest)
3. click menu "สร้างหลักสูตร"
4. click curriculum "performance test"
5. click tab "จัดการไฟล์"
6. click "choose file" -> browse test file (1MB, 10MB, 20MB). **
7. click button "upload"
8. Repeat for 3 files: 20MB, 10MB, and 1MB.
9. Record speed and duration from DU meter to AllDataCollectionSheet (sheetname: APL-LMS)
10. Add any comment on column AG



Videoconference Testing (by Team 2)

- Frequency: twice a year, depending on test results
- Data collection schedule
 - 3rd Caravan (Nov., 2010)
 - 5th Caravan (Mar., 2011)
 - Jul., 2011 * Team 1 Japanese experts and C/P (team 2)
 - Oct., 2011 *Team2 to collect data
- Location: The top 2 sites in terms of network performance from each region (MHS, PAI, MSR)
- Tools
 - AcuConference Server
 - PCs at two selected sites, webcam, headphone, good quality microphone



Videoconference Testing Scenario

- A call within the same WiMAX coverage and across different coverages i.e. MHS-MHS, MHS-MSR, MHS-PAI, and so on
- Need to identify the best configuration parameters for best call quality (vendor?)
- Measurement metrics
 - Connectivity (can make the connection to the server or not)
 - Quality of connection (voice and video clarity, delay) and record in the Mean Opinion Score (MOS, 1-5)



Videoconference Testing Scenario

MOS Voice score	Quality	Voice Impairment
5	Excellent	No break, no obstacles for voice communications
4	Good	No breaks, but difficult to listen
3	Fair	Some breaks of voice, but able to converse
2	Poor	Interruptions and breaks of voice, unable to converse
1	Bad	No connection established, unable to converse

MOS VDO score	Quality	Video Impairment
5	Excellent	Smooth picture transferring, good picture quality and no problem for viewing
4	Good	No interruptions, or blocks, but picture quality is poor
3	Fair	Some interruptions in motions, blocks, but able to view
2	Poor	Frequent interruptions in motions, blocks, and unable to view
1	Bad	No picture appearing

Videoconference Testing Procedure 1

1. Connect webcam, headphone, and microphone to the WiMAX PCs.
2. From 2 WiMAX sites, connect to AcuConf server at <http://10.100.1.4/login>
3. Login (Company Name: nectec, user: nectec01, passwd: nectec01)
4. Click on conference room "live_class_Demo" (see AcuConf user guide)
5. Click Start button.
6. If successful, record data to AllDataCollectionSheet (sheetname: APL-VDOConference), column J.
7. Add any comment in column N

Videoconference Testing Procedure 2

1. Conference participants each introduces themselves
2. Each participant says their name, school, hobby, teaching experience, what do you think about WiMAX project? (2 minutes each)
3. Record MOS scores to AllDataCollectionSheet (sheetname: APL-VDOConference)
4. Add any comment
5. Share a desktop/PPT



Videoconference Testing Procedure 3

1. Share a desktop/PPT
2. Switch to “host control” mode
3. Click “Share screen” button
4. Host: open a presentation file
5. Host show Page #1 and asks students what they see.
6. Students speak back what they see on Page #1
7. Repeat for 2 more pages
8. Everyone records the MOS scores to AllDataCollectionSheet (sheetname: APL-VDOConference)
9. Add any comment



VOD Testing (by Team 2)

- Frequency: twice a year, depending on test results
- Data collection schedule
 - 3rd Caravan (Nov., 2010)
 - 5th Caravan (Mar., 2011)
 - Jul., 2011 * Team 1 Japanese experts and C/P (team 2)
 - Oct., 2011 *Team2 to collect data
- Location: The top site in terms of network performance from each region (MHS, PAI, MSR)
- Tools
 - Learnsquare server access with contents of different bit rate
 - PC or laptop with Windows Media Player Software
 - DU Meter



VOD Testing Scenario

- Test VOD on Learnsquare server at Core I
- Measurement metrics
 - Connectivity (can make the connection to the server or not)
 - Quality of connection (voice and video clarity, delay) and record in the Mean Opinion Score (MOS, 1-5) – see VOIP section
- Performance matrix with MOS score (Please refer to Voice MOS and Video MOS of section videoconference testing)
- Video bit rate content to test (4Mbps, 2 Mbps, 1 Mbps, 512 kbps) streaming from Learnsquare through WiMAX and ADSL



VOD Testing Procedure 1

1. Connection to the server
2. On WiMAX network, connect to <http://10.100.1.3/>. Learnsquare main page will be shown if connection is successful.
3. On a non-WiMAX network, connect to <http://202.29.94.78> (internet). Learnsquare main page will be shown if connection is successful.
4. click menu "รายวิชา"
5. click curriculum "performance test"
6. click tab "สารบัญ"
7. click "download step"
8. Right click at video link (512 kbps) and copy to clipboard



VOD Testing Procedure 2

9. Open Windows Media Player and show the classic menu
10. Goto File → Open URL and paste video link of step 8 to the block and start playing the video
11. At the same time of the step 10, Open DuMeter → New Stopwatch and press start to start the clock
12. Watch video until the end, click stop at Stopwatch of DuMeter and record the total playback time.
13. Calculate the delay by total playback time (from step 12) minus total video time
14. Repeat step 8-13 on both through WiMAX and ADSL
15. Repeat step 8-14 on different video bit rate contents





4. Mobility Test



Mobility Test

Objective

- Learn how to test and study mobility feature of WiMAX system
- To measure the performance of handover in both sector-to-sector handover and BS-to-BS handover during the continuous application usage

Location and Frequency of Testing

- Perform mobility test in MSR where there are two BSs of WiMAX System
- Testing one time
- Tools
 - Notebook with WiMAX USB Dongle
 - Applications to be tested (FTP, Videostreaming, VoIP)
 - DU Meter software
 - Video capture software on notebook



Mobility Test Procedure (Sector-to-sector)

1. Select the driving route that covers by two sectors of the same BS and can perform the handover by these two sectors of one BS
2. Locate at the starting point of driving route (Record data of "Coordinates")
3. Installed WiMAX USB dongle on the roof of a Van
4. Connect to a sector of WiMAX
5. Open video capture software (Record data of "all images")
6. Open multiple windows of applications on screen
 1. Testing application (i.e., FTP, Videoconference, VoIP)
 2. WiMAX Connection Software to show the level of signal strength and the status of connection (Record data of "level of signal strength")
 3. DU Meter application to measure throughput (Record data of "real time throughput")
7. Start testing application and start video capture software
8. Drive along the selected route and keep observing the status of connection
9. Capture the event of handover and observe the quality of testing application during the handover (Record data of "time of handover and its interruption")
10. Repeat 6-9 with different applications (i.e., FTP, Videoconference, VoIP)



Mobility Test Procedure (BS-to-BS)

1. Select the driving route that covers by two sectors of the different BS and can perform the handover by these two sectors of two BSs
2. Locate at the starting point of driving route(Record data of "Coordinates")
3. Installed WiMAX USB dongle on the roof of a Van
4. Connect to a BS
5. Open video capture software(Record data of "all images")
6. Open multiple windows of applications on screen
 1. Testing application (i.e, FTP, Videoconference, VoIP)
 2. WiMAX Connection Software to show the level of signal strength and the status of connection(Record data of "level of signal strength")
 3. DU Meter application to measure throughput(Record data of "real time throughput")
7. Start testing application and start video capture software
8. Drive along the selected route and keep observing the status of connection
9. Capture the event of handover and observer the quality of testing application during the handover(Record data of "time of handover and its interruption")
10. Repeat 6-9 with different applications (i.e., FTP, Videoconference, VoIP)



5. Interference Test



Objective

- To investigate the interference that affects to the performance of WiMAX system



Location and Frequency of Testing

- Perform interference testing at NECTEC site
- Testing one time
- Tools
 - Notebook with WiMAX USB Dongle
 - Applications to be tested (FTP, Videostreaming, VoIP)
 - DU Meter software
 - Signal Generator with Amplifier



Test Setup

- Setup Signal Generator, Amplifier, Patch antenna to create the interference source
- Setup center frequency, bandwidth, and power output of the interference source

Anritsu RF Signal Generator



WiMAX Amplifier



Patch Antenna



Test Procedure (Test 1 – Benchmark Test)

1. Locate USB dongle to receive a good signal (RSSI < -60 dbm)
2. Check WiMAX connection, record RSSI and CINR
3. Perform Throughput Test using IXChariot to measure UL and DL throughput under normal condition



Test Procedure (Test 2 – Interference near BS)

1. Locate USB dongle to receive a good signal (RSSI < -60 dbm)
2. Check WiMAX connection, record RSSI, CINR
3. Put the interference source close to BS (Point the antenna of BS)
4. Observe the connection condition, record RSSI, CINR
5. Perform Throughput Test using IXChariot to measure UL and DL throughput under interference condition
6. Repeat step 4,5 with various interference power



Test Procedure (Test 3 – Interference near CPE)

1. Locate USB dongle to receive a good signal (RSSI < -60 dbm)
2. Check WiMAX connection, record RSSI, CINR
3. Put the interference source close to CPE (Point the antenna of CPE)
4. Observe the connection condition, record RSSI, CINR
5. Perform Throughput Test using IXChariot to measure UL and DL throughput under interference condition
6. Repeat step 4,5 with various interference power



Impact Survey Report

**The Project of Human Resource Development
Through Utilizing The Information Technology for
Rural Community Vitalization in Kingdom of Thailand**

31 January 2012

Executive Summary

As part of the MHS IT Valley Project, the National Electronics and Computer Technology Center (NECTEC) and Japan International Cooperation Agency (JICA) initiated the so-called “Project of Human Resource Development Through Utilizing the Information Technology for Rural Community Vitalization in the Kingdom of Thailand” in December 2007 in order to realize the practical application of a local wireless communications system (WiMAX in Mae Hong Son) that would contribute to local vitalization. After some delays, the WiMAX service and its support website officially started in Mae Hong Son on 20 September 2010, expecting to achieve two major outputs: a model system for local wireless communications co-developed by NECTEC and JICA and curriculums that would contribute to local vitalization co-developed through the collaboration of NECTEC, JICA, and participating schools in Mae Hong Son areas.

To conduct the survey, 45 local communities/ administration in three districts of Mae Hong Son -- namely Mae Hong Son, Mae Sariang, and Pai – were targeted. The target sites were broken down into three types, namely schools and community colleges, government offices, and local communities. Then, three set of questionnaires as well as an interview agenda were designed to collect data from the identified targets. Survey data were collected from 45 administrators from all 45 sites, 40 e-Learning teachers and 117 “IT-Valley” students from eight schools. Questions were asked in the areas of system status (number of PCs, network conditions, internet access and usage, wireless access, and electricity), system training, and e-Learning (use of LearnSquare and AcuConference) on both teacher and student sides. The questionnaire survey method was also accompanied by two focus groups and individual interviews with 48 stakeholders, consisting of system administrators, teachers, government officials, and business owners, to identify key success factors of the project as well as concerns that need to be addressed for further actions. Data collection was done via two field trips during 15-19 August and 5-17 September 2011.

Within one year after complete installation, the WiMAX service proved to have great many impacts on the local communities. System-wise, there was a great improvement in PC and network conditions partly due to the project’s support on equipment and maintenance as well as knowledge transfer through trainings/workshops. Availability and bandwidth of wireless communication hugely increased within one year. Even though such improvement was a global trend but the effect was also magnified by the fact that the project did supply an additional access point to each site and that WiMAX was provided as an alternative wireless communication system to give that extra bandwidth to local users.

Also, technology and knowledge transfer to local users was accomplished at both technical and usage levels. At the technical level, the project was a huge success in both quantity and quality. Through a series of trainings and workshops, the project produced more wireless technology training instructors, who reported expanded wireless system skills. At the usage level, many teachers reported expanding their IT curriculum, helping their peers on IT problems as well as content development, and using LearnSquare for both the project's workshops and their school activities. Students, at the same time, accessed the Internet more frequently and did show strong interest in studying IT curriculum and other e-Learning subjects in the future.

The last impact might not be one of the project's initial targets but was a pleasant surprise. As the project provided series of trainings/ workshops over the year, the workshop participants started networking both inside and outside of the WiMAX project, bringing such vitality to the local IT and education communities.

Recommended further actions

This phase of the project is drawing to an end, with a terminal evaluation scheduled in March 2012. While the project did achieve many of the intended goals, some issues must still be worked on in the next phase. As a big picture, a sustainability/ promotion plan is being drafted to ensure WiMAX adoption and sustainability in Mae Hong Son over the long run. This report recommends further actions to be included in the plan as follows:

For the system:

- Allow the use of Internet for the next phase of the project, if future bandwidth permits.
- Expand the WiMAX service in three strategic areas for Mae Hong Son: education, healthcare, and tourism.
- Consider relocate some of the current WiMAX sites that are not a good fit to the project.
- Support the locals in the quest to expedite the improvement of MHS power system

For technical training:

- Update and expand the existing training database (location, number of people, training topics, participants' training history, etc.) for more active and continuous participation.

- Conduct a demand survey to maximize the training experience.

For e-Learning and other applications:

- Conduct a demand survey in terms of applications and contents to meet the needs of users.
- Encourage the Ministry of Education to give career rewards to teachers who excel at e-Learning for motivation purposes (Top-down approach).
- Put stronger emphasis on students creating e-Learning contents themselves.

For communication:

- Encourage the setting up of local help desk/ self-sustained local help stations.
- Brainstorm for a comprehensive promotion plan.

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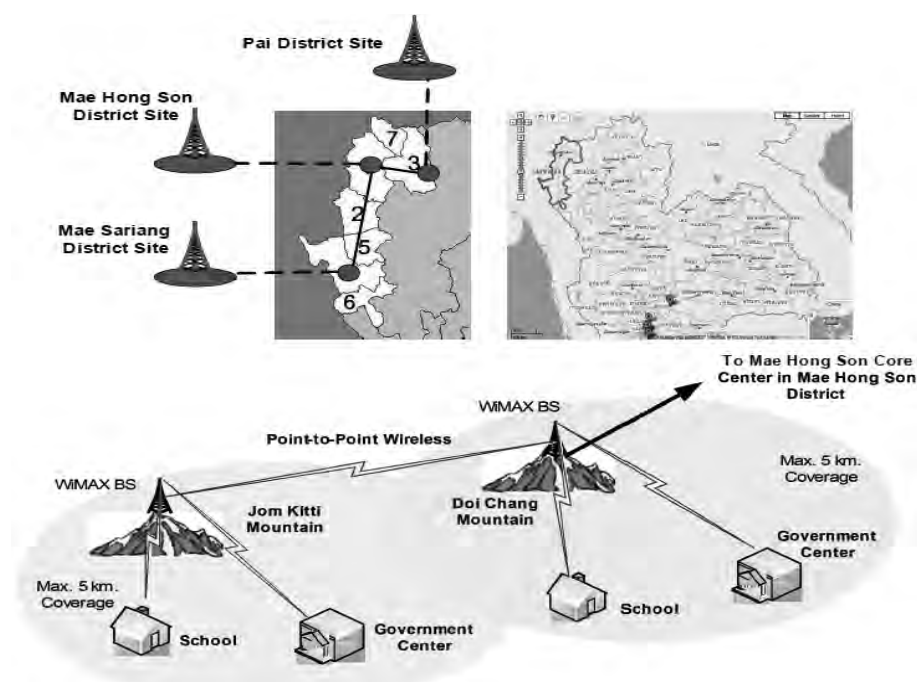
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1. Overview

1.1 Project background

As part of the MHS IT Valley Project, the National Electronics and Computer Technology Center (NECTEC) and Japan International Cooperation Agency (JICA) initiated the so-called “Project of Human Resource Development Through Utilizing the Information Technology for Rural Community Vitalization in the Kingdom of Thailand” in December 2007 in order to realize the practical application of a local wireless communications system (WiMAX in Mae Hong Son) that would contribute to local vitalization. After some delays, the WiMAX service and its support website officially started in Mae Hong Son on 20 September 2010, expecting to achieve two major outputs: a model system for local wireless communications co-developed by NECTEC and JICA and curriculums that would contribute to local vitalization co-developed through the collaboration of NECTEC, JICA, and participating schools in Mae Hong Son areas.

Figure 1. WiMAX location



Source: the Project of Human Resource Development through Utilizing the Information Technology for Rural Community Vitalization in the Kingdom of Thailand (NECTEC, 2011)

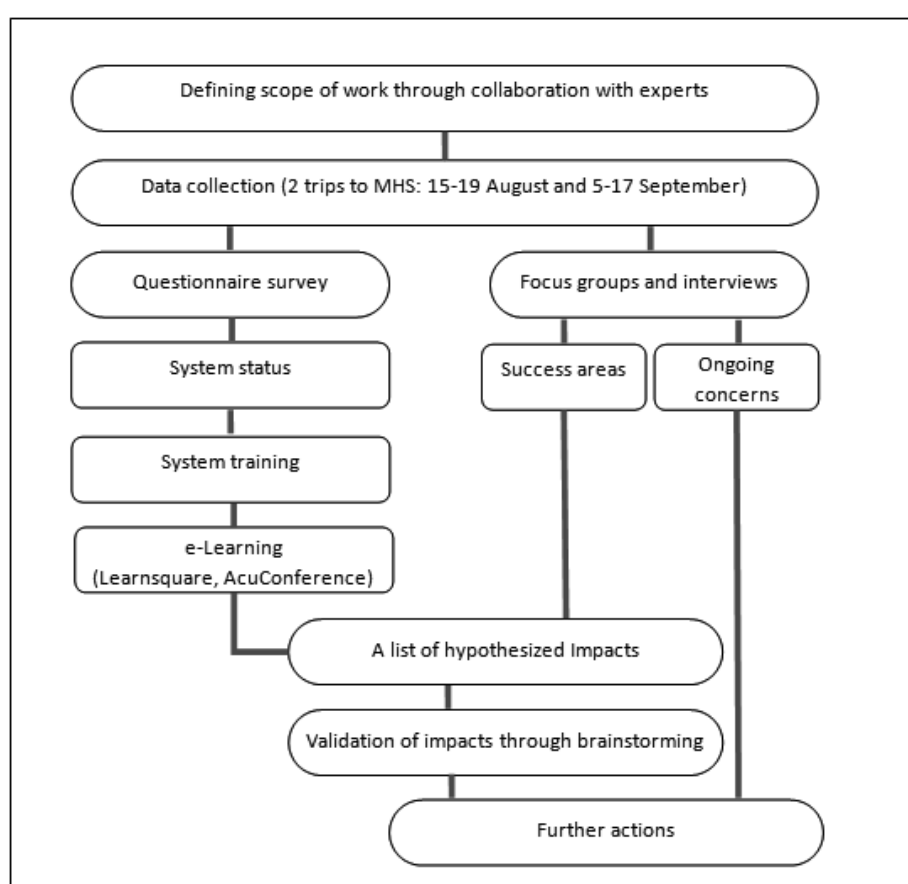
Slightly before the start of the WiMAX service, a survey had been conducted to collect baseline data. This impact survey is thus being done to compare and evaluate the impacts of the WiMAX service approximately one year after system completion.

Therefore, the objectives of this impact survey are two-pronged: to collect and analyze data on current system status, users' training experience, and actual e-learning content development and usage as well as to identify project success factors and ongoing issues that need to be addressed for further actions in the next phase of the project.

1.2 Framework and methodology

This impact survey project takes approximately four months to conduct and follows the following framework.

Figure 2. Impact survey framework



In defining the scope, 45 local communities/ administration in three districts of Mae Hong Son -- namely Mae Hong Son, Mae Sariang, and Pai – were targeted. As shown in Table 1, the target sites were broken down into three types, namely schools and community colleges, government offices, and local communities.

Table 1. Target groups

	School	Government	Community	Total
Mae Hong Son	9	8	2	19
Mae Sariang	12	3	1	16
Pai	6	3	1	10
Total	27	14	4	45

Three set of questionnaires as well as an interview agenda were designed to collect data from the identified targets. Survey data were collected from 45 administrators from all 45 sites, 40 e-Learning teachers and 117 “IT-Valley” students from eight schools. Questions were asked in the areas of system status (number of PCs, network conditions, internet access and usage, wireless access, and electricity), system training, and e-Learning (use of LearnSquare and AcuConference) on both teacher and student sides. The questionnaire survey method was also accompanied by two focus groups and individual interviews with 48 stakeholders, consisting of system administrators, teachers, government officials, and business owners, to identify key success factors of the project as well as concerns that need to be addressed for further actions. Data collection was done via two field trips during 15-19 August and 5-17 September 2011.

Results from questionnaire survey, focus groups, and interviews were then analyzed to generate a list of possible impacts of the WiMAX service on the target sites, which later was validated through an internal brainstorming session. In the final step, validated impacts and learned lessons were translated into recommended further work. Tasks and timeline for this impact survey can be summarized as follows:

Table 2. Tasks and timeline of the project

Tasks	Timeline
1. Defining scope	August 2011
2. Survey and interview design through Collaboration	August 2011
3. Data Collection via questionnaire survey, focus groups, and interviews	15-19 August 2011 5-17 September 2011
4. Preliminary data analysis	September 2011*
5. Further analysis: Survey results compared with baseline data and in-depth analysis	December 2011
6. Summary of possible project impacts and impact validation	December 2011

* From Mid-October to November, tasks were suspended due to a severe flood situation at Thailand's Science Park and surrounding areas.

2. Results of the survey

Results of impact survey are divided into four sections. The first section reports statistics on system status. The second section focuses on technical training provided by NECTEC and JICA. This is followed by a section on e-Learning for both teachers and students. The last part discusses additional information on project success and issues of concern derived from focus groups and users' interviews.

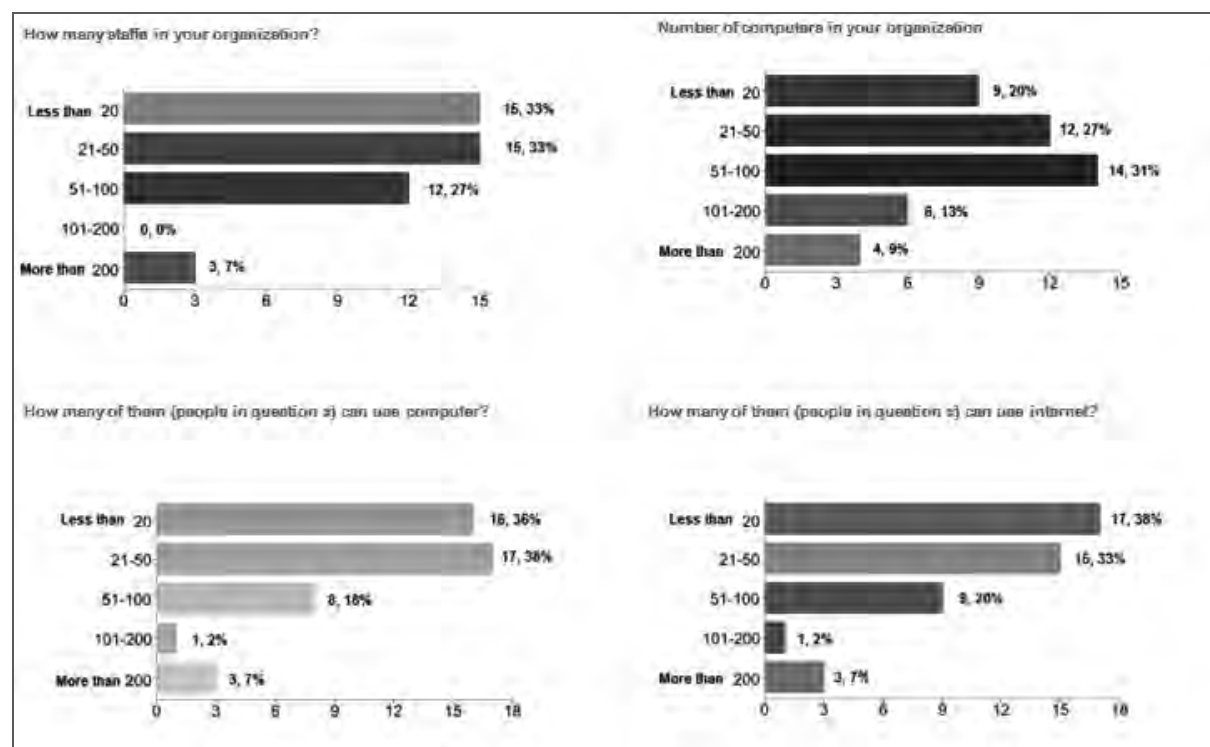
2.1 System status

2.1.1 Number of PCs

Number of PCs in organizations

Regarding the number of staffs and the number of PCs shown in Figure 3, there were enough computers for staffs and most of them could use both computer and the Internet (in the same proportion).

Figure 3. Number of PCs in organizations

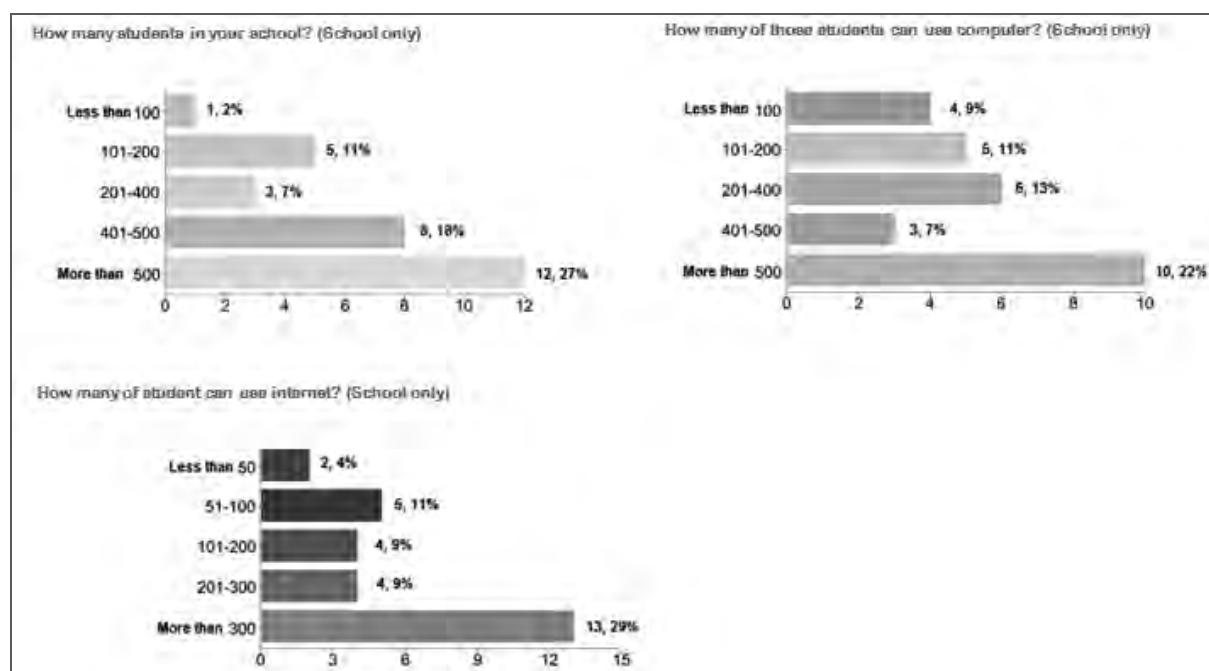


Compared to the baseline data, during the period of one year there was NO significant change in the number of staffs, number of computers in organizations, or number of people who could use computer and the Internet.

Number of PCs in schools

A majority of schools were relatively large, with 8 schools having around 400 students and 12 schools having over 500 students. Figure 4 shows that most students could use both computer and the Internet.

Figure 4. Number of PCs in schools



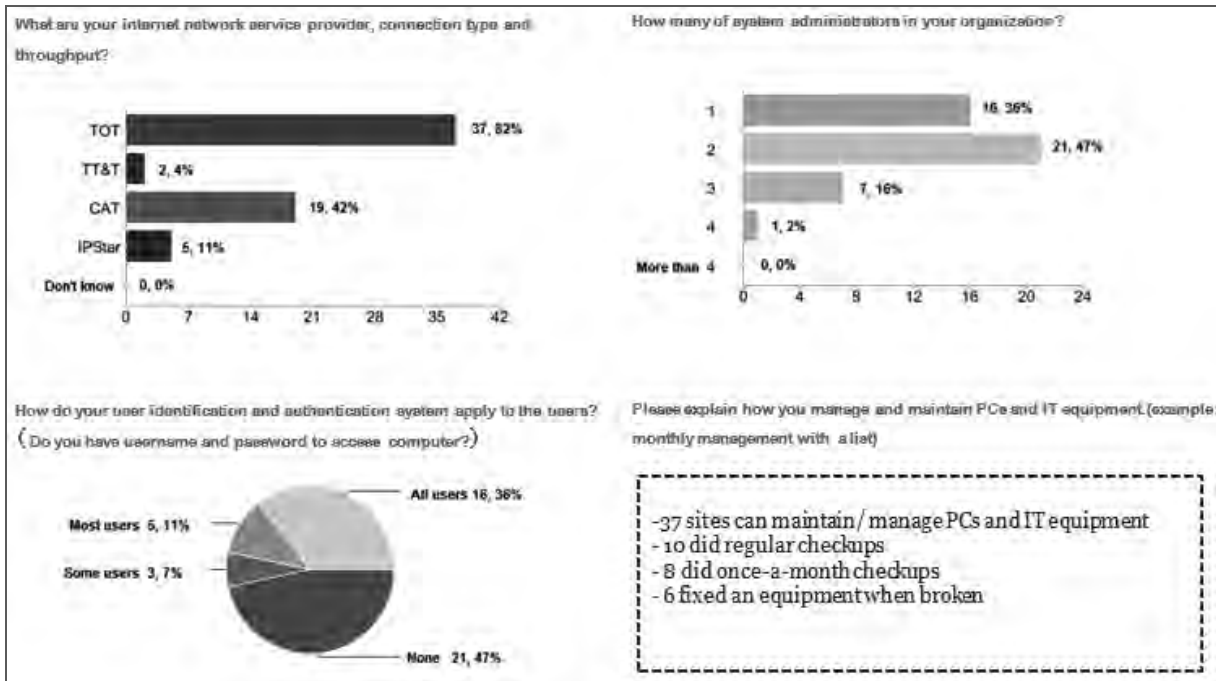
Compared to the baseline data, school size this year seemed slightly bigger. However, there was NO significant change regarding the number of students that could use computer and the Internet.

2.1.2 Network conditions

Network connection and management

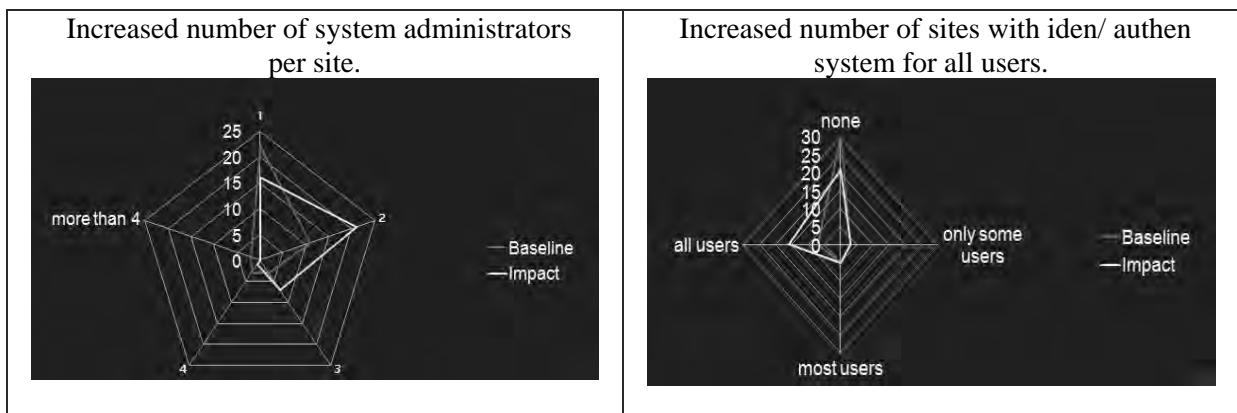
TOT and CAT were the main network service providers. Most sites were manned by 1-2 system administrators. Over half of the sites (24 out of 45) had some form of user identification and authentication system for users. Also, most administrators (31 out of 45) could maintain and manage their PCs and IT equipment like regular checkup, once-a-month checkup, or upon-report checkup.

Figure 5. Network connection and management



Compared to the baseline data, there were more connections through CAT, increasing from 8 sites of last year to 19 sites this year. As shown in Figure 6, the number of system administrators per site also increased, with many sites reporting more administrators than last year. Also, better management of network was reported, with a decreasing number of sites that had no identification and authentication system and more sites with such system for all users.

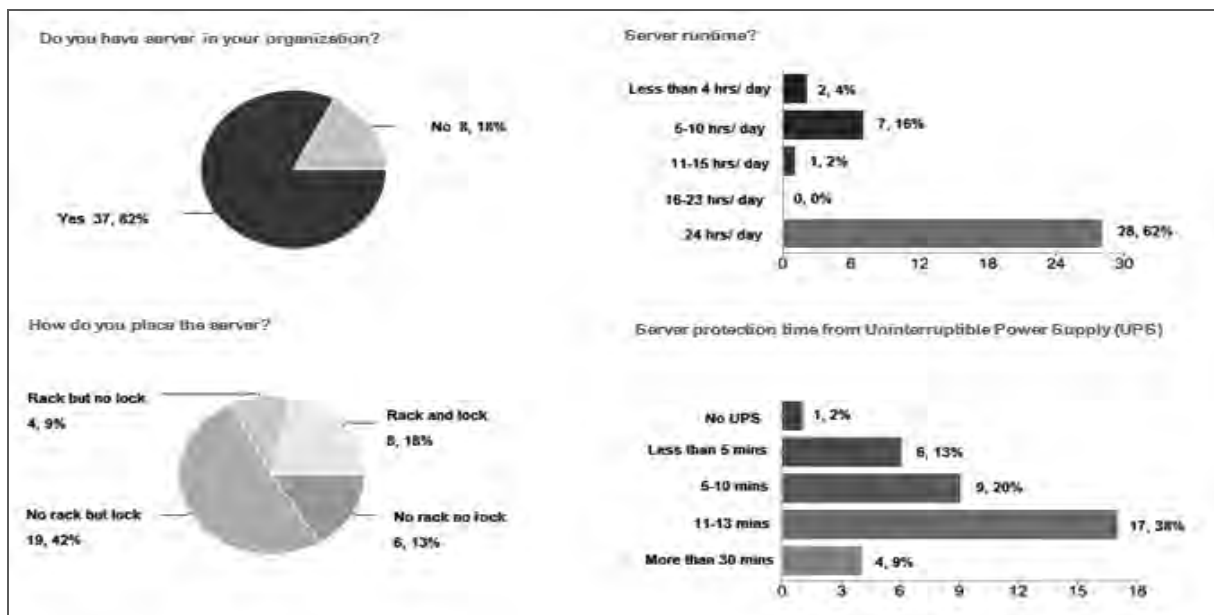
Figure 6. Number of system administrators and number of sites with identification and authentication system



Servers

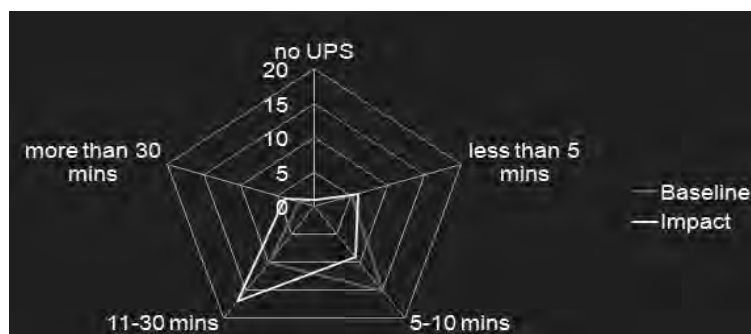
Most administrators reported having a server in their organization. 28 out of 45 sites had a server that ran 24 hours/ day. More than half of the servers (27 out of 45) were housed in a locked facility but only 19 of which were placed on a server rack. Also, most uninterruptible power supplies (UPS) lasted for about 5-13 minutes after a blackout.

Figure 7. Server conditions



Compared to the baseline survey, there was NO significant change in the server runtime or how the servers were placed and kept. However, it was found that for the past year the number of organizations with server did increase from 31 to 37 (as reported) and that there was a slight improvement in UPS time as shown in Figure 8.

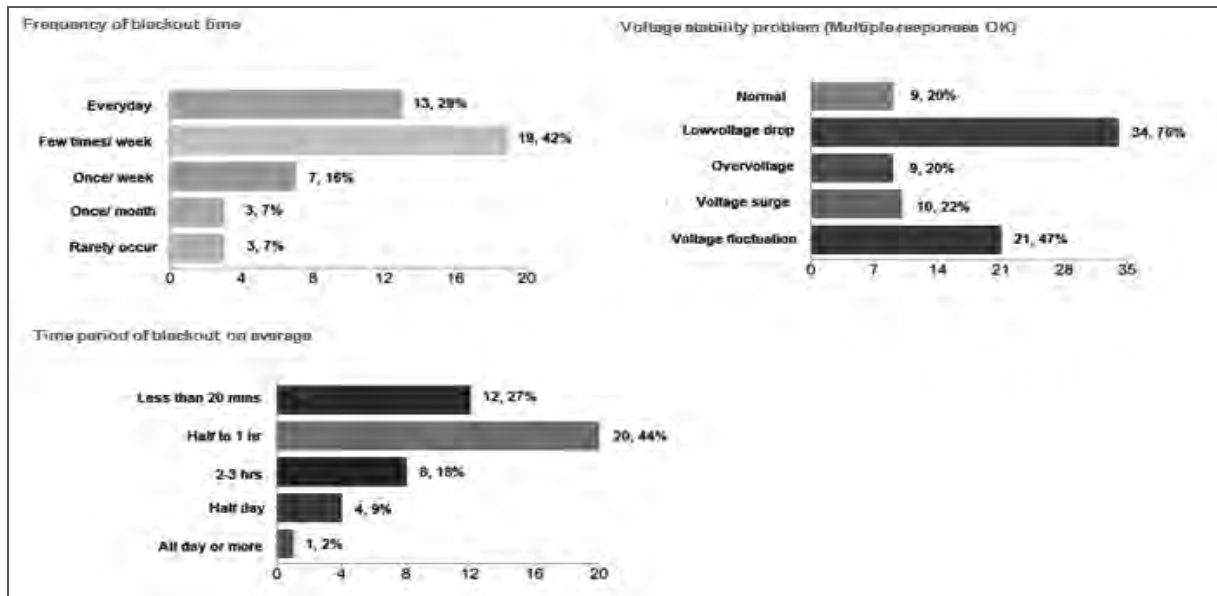
Figure 8. Server protection time from UPS



Electricity

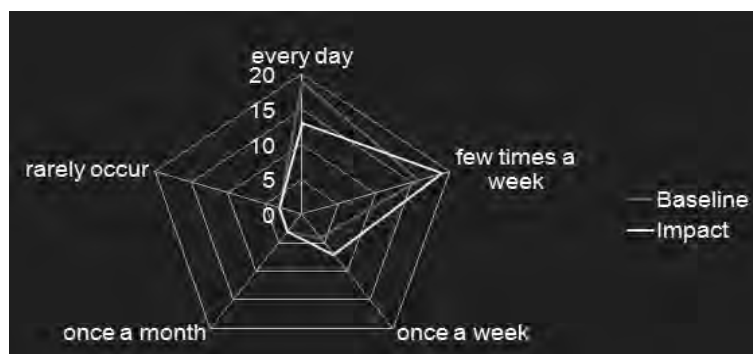
Electricity problems were critical in Mae Hong Son areas. Blackouts were frequent (except in Pai), usually lasting from 0 to 1 hour. Voltage instability came mostly in the forms of voltage drop (76%) and voltage fluctuation (47%).

Figure 9. Electricity problems in Mae Hong Son



Compared to the baseline data, there was a slight improvement in blackout problems, shifting from mostly everyday to few times a week, as shown in Figure 10. However, there was NO change in blackout time period or voltage instability problems.

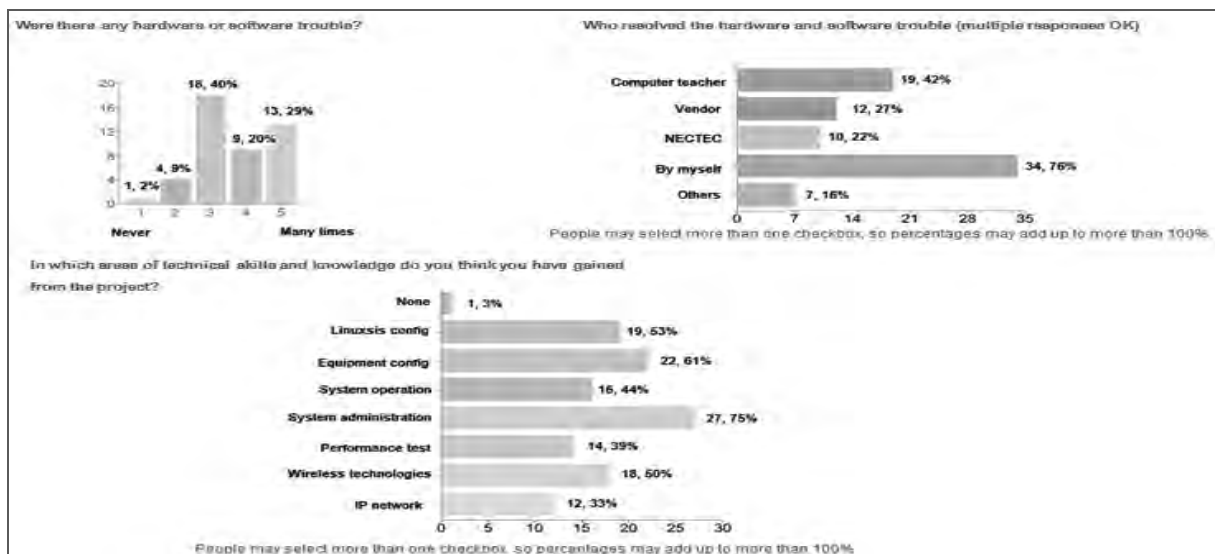
Figure 10. Frequency of blackouts in Mae Hong Son



Hardware and software trouble

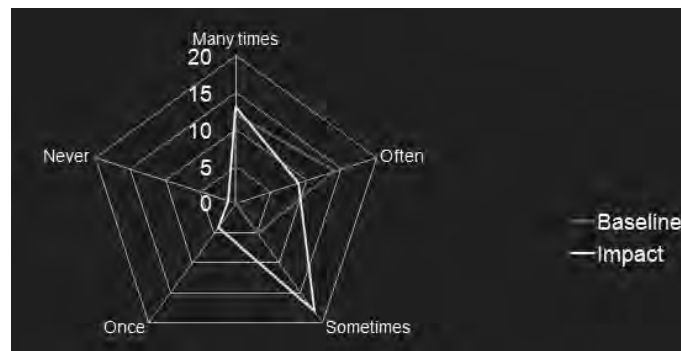
Hardware and software trouble was reported as quite frequent, with mostly system administrators (76%) or computer teachers (42%) fixing the problems themselves. System administrators learned most from the project in the areas of system administration (75%), equipment configuration (61%), Linuxsis configuration (53%) and wireless technologies (50%), respectively.

Figure 11. Hardware and software trouble



Compared to the baseline data, as shown in Figure 12, hardware and software trouble this year somewhat decreased, with less “often” and more “sometimes.” There was NO change in persons resolving hardware and software problems. Most of the answers were still system administrators themselves or computer teachers.

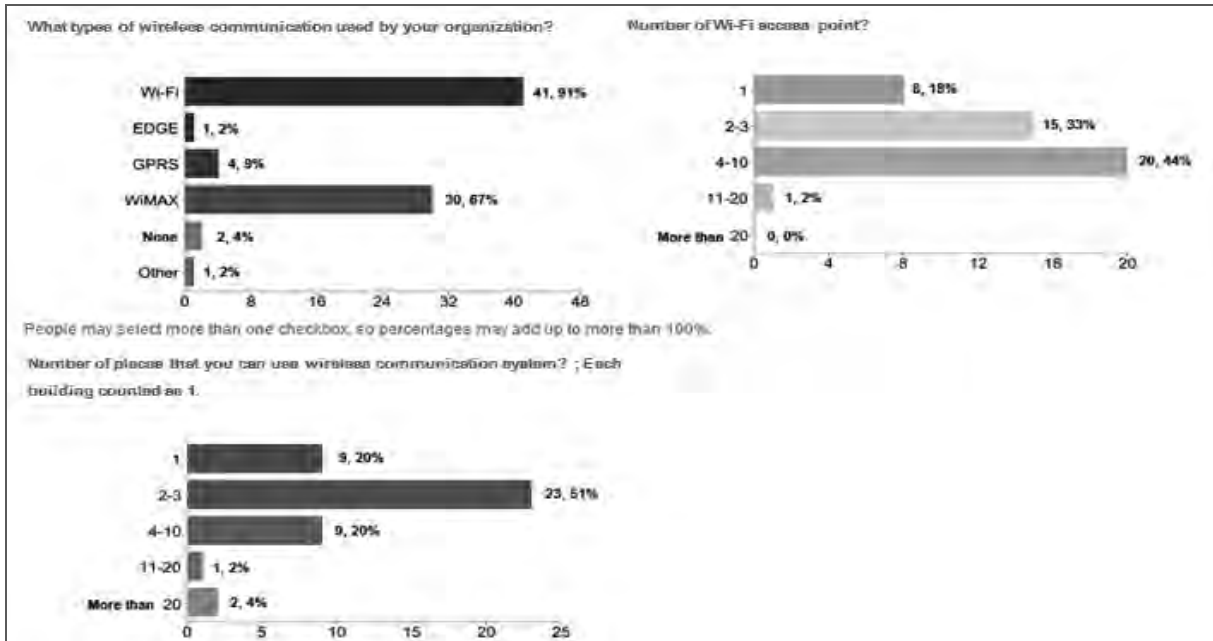
Figure 12. Frequency of hardware and software trouble



2.1.3 Wireless access

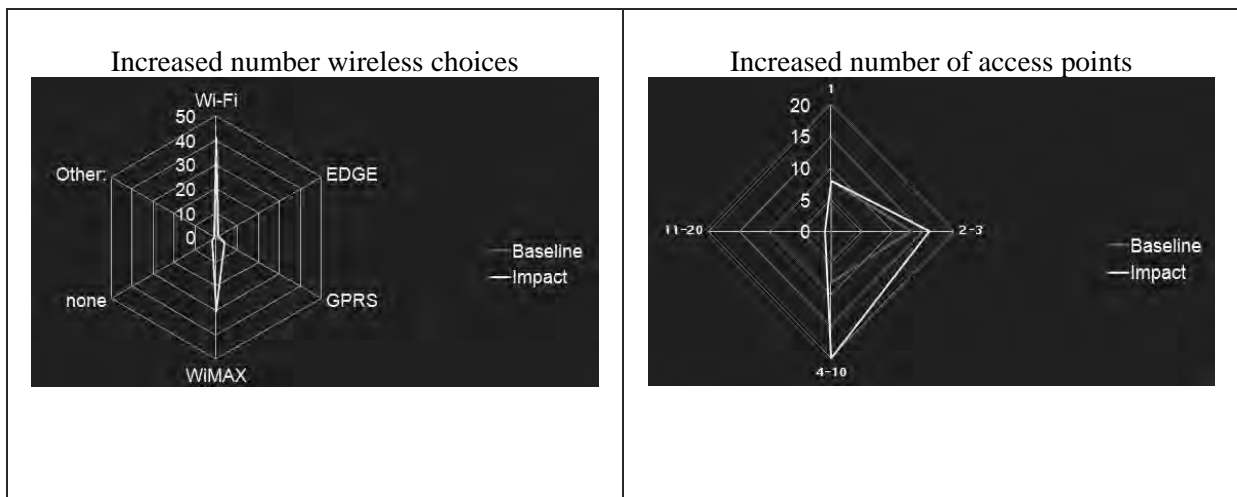
While 30 out of 45 sites (67%) could get WiMAX communication up and running, almost all sites (91%) had a Wi-Fi connection. Most sites (77%) had at least 2 access points covering most buildings at each site.

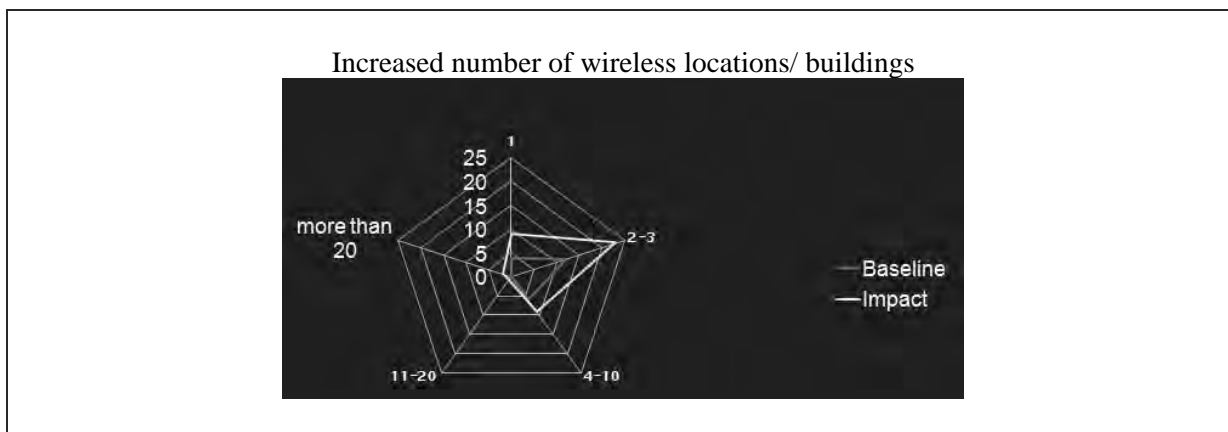
Figure 13. Wireless communication



Compared to the baseline data, the use of wireless communication hugely increased during the past year, with WiFi increasing from 27 to 41 sites and WiMAX going from zero to 30 sites. Marked increases in the number of wireless access points and wireless locations/ buildings were also seen, as shown in Figure 14.

Figure 14. Wireless communication choices, wireless access points, and locations



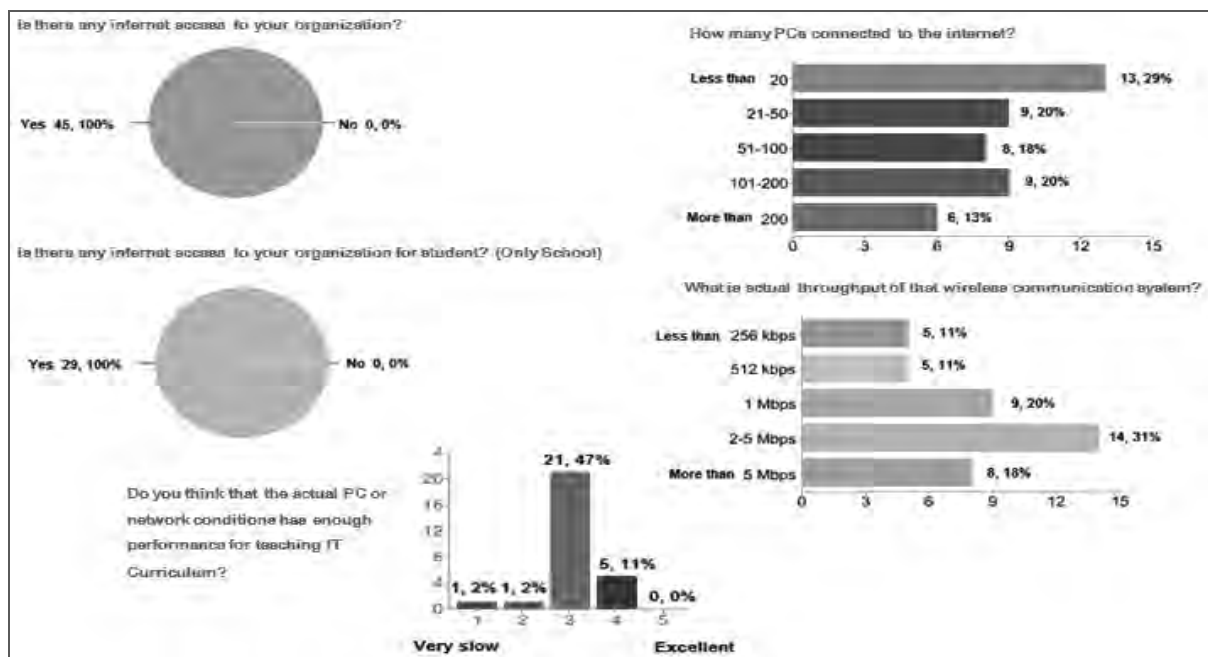


2.1.4 Internet access and usage

Internet access

All sites (100%) had Internet access, including Internet access in school for students. The number of PCs connecting to the Internet varied according to the size of organizations/ schools. Most of the sites (69%) had the connection speed of at least 1 Mbps. Also, most system administrators/ teachers thought the actual PC and current network conditions were quite sufficient for teaching IT curriculum.

Figure 15. Internet access



Compared to the baseline survey, there was almost NO change in numbers of sites with Internet access (from 44 out of 45 sites to all 45 sites). However, Figure 16

and 17 show an increase in the number of PCs in organizations that could connect to the Internet, a jump in wireless communication throughput, and a big improvement in PC and network conditions for teaching IT curriculum.

Figure 16. Number of PCs connecting to the Internet and wireless communication bandwidth

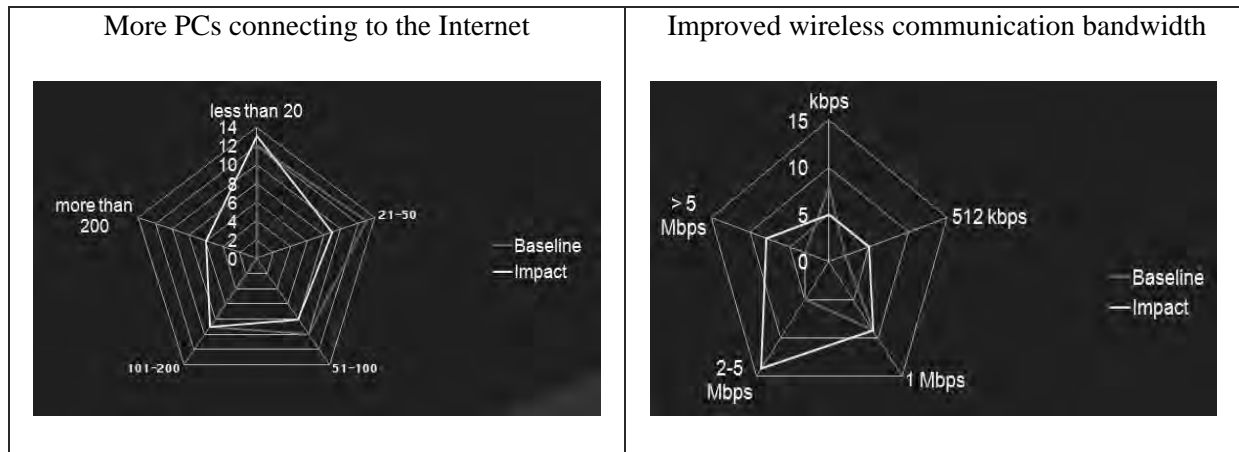
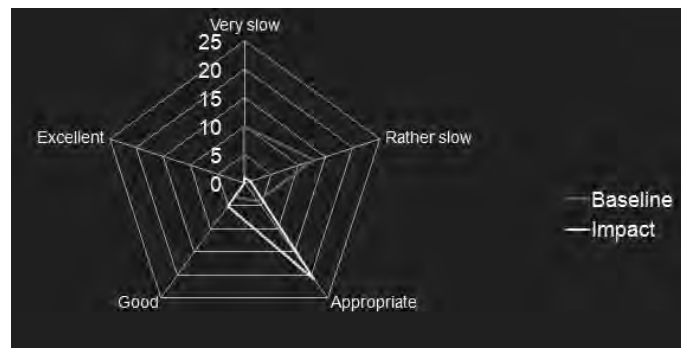


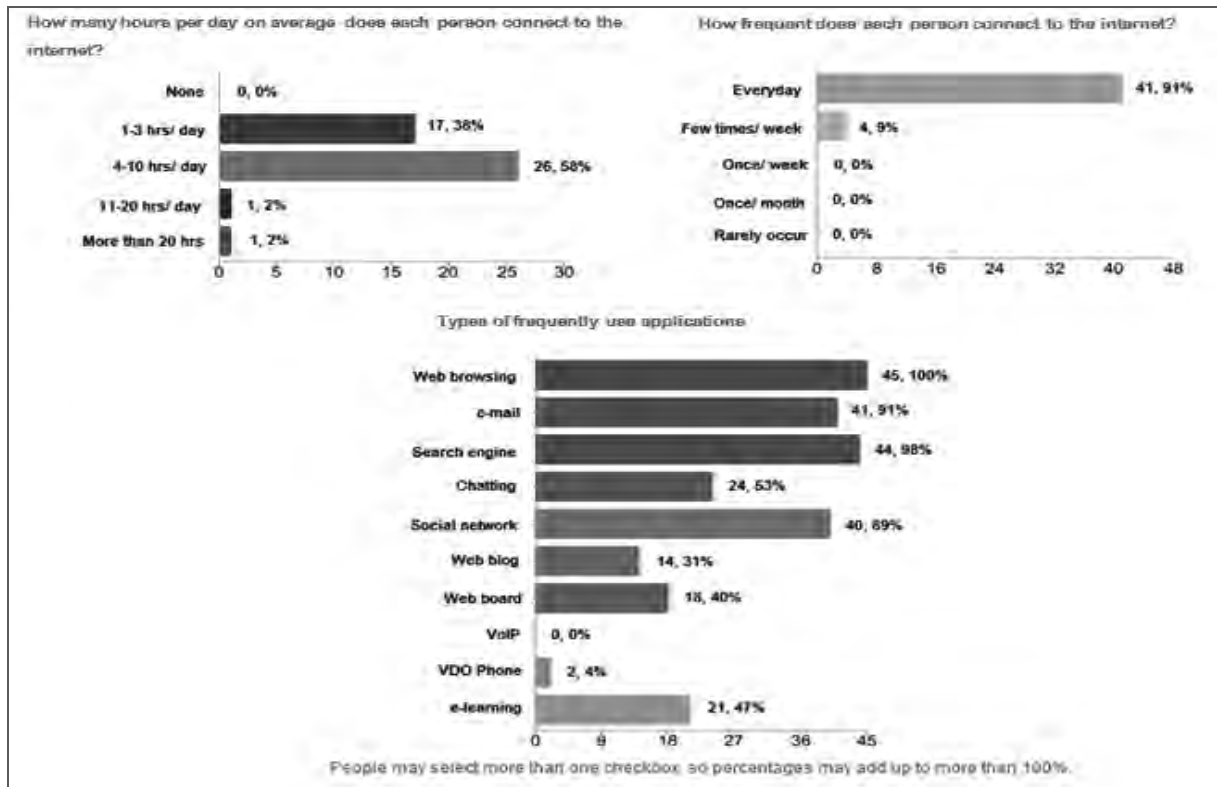
Figure 17. Improvement in PC and network conditions



Internet usage for staffs/ teachers

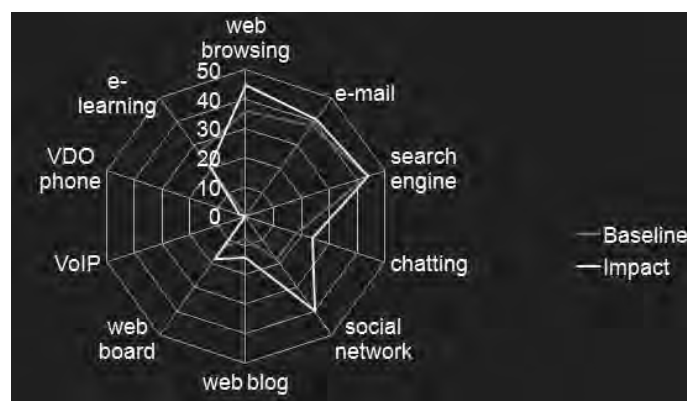
Most people spent about 4-10 hours per day (58%) and 1-3 hours per day (38%) on the Internet, every day. Popular applications for them were web browsing (100%), searching for information (98%), using email (91%), and social networking (89%).

Figure 18. Internet usage for staff



Compared to the baseline survey, the amount of time each person spent on the Internet went through NO change. However, Figure 19 reveals that social network became hugely popular during the past year.

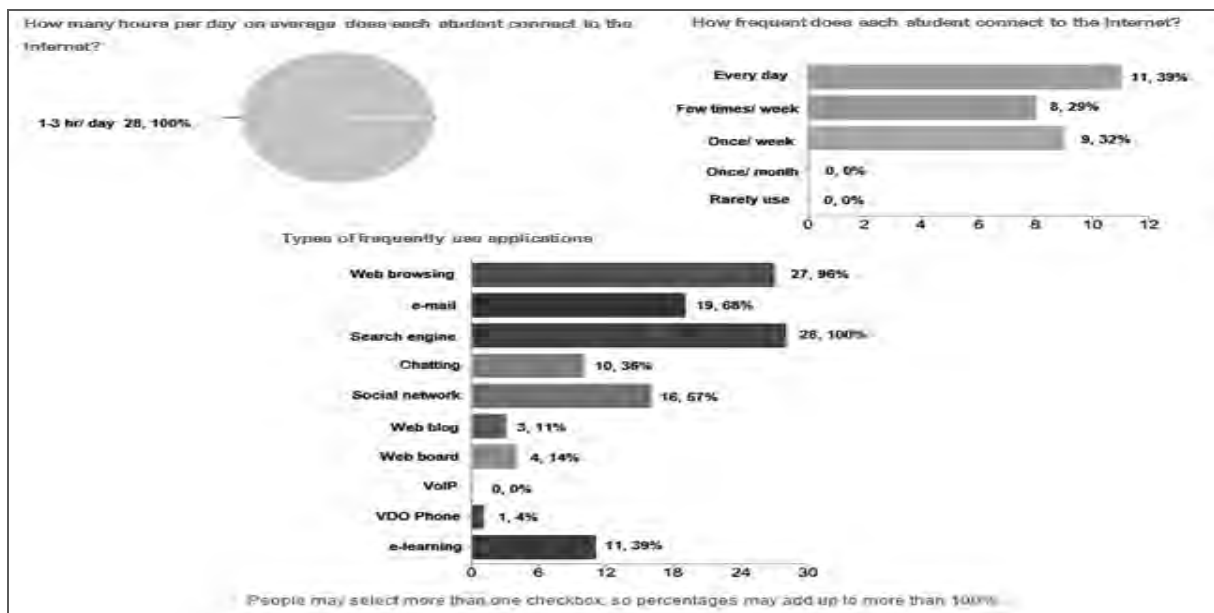
Figure 19. Type of frequently used applications by staffs/ teachers



Internet usage for students

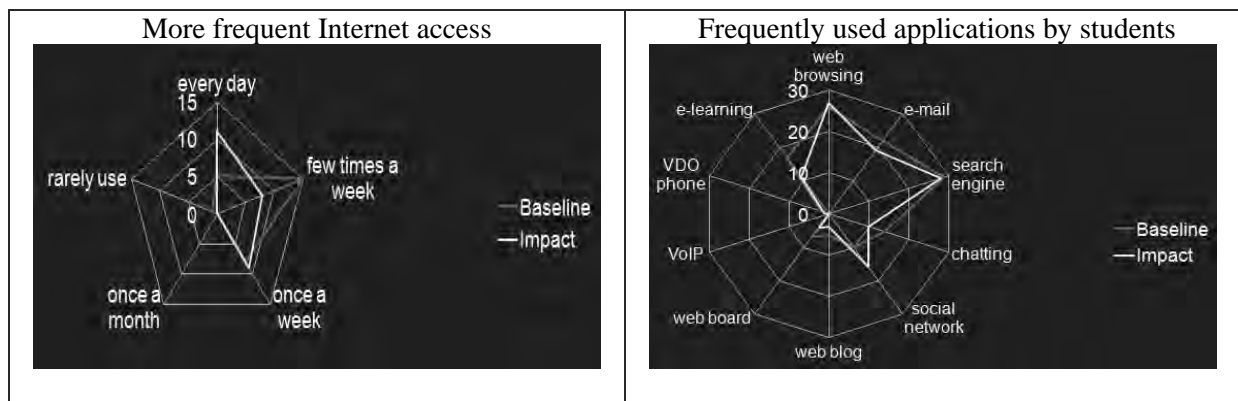
All students spent 1-3 hrs a day accessing the Internet, with a little over 1/3 of them using the Internet everyday, 1/3 few times a week, and 1/3 once a week. Students used the Internet mostly for searching for information (100%), web browsing (96%), email (68%), and social networking (57%). The e-Learning application ranked number five (39%) on the list.

Figure 20. Internet usage for students



Compared to the baseline data, the length of Internet usage (hours) per day for students was the same as last year’s data. However, as shown in Figure 21, many students accessed the Internet more frequently, from few times a week to every day. As for the type of applications favored by students, the pattern remained the same, except a sharp increase in the popularity of social network applications.

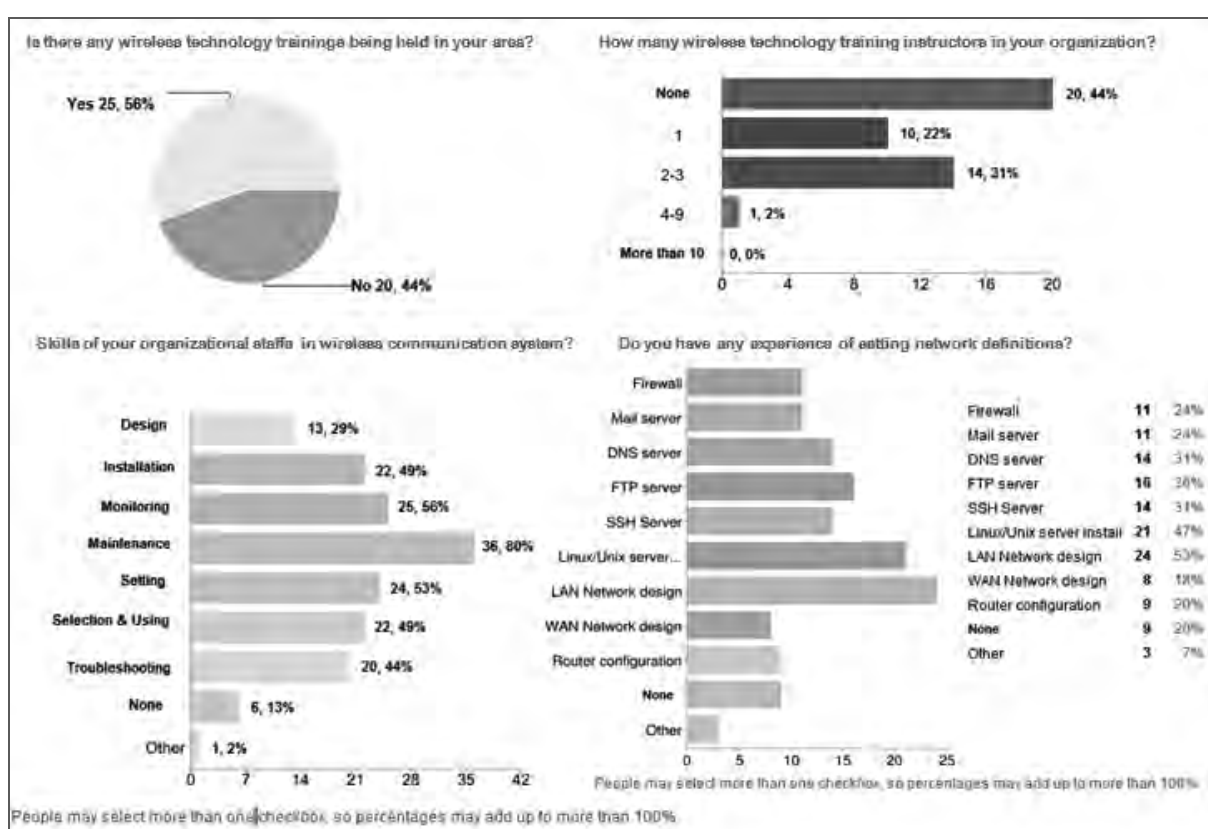
Figure 21. Frequency of Internet usage and type of applications used by students



2.2 System training

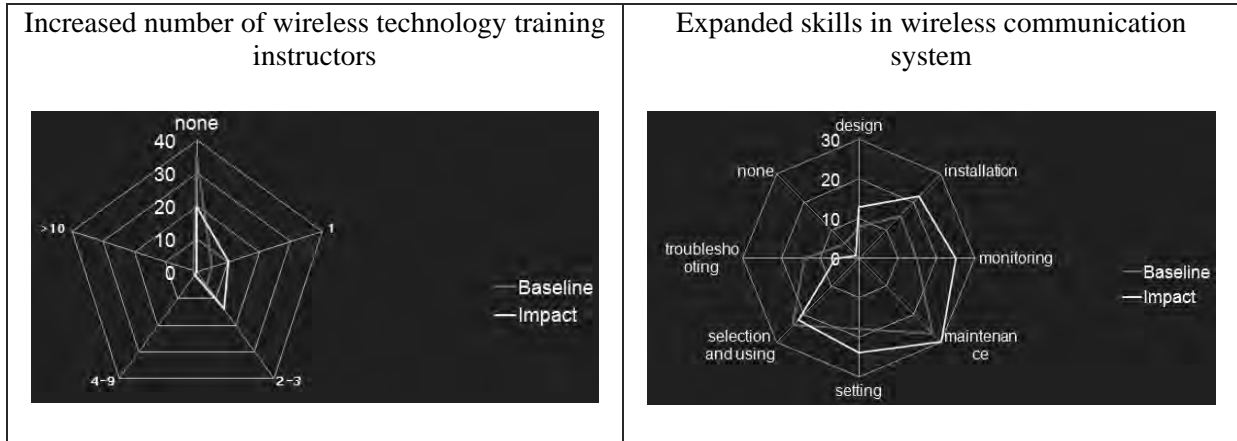
Over half of system administrators (25 out of 45 or 56%) reported wireless technology trainings being held in their areas. While 44% of the sites had no wireless technology training instructor, the rest did have at least 1 training instructor in their organization. Most cited technical skills for system administrators were maintenance (80%), monitoring (56%), and setting (53%). Also, regarding the experience of setting network definitions, LAN network design (53%), Linux/ Unix server installation (47%) and FTP server (36%) were the top three.

Figure 22. Wireless technology trainings and acquired skills



Compared to the baseline survey, after one year of WiMAX service the number of system administrators being aware of wireless technology trainings held in their area went up from 2 to 25. It was also found that there were more wireless training instructors and that their wireless skills expanded (Figure 23).

Figure 23. Number of wireless technology training instructors and skills in wireless communication system.



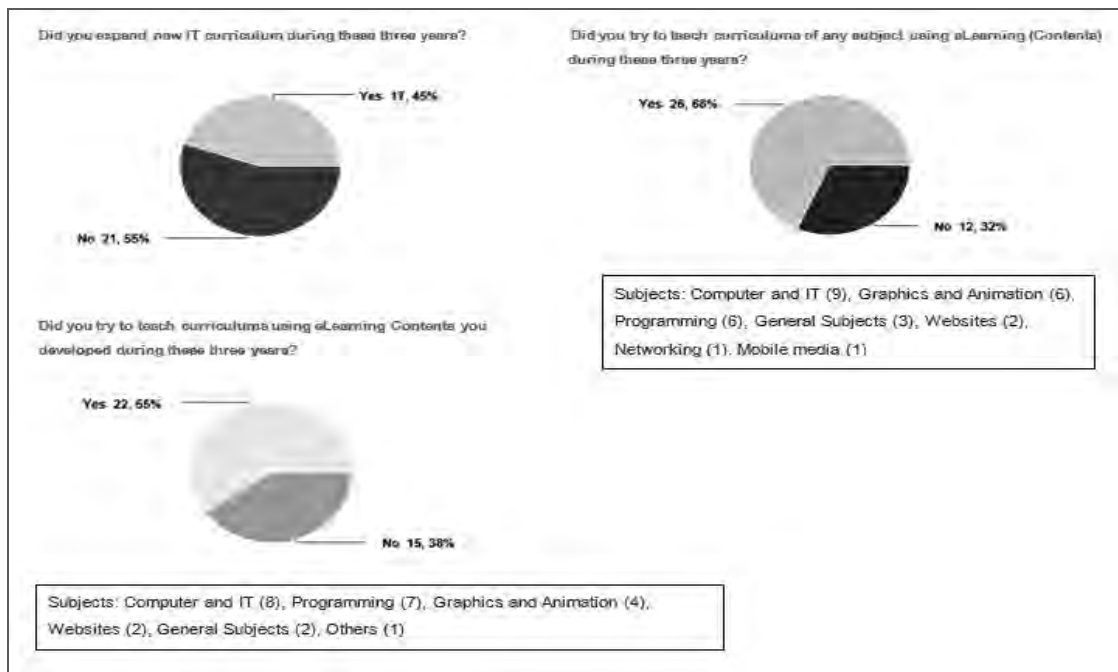
2.3 e-Learning

2.3.1 e-Learning for teachers

e-Learning experience

While 45% of the teachers expanded new IT curriculum during the past three years, 64% reported trying to teach a subject using e-Learning contents. Also, over half of the teachers (55%) developed some e-Learning contents themselves.

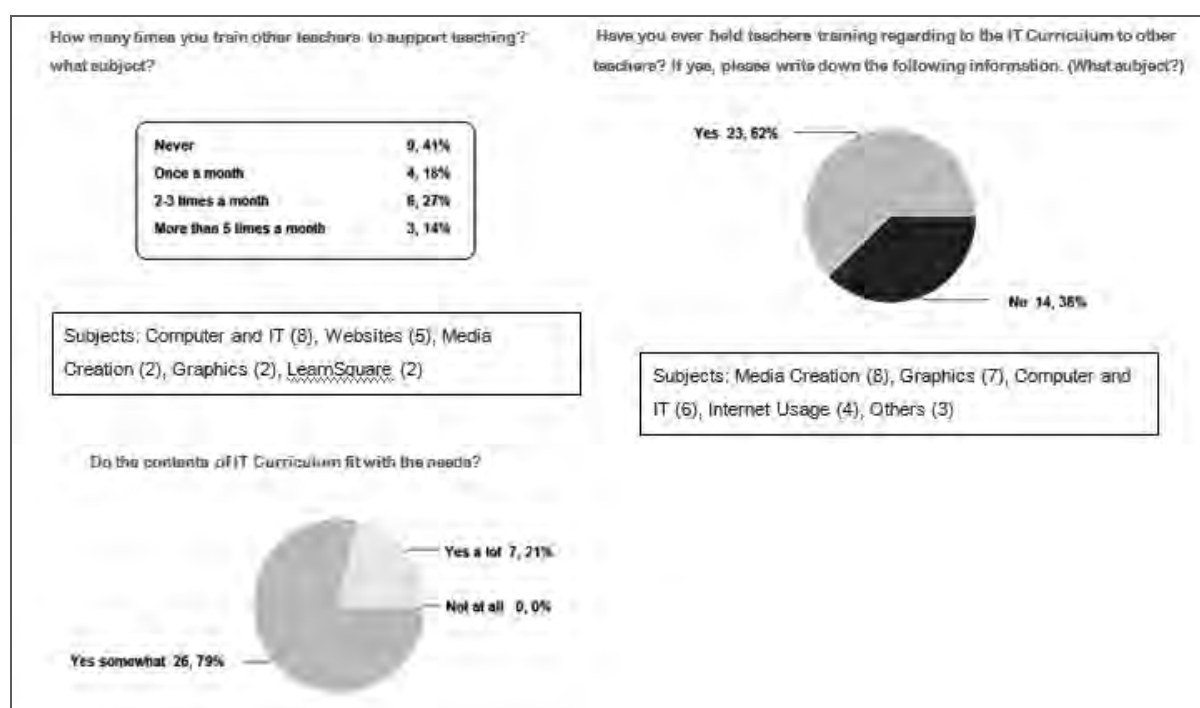
Figure 24. IT curriculum and e-Learning contents



Train the trainers

In general, more than half of the teachers (59%) helped train others to support teaching when they can. To be specific, 62% of the teachers did help their colleagues on IT curriculum such as Media creation, Graphics, Computer and IT and Internet usage. In addition, most of the teachers (79%) felt that the contents of IT curriculum somewhat fit their needs.

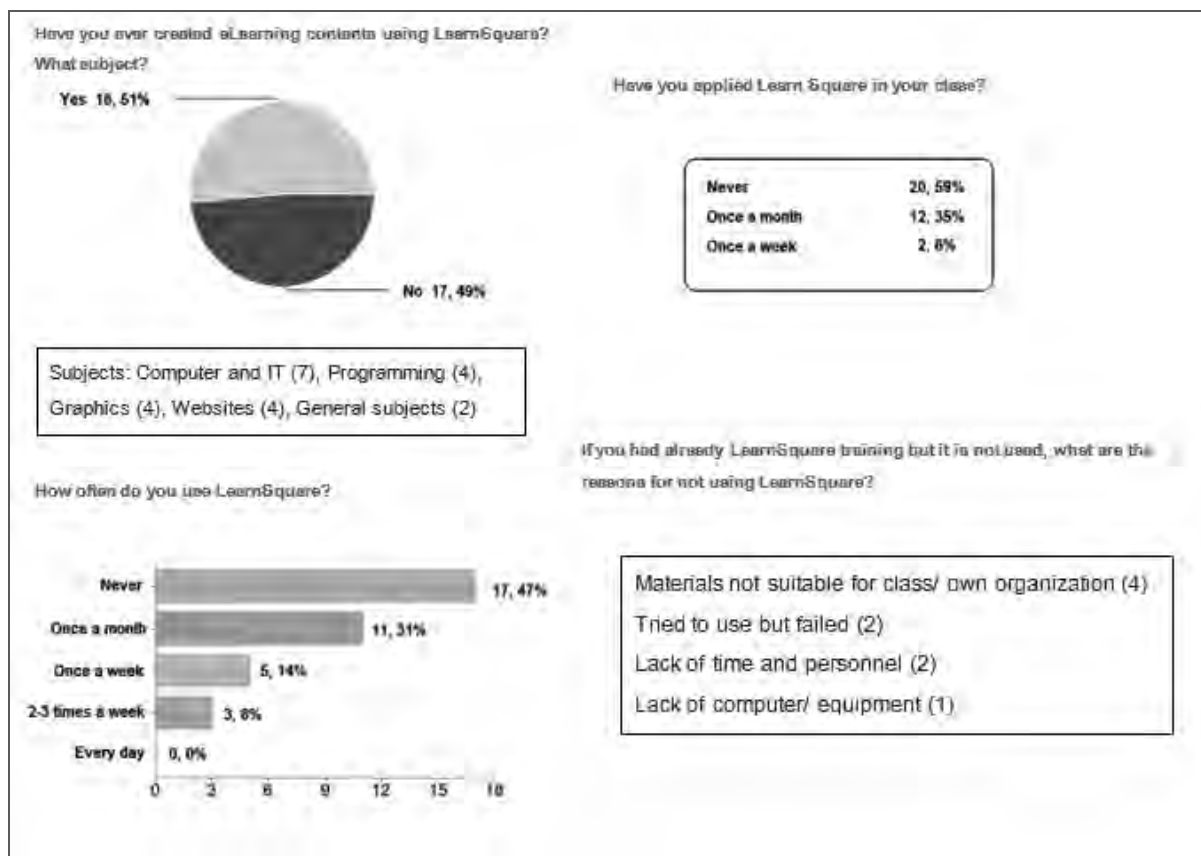
Figure 25. Train the trainers



LearnSquare

51% of the teachers reported using LearnSquare but 59% still did not apply it to the class context. Most of the teachers that used LearnSquare used it about once a month (31%). For those that did not use the application, thereasons were materials not being suitable for own class, failed attempts to use the application, and lack of time/ personnel.

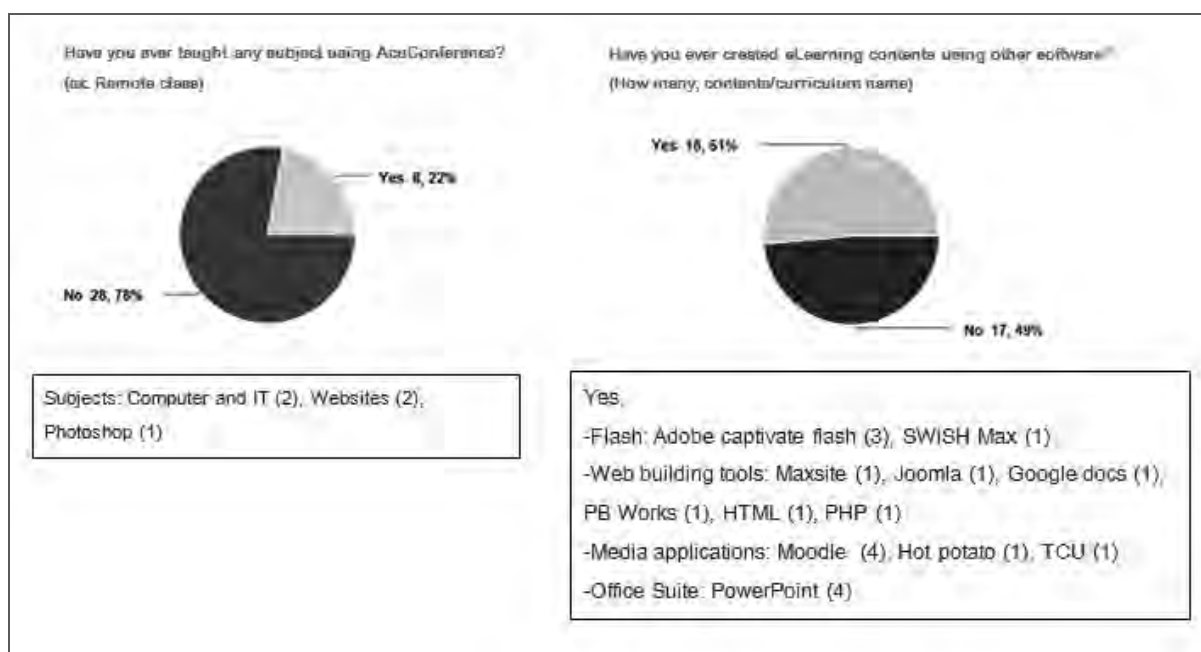
Figure 26. Teachers using LearnSquare



AcuConference and other software

As AcuConference was introduced late in the year, only 22% of the targeted teachers did teach a class using the application. About 51% of the teachers also used other software to create contents such as Flash, web building tools, and media applications.

Figure 27. Teachers using AcuConference and content-creating software

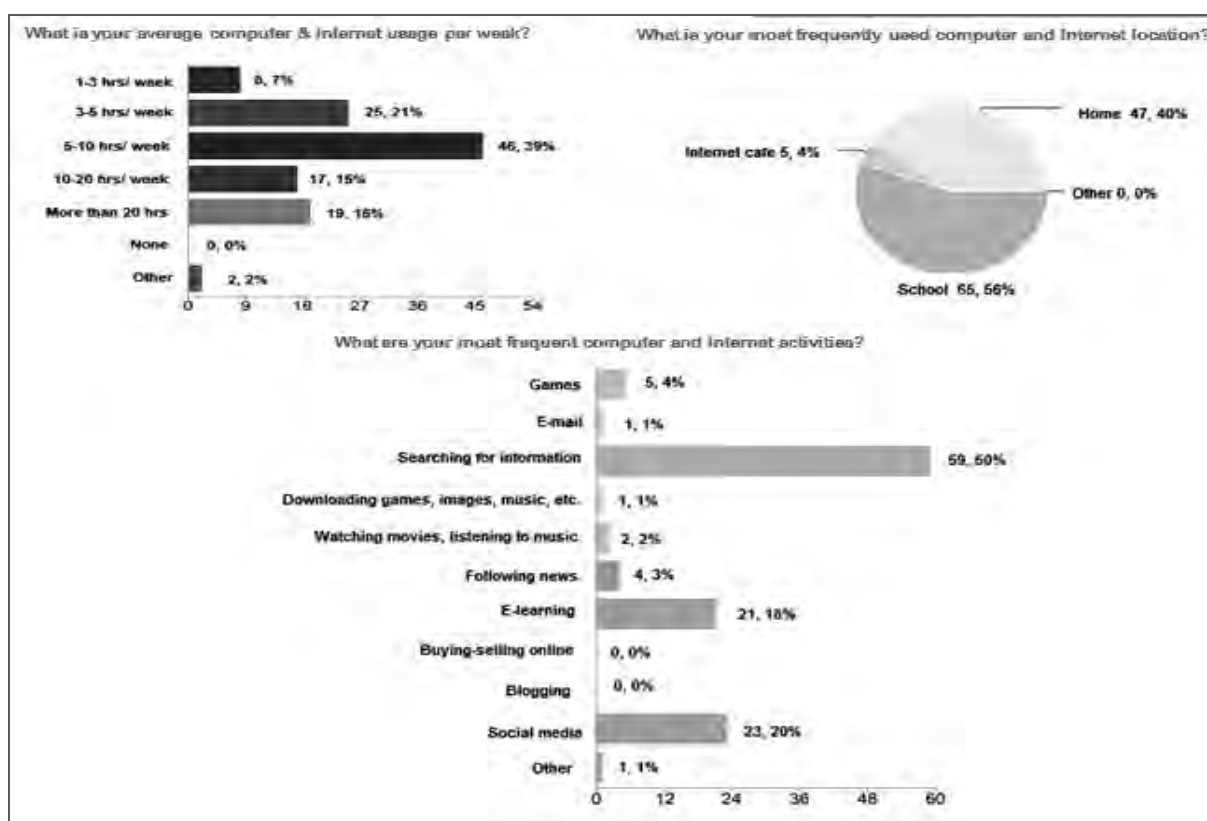


2.3.2 e-Learning for students

Computer and Internet usage

Most students reported using the Internet for about 5-10 hrs per week (39%) and about 3-5 hours per week (21%), from both at school (56%) and at home (47%). Most frequent Internet activities for them were searching for information (50%), social media (23%), and e-Learning (21%).

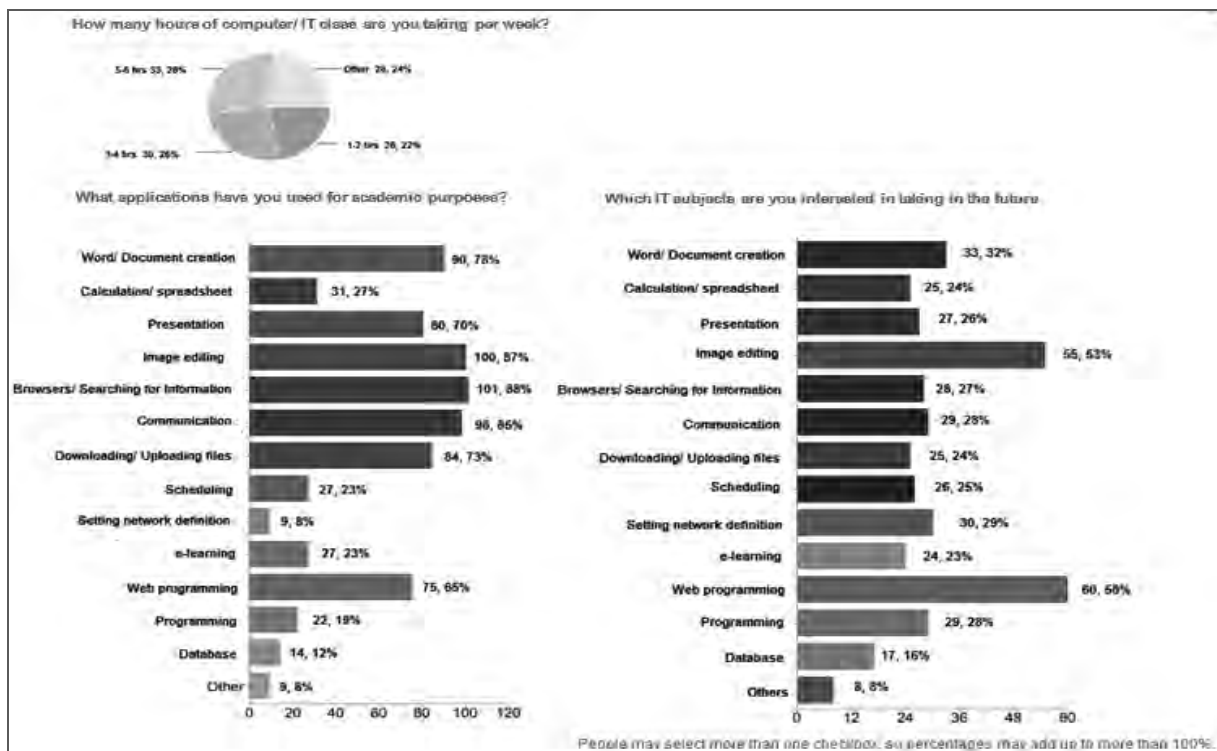
Figure 28. Computer and Internet usage for students



Use of IT for academic purposes

Computer/ IT class for students could range from 1-2 hours, 3-4 hours to 5-6 hours per week. Applications most used for academic purposes were browsers (88%), image editor (87%), communication program (85%), word/document creator (78%), uploader/downloader (73%), and presentation program (70%). IT subjects that the students would like to learn in the future were web programming (58%), image editing (53%), word/document creation (32%), and programming (28%).

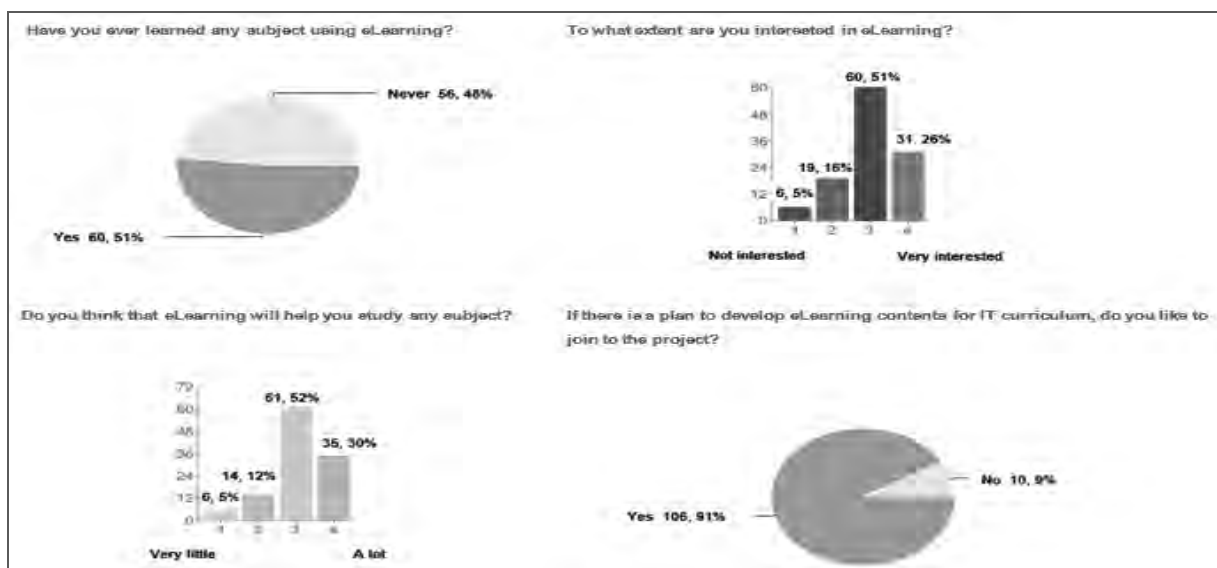
Figure 29. IT for academic purposes



e-Learning usage

Half of the students (50%) reported having learned online. Also, the same percentage showed interest in e-Learning and thought it could be useful/ helpful. If there was a project to develop IT curriculum contents, most students (91%) would like to participate.

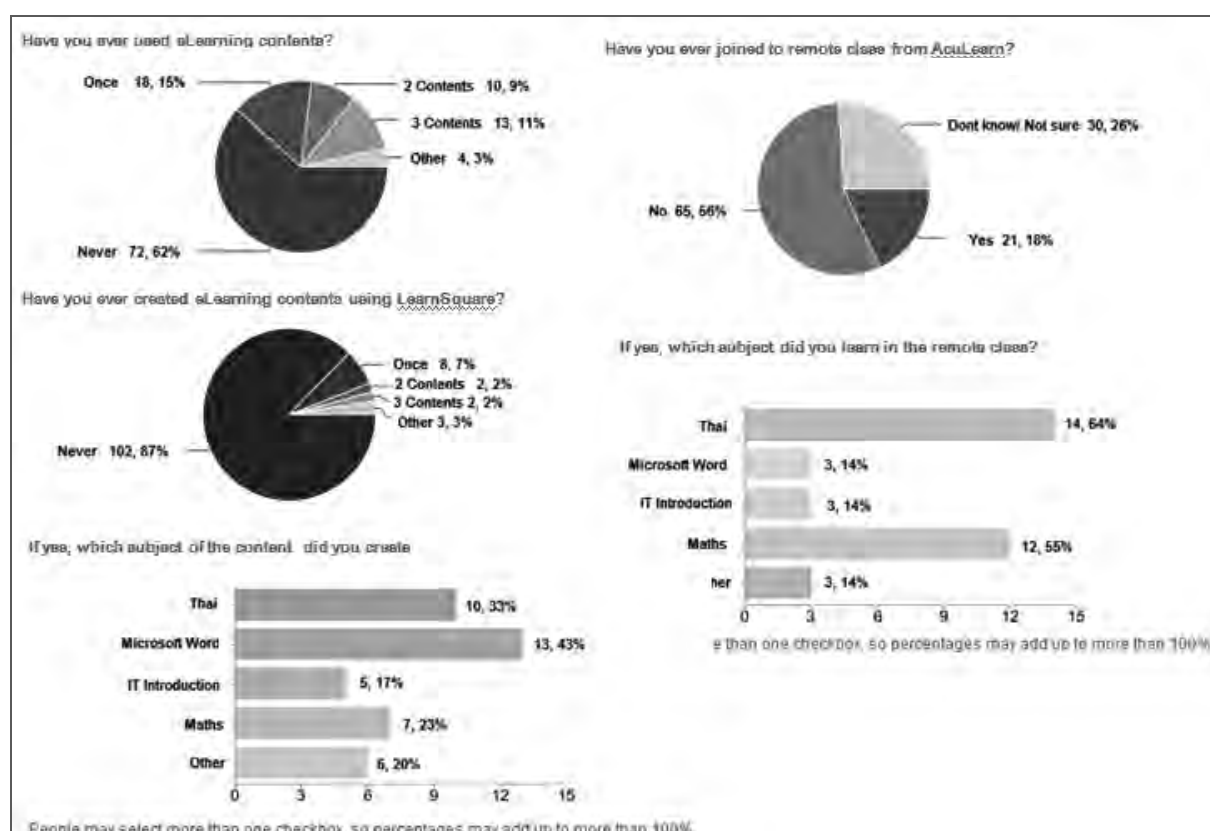
Figure 30. e-Learning experience



LearnSquare and AcuConference

62% of the students never used e-Learning contents (in general) and 87% never used LearnSquare. For those who did, Microsoft Word (43%) and Thai (33%) were popular subjects. In the same way, most students never used AcuLearn/ AcuConference. For those who did, they learned Thai (64%) and Math (55%) via these remote classes.

Figure 31. e-Learning, LearnSquare and AcuConference for students



2.4 Focus groups and interviews

To gain additional information, the above questionnaire survey was accompanied by two focus groups (in Mae Sariang and Mae Hong Son) and individual interviews on how users of various categories perceived the benefits of the WiMAX service as well as what they would like to see more (or changed) in the future. Focus group and interview messages can be summarized as follows:

Project strengths

- **System implementation:** The WiMAX service for local communities had strong signals in coverage areas. WiMAX could be used as an alternative communication network and/ or a backup system in many cases. The WiMAX dongles were well-received by all users.
- **Technology and knowledge transfer:** Wireless communication technology and knowledge were transferred to local communities. A mission-oriented project that brought such technology and knowledge to the province was highly appreciated by local people, especially the IT community. The project also helped build a strong network for local personnel in the field of information technology and education, even beyond the WiMAX context.
- **e-Learning:** For the first time, a platform was built to allow local teachers to utilize IT to create digital contents and share them with both colleagues and students. The project significantly helped the IT-savvy teachers to improve on their e-skills. Also, despite being new to e-Learning, students showed strong interest in e-Learning activities and such IT curriculum as programming, and image editing.
- **AcuConference:** Despite being introduced late in the project, WiMAX had great potential to save time and traveling expenses for a province like Mae Hong Son. Several IT-oriented teachers would like conduct AcuConference class to offset the shortage of specialized teachers. The Mae Hong Son Courthouse and local prisons also showed strong interest in using the service so as to avoid having to transport prisoners to the courthouse located in another district back and forth, thus saving a lot of energy, time, and the government's money.
- **WiMAX Dongles:** Users reported that the provided dongles greatly enhanced their mobility, enabling them to work outside their office and that the connection was fast and stable. Mae Hong Son ex-governor (Mr.Direk Konkleep) and the tourism community also strongly suggested using the WiMAX service to promote the local tourist industry.

Lessons learned

- **System:** WiMAX suffered from stability issues as electricity problems often caused the system to go down for a long stretch of time as well as damaged related equipment. Time taken to have said equipment fixed or replaced was also an issue.
- **System training:** Training issues were complicated and multi-layered. While some mentioned the difficulty of technical content, most were human-

related limitations. Several reported not being able to regularly attend the project's training workshops due to routine work and funding issues.

Lacking continuity was also a problem due to frequent personnel transfer.

- Policy and management: One of the major complaints of the WiMAX service was that users were unable to access the Internet via the system. As the use of system was limited to a few specified functions for academic purposes, sometimes the users felt they might not choose to use WiMAX, provided that they had an alternative connection.
- e-Learning: Time and motivation were issues for some local teachers. While many were model e-Learning teachers, some were still not motivated enough to learn and create their e-Learning contents independently. Some teachers reported finding no content that would align with their needs. Also, at this stage of the project, LearnSquare was still used mainly for teachers creating contents and students downloading specified learning materials. Students must be encouraged to create e-Learning contents themselves in the next stage of the project.
- AcuConference: As AcuConference (at the time of interview) was going through a trial and test, many teachers might not be competent enough to run or troubleshoot the system on their own, especially with quality-of-equipment and bandwidth issues. Also, outside the school context, some of the organizations had their own AcuConference network that was separated from this project. Last but not least, AcuConference might not be suitable organizations that had no peer to connect in specified areas of the three districts.
- Non-academic service: Sometimes non-academic users could not make full use of the WiMAX service that focused more on application like LearnSquare. Other times, they already had wired networks and internal WiFi in place and did not quite know what to do with the project's provided service.

3. Impacts of the WiMAX Service

3.1 Impacts of the WiMAX service

Deriving from the results in the previous section, impacts of the WiMAX service can be hypothesized as follows:

Impact 1: There was a marked improvement in PC and network conditions. More PCs were connecting to the Internet after 1 year of installation.

Impact 2: There was a marked increase in availability and bandwidth of wireless communication.

Impact 3: There were more choices of wireless communication including WiMAX

Impact 4: There were more wireless technology training instructors. Wireless system skills expanded.

Impact 5: Internet access was more frequent. Social network became more popular.

Impact 6: Schools expanded their curriculum, including IT curriculum. Teachers and students became more interested in e-Learning and studying IT subjects.

Impact 7: The project helped build a network for local personnel in the field of information technology and education.

3.2 Validation of the impacts

In this section, hypothesized impacts are validated by evidence from questionnaire survey, focus groups, and in-depth interviews. PDM related indicators are also referenced. Only items that show apparent change from the past year data are included here. Causal relationships between the introduction of WiMAX service and the said change are also determined.

Table 3. Impact validation through baseline and impact survey results

	Impacts	Evidence	Reference	Contribution from the Project	Reasons
1	There was a marked improvement in PC and network conditions. More PCs were connecting to the Internet after 1 year of installation.	More PCs connecting to the Internet	OP1_BL4.1	Partial	2 PCs per site were provided by the Project
		More sites connecting through alternative network providers (CAT).	OP1_BL2.1	No	
		Better identification and authentication system	OP1_BL2.1	Yes	Trainings/workshops were provided by the Project
		More system administrators	OP1_BL2.1	Yes	Trainings/workshops were provided by the Project
		More organizations with server	OP1_BL2.1	Partial	Servers were provided at 2 sites by the Project
		Slight improvement in UPS time	OP1_BL2.4	Partial	New UPSs were provided by the Project with maintenance supports
		Slight improvement in blackout incidents	OP1_BL3.1	No	
		Slight decrease in hardware/ software trouble	OP1_BL2.1	Partial	Trainings/workshops were provided by the Project with maintenance supports
2	There was a marked increase in availability and bandwidth of wireless communication.	Marked increase in the number of WiFi access points	OP1_BL6	Partial	1 additional access point per site was provided by the Project
		Marked increase in availability (locations/ places) of wireless communication	OP1_BL6	Partial	1 additional access point per site was provided by the Project
		Marked improvement in wireless communication bandwidth	OP1_BL4.2	Partial	ISP improvement and WiMAX helped improve bandwidth
3	There were more choices of wireless communication including WiMAX	WiMAX becoming an alternative wireless communication system	OP1_BL6	Yes	WiMAX did not exist before the Project

4	There were more wireless technology training instructors. Wireless system skills expanded.	Greater number of wireless technology training	OP1_PDM1-2	Yes	Trainings/workshops were provided by the Project
		More wireless technology training instructors	OP1_PDM1-2	Yes	Trainings/workshops were provided by the Project
		Expanded wireless system skills	OP1_PDM1-2	Yes	Trainings/workshops were provided by the Project
5	Internet access was more frequent. Social network became more popular.	More frequent internet access for students	OP1_BL5.2	Partial	Better wireless communication provided by the Project helped induce more Internet access
		Social networks gaining popularity for teachers	OP1_BL5.2	No	
		Social networks gaining popularity for students	OP1_BL5.2	No	
6	Schools expanded their curriculum, including IT curriculum. Teachers and students became more interested in e-Learning and studying IT subjects.	Marked improvement in the performance of PC/ network for teaching IT curriculum	OP1_BL4.3	Partial	PCs, servers and WiMAX helped improve performance
		Expanded IT curriculum in many school sites	Survey 2_Q17	Yes	Trainings/workshops were provided by the Project
		Many teachers becoming active e-Learning content users	Survey 2_Q18	Yes	Trainings/workshops were provided by the Project
		Many teachers becoming active content developers	Survey 2_Q21	Yes	Trainings/workshops were provided by the Project
		More widespread “train the trainers adoption”	Survey 2_Q22	Yes	Trainings/workshops were provided by the Project
		More LearnSquare usage	Survey 2_Q24	Yes	Trainings/workshops were provided by the Project
		Students’ strong interest in learning IT-related course	Survey3_Q19	Partial	Trainings/workshops were provided by the Project
		Students’ strong interest in participating in an e-Learning IT curriculum	Survey3_Q23	Partial	Trainings/workshops were provided by the Project
7	The project helped build a network for local personnel in the field of information technology and education.	WiMAX project building a network for local users in IT and education (side effect)	Interview	Yes	Through various project activities, people gained more awareness of technologies and get together for cooperative actions

Other impacts

Through brainstorming among the NECTEC, NSTDA and WISEComNet teams, other impacts and comments were also raised as listed below:

1. WiMAX utilization could have been better if Internet access were allowed through the WiMAX system. More applications such as VoIP could have added to WiMAX popularity.
2. There were cases of good success of AcuConference. However, usability pretty much depended on the quality of network and other hardware and the low quality of which led to poor voice streaming.
3. Users wanted to have more WiMAX dongles and mobile broadband.
4. Strong interest in WiMAX from business community of Mae Hong Son pointed to commercial service potential.
5. e-learning propagation did improve but still needed more push by interested parties.
6. Local communities were vitalized through the introduction of this advanced technology and training/workshop participation.

3.3 Socio-economic impacts

At the time this impact survey was commenced, the fully functioned WiMAX system had been in place for less than 9 months, most of which were spent for system introduction and training. The teams thus felt that the time was too early to make a conclusive call on socio-economic impacts. Nonetheless, initial assessment revealed some evidence of impacts. Examples include:

Reduction in travel time and expenses

- The local justice offices showed strong interest in using AcuConference to reduce the number of trips made to transfer back and forth prisoners from local prisons to the Mae Hong Son Courthouse.
- Even though AcuConference for schools was still at a trial and test stage, several teachers agreed that, after ironing out the glitches, remote classes could help offset the shortage of specialized teachers in many schools.

Improvement in job skills and productivity

- As the project provided a series of technical trainings to close to 50 local personnel, particularly in the areas of networking and e-learning applications. Many of them reported having expanded skills that could further enhance their career.
- Local teachers became more interested in using and developing own e-Learning contents that would in turn improve both their teaching repertoire and learning experience for students.

Vitalization of business and IT communities

- About 40 dongles were distributed to individuals for test and trial, many of which were local business owners. Even with limited signal coverage, these business users reported being completely satisfied with the WiMAX service and expressed their wish that the service be expanded on a commercial scale to support the local tourist industry.
- By introducing the WiMAX service into Mae Hong Son and providing training to local IT users, the project helped create a strong network for local people, particularly in the fields of information technology and education. Many of them even started extending their ties beyond the scope of this project.

3.4 Conclusion

Within one year after complete installation, the WiMAX service proved to have great many impacts on the local communities. System-wise, there was a great improvement in PC and network conditions partly due to the project's support on equipment and maintenance as well as knowledge transfer through trainings/workshops. Availability and bandwidth of wireless communication hugely increased within one year. Even though such improvement was a global trend but the effect was also magnified by the fact that the project did supply an additional access point to each site and that WiMAX was provided as an alternative wireless communication system to give that extra bandwidth to local users.

Also, technology and knowledge transfer to local users was accomplished at both technical and usage levels. At the technical level, the project was a huge success in both

quantity and quality. Through a series of trainings and workshops, the project produced more wireless technology training instructors, who reported expanded wireless system skills. At the usage level, many teachers reported expanding their IT curriculum, helping their peers on IT problems as well as content development, and using LearnSquare for both the project's workshops and their school activities. Students, at the same time, accessed the Internet more frequently and did show strong interest in studying IT curriculum and other e-Learning subjects in the future.

The last impact might not be one of the project's initial targets but was a pleasant surprise. As the project provided series of trainings/ workshops over the year, the workshop participants started networking both inside and outside of the WiMAX project, bringing such vitality to the local IT and education communities.

Recommended further actions

This phase of the project is drawing to an end, with a terminal evaluation scheduled in March 2012. While the project did achieve many of the intended goals, some issues must still be worked on in the next phase. As a big picture, a sustainability/ promotion plan is being drafted to ensure WiMAX adoption and sustainability in Mae Hong Son over the long run. Deriving from the final internal workshop, this report recommends further actions to be included in the plan as follows:

For the system:

- Allow the use of Internet for the next phase of the project, if future bandwidth permits.
- Expand the WiMAX service in three strategic areas for Mae Hong Son: education, healthcare, and tourism.
- Consider relocate some of the current WiMAX sites that are not a good fit to the project.
- Support the locals in the quest to expedite the improvement of MHS power system

For technical training:

- Update and expand the existing training database (location, number of people, training topics, participants' training history, etc.) for more active and continuous participation.
- Conduct a demand survey to maximize the training experience.

For e-Learning and other applications:

- Conduct a demand survey in terms of applications and contents to meet the needs of users.
- Encourage the Ministry of Education to give career rewards to teachers who excel at e-Learning for motivation purposes (Top-down approach).
- Put stronger emphasis on students creating e-Learning contents themselves.

For communication:

- Encourage the setting up of local help desk/ self-sustained local help stations.
- Brainstorm for a comprehensive promotion plan.

CAPEX SIMULATOR

<p>Target Coverage Area Requirement <input style="width: 50px; text-align: center;" type="text" value="0"/> KM²</p> <p>Proportions of Geographical Characteristics of the Area in percents</p> <table style="width: 100%; border-collapse: collapse;"> <tr><td style="width: 80%;">Flat</td><td style="width: 20%; text-align: center;"><input style="width: 30px;" type="text" value="0"/> %</td></tr> <tr><td>City</td><td style="text-align: center;"><input style="width: 30px;" type="text" value="0"/> %</td></tr> <tr><td>Inside valley</td><td style="text-align: center;"><input style="width: 30px;" type="text" value="0"/> %</td></tr> <tr><td>Non target Area</td><td style="text-align: center;"><input style="width: 30px;" type="text" value="0"/> %</td></tr> <tr><td>Total</td><td style="text-align: center;"><input style="width: 30px;" type="text" value="0"/> %</td></tr> </table>	Flat	<input style="width: 30px;" type="text" value="0"/> %	City	<input style="width: 30px;" type="text" value="0"/> %	Inside valley	<input style="width: 30px;" type="text" value="0"/> %	Non target Area	<input style="width: 30px;" type="text" value="0"/> %	Total	<input style="width: 30px;" type="text" value="0"/> %	<p style="text-align: center;">Target On Throughput Demand</p> <p>Expected number of client sites <input style="width: 50px; text-align: center;" type="text" value="0"/> Units of CPE</p> <p>Throughput demand per client site <input style="width: 50px; text-align: center;" type="text" value="0"/> Mbps</p> <p>Over-subscription ratio <input style="width: 50px; text-align: center;" type="text" value="1:1"/></p> <p>Total spectrum bandwidth in one cell <input style="width: 50px; text-align: center;" type="text" value="30"/> MHz</p>
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<p>Base Station Tower Cost Assumption <input style="width: 50px; text-align: center;" type="text" value="Build"/> <input style="width: 50px; text-align: center;" type="text" value="1,600,000"/> Cost per Site</p>											
<p>WiMAX Core Equipment Cost <input style="width: 50px; text-align: center;" type="text" value="2,500,000"/> THB</p>	<p>WiMAX BS Equipment Cost <input style="width: 50px; text-align: center;" type="text" value="2,100,000"/> per Site</p> <p style="text-align: center;">x <input style="width: 50px; text-align: center;" type="text" value="0"/> Sites</p> <p>Total WiMax BS Equipment Cost <input style="width: 50px; text-align: center;" type="text" value="0"/> THB</p>	<p>Base station tower Cost <input style="width: 50px; text-align: center;" type="text" value="1,600,000"/> per Site</p> <p style="text-align: center;">x <input style="width: 50px; text-align: center;" type="text" value="0"/> Site</p> <p>Total Base station tower Cost <input style="width: 50px; text-align: center;" type="text" value="0"/> THB</p>	<p>CPE Cost <input style="width: 50px; text-align: center;" type="text" value="10,000"/> per unit</p> <p style="text-align: center;">x <input style="width: 50px; text-align: center;" type="text" value="0"/> Units</p> <p>Total CPE cost <input style="width: 50px; text-align: center;" type="text" value="0"/> THB</p>								
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">Grand Total (excluding CPE cost)</td> <td style="width: 40%; text-align: center;"><input style="width: 50px; text-align: center;" type="text" value="0"/> THB</td> </tr> </table>		Grand Total (excluding CPE cost)	<input style="width: 50px; text-align: center;" type="text" value="0"/> THB								
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