Application of the Use of Transceiver Radio to Business

By

Mr. Perasit J. Jitcharoenchai

A Final Report of the Three - Credit Course
CE 6998 Project

Submitted in Partial Fulfillment
of the Requirements for the Degree of
Master of Science
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Project Title: Application of the Use of Transceiver Radio to Business

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The Graduate School of Assumption University has approved this final report of the three-credit course, CE 6998 PROJECT, submitted in partial fulfillment of the requirements for the degree of Master of Science in Computer and Engineering Management.

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ABSTRACT

This project is developed to improve the existing system of security by applying the transceiver radio to the existing system, and all of the work process of this existing system is man-power. It has a high cost of salary each year. The project is based on Security Management in the condominium project. The system analysis and design process cover the current problem definitions, cost analysis, equipment consideration for suitable work, and the existing system consideration providing the transceiver radio for improvement of the efficiency of the security system and cost reduction.

The new system is transceiver radio application to the existing system. The cost and benefit requirements are very important for the project. So the transceiver radio application can reduce the cost and can increase the efficiency of the guardian for the security system.

The scope of the project includes the choice of the suitable set of transceiver radio. And find the suitable equipment for the existing system with transceiver radio application. Finally, transceiver radio application with the existing system is the best choice for this project because of the existing system and also can increase the efficiency of the guardian.

ACKNOWLEDGEMENTS

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I. INTRODUCTION

1.1 Introduction

Now a day communication through the high technology devices is basic thing for human being. So they try to find not only the suitable way but cost saving also. In general, people use the telephone to contact to other person or use the facsimile to send and receive messages. Mobile phone is the other choice. Those are two ways communication devices. For one way communication device as pager is also used in communication. And the factors that made them to choose the type of communication depend on their type of business cost, and area they want to contact as they want to contact to other persons in their group or their organization very often but in short time each we can use the internal line telephone system.

The advantage of internal line telephone system is there is no using expense while using it to contact other person or department inside our organization. And the use of the telephone can be controlled because we can set to the PABX (Private Automatic Branch Exchange) to lock the distance call or mobile call and etc.

The disadvantages are it only stay in fix position that we cannot bring it along with the user. And the cost of the controller box and asking the new telephone number are expensive. We need to pay for installation cost of the controller box and cost of the asking the number from the Telephone Organization of Thailand or Telecom Asia about 6,000 bahts per number.

So we try to find the suitable type of communication that can solve those above problems, then we consider the "Transceiver Radio". We can use the transceiver radio contact to other persons in our group as much as we can by not occur cost of using. In business side we can use the transceiver radio set in security service, hotel, campus, dispatching and so on. And on the service organization side are Traffic Police Department, Fire Police Department, Charity Foundation, Amateur radio, and etc.

1.2 Objective

The objective of this project is to apply the transceiver radio to help the business side as security service, hotel or condominium service, transportation, and etc. Which includes following:

(a) Review and evaluate the transceiver radio.

(b) Find and develop the system the match the need of business.

(c) Optimize the use of accessories.

1.3 Scope

The scope of this project including following:

(a) Develop the suitable system of using transceiver radio to match the business as CB, VHF, UHF system that can help the owner to reduce cost of running business.

(b) Develop the suitable accessory for the selected business.

(c) Optimize the use of the equipment for wireless communication.

II. BACKGROUND OF RADIO

2.1 The Invention of the Radio

During the second half of the last century scientists were searching the way to wireless communication; but many attempts were made with electromagnetic waves which didn't lead to any result. The scottish CLARK MAXWELL demonstrated mathematically how electromagnetic "actions" did spread with an "undulatory" movement. In 1887 the German HEINRICH HERTZ, using periodic currents at very high frequency, demonstrated the real existence of electromagnetic waves transforming the "undulatory movement" into a stationary phenomenon, which could be easily checked in a laboratory. The Italian physicist AUGUSTO RIGHI continued and improved in Bologna HERTZ's work, also demonstrating also the complete identity between optical and electrical vibrations. In 1884 TEMISTOCLE CALZECCHI-ONESTI, teacher in the lyceum of Fermo, noticed the influence of electrical discharges of athmosferic perturbations on iron filing, constructing the famous "tube" which was named by the English physicist OLIVER LODGE in 1894 the "coherer". The same LODGE, with the coherer improved by the French BRANLY in the Cambridge experiments, could notably increase the reception gain of the Hertzian waves.

Finally in Kronstadt the Russian POPOV used the LODGE coherer acting with athmosferic disturbances collected with a rudimentary antenna: a vertical metal pole. These were the main scientific conquests which led to the comprehension of identity between light and electromagnetic action, that took GUGLH-LMO MARCONI to his wonderful discovery, producing the device capable to make the electromagnetic waves travel the air, confined in conductive media as the ionosphere and the earth surface, and still capable to preserve precisely their own features. Let me now write shortly of the studies and experiences of MARCONI. Few books treat the argument systematically, so I think it is nice for the 100 years of invention of the radio to find a place to write of it, since I think that the name of GUGLIELMO MARCONI will never be celebrated enough.

GUGLIELMO MARCONI was born in Bologna in April the 25th, 1874. His father was named Joseph and his mother, Annie Jameson, protestant, was the second wife of his father. From his mother he inherited tenaciousness and perseverance, and knowledge of the English language; from his father a strong will and business skill. When he was seven years old he entered the Istituto Cavallero in Florence, and in 1885 the Istituto Nazionale in Livorno, where meanwhile the family had moved. In Livorno GUGLIELMO acquired also a religious culture in the local Valdese church, where he was "confirmed" in 1882; in fact his mother before marrying laid down the condition that her sons would have been educated as protestants. GUGL1F'LMO himself will marry as first wife a protestant: Beatrice O'Brien. A self-taught person, when he was just eighteen, felt the growth of an irresistible vocation inside for physics and electricity. Pupil in Livorno of professors Vincenzo Rosa and Giotto Bizzarrini, he acquired a more rigorously scientific way of thinking in a crucial moment for the direction of his studies. He knew well the ideas and theories of MAXWELL, the experiments of HERTZ, RIGHT, CALZECCHI-ONESTI, BRANLY. During the summer 1894, during his family vacations on the mountains near Biella (in the surroundings of Turin) Young GUGLIF LMO could meditate on HERTZ's experiments, and had the idea to use the Hertzian waves to communicate. This was his marvelous intuition, never thought of before by anybody. During the following Fall, in the villa in Pontecchio near Bologna, the twenty-years-old boy transformed the granary into his laboratory, working night and day among rolls of copper wire, brass spheres, Ruhmkorff coils, Morse keys and electric bells, realizing the first elementary radio sets. The first weak signals could reach few hundred meters from the window of the granary where was placed the transmitter to the hill at the end of the garden where was the receiver, the three points of the letter S travelled the space, reaching the destination, and the farmer waved his handkerchief to show the successful reception. But MARCONI wanted to get over the obstacles of the ground and connect two reciprocally invisible points. He took the receiver to the other side of the hill, where Mignani with his gun waited for the ring to sound three times. From the granary MARCONI pushed three times the key of the transmitter and heard the answer of a distant gunshot, electromagnetic waves had overtaken the obstacle, radio communications where now possible! It was the month of April 1895. For this experiments MARCONI used the oscillators of HERTZ and RIGHT, but the waves were too weak to go too far. He overcame the difficulties connecting to the oscillator an antenna and a ground, thus obtaining more power.

In 1886 he obtained his first patent, which he presented to the Italian government at that time, an offer that wasn't even considered. His mother, understanding the importance of the invention, wrote to her parents in England, who advised her to send him to London, where it could have been easier to find the money necessary to develop the invention. On February 2, 1896 MARCONI left for England where, with the help of engineer DAVID JAMESON, his mother's cousin, he was introduced to the director of the Post and Telephones company, Sir WILLIAM PREECE, who became an enthusiastic supporter. On July27 he performed his first official experiment from the terrace of the Post Office to the Salisbury plain. Other transmissions were performed successfully across the Bristol channel, between Penarth and Weston. In 1897 MARCONI founded the first organization for the commercial development of his invention and in July of the same year, invited by the Italian government, came back to

Italy and performed in La Spezia a communication between the arsenal and the battleship San Martino, surpassing the distance of 18 Km. Back in England, on July 20 MARCONI founded the WIRELESS TELEGRAPH TRADING SIGNAL CO. L ID. In November was built the first MARCONI fixed station in Needless in the Isle of Wight, and were performed the first connections with Bournmouth 23 Km. away.

In May 1898 MARCONI realized the first equipments with tuning circuits to guarantee the independence of simultaneous communications between more stations (the future and the famous patent 7777), and in July of the same year he carried out the first journalistic radiotelegraphic service for the Daily Express during the Royal Yacht Club Regatta, reporting from the deck of the yacht Flying Hontress to Kingstown, which was connected via telephone to Dublin. On August the 26th for the first time a help signal was sent from a lighthouse boat using wireless telegraphy; on March 3 was made the first rescue of the shipwreck of a boat, the Mathens, using radio telegraphy.

On day 27 of the same month MARCONI achieved the telegraphic connection between England and France, from Wimereux near Boulogne-sur-Mer to South Foureland near Dover, a distance of 32 miles. In September MARCONI went to the United States where he carried out the connection between the cruisers New York and Massachusetts of U.S. Navy. In this period he improved his equipment to overcome the difficulties in order to obtain more distant connections, to get over the mountains and most of all the curve of the earth surface, which scientists considered unsuperable to the radio waves. It was in the year 1900: the WIRELESS TELEGRAPH TRADING SIGNAL CO. LTD. change its name to MARCONI WIRELESS LELEGRAPH CO. and on April 26 MARCONI obtained the historical English patent n. 7777 on his first tuning equipment. In October he ended building the Poldhu station in Cornwall, the most powerful telegraph station ever built until then. On November 26, 1901

MARCONI with his two assistants PAGET and KEMPT embarked in Liverpool and reached St. John's in Terranova, where he built another radio station. On December 12 around 12.30, local time, MARCONI received three weak signals corresponding to letter S in MORSE code. For the first time in the world electromagnetic waves had crossed an ocean.

On February 22 MARCONI embarked on the boat in Philadelphia bound for America to build a big radio station in Glace Bay in Nova Scotia, upon invitation of the canadian government. During the trip the scientist made important experiments discovering the harmful influence of solar radiation on transmissions, and, as he saw that the coherer did not meet the increasing needs of stability of reception, created a new kind of detector. This new device will be the Magnetic Detector, which will be patented on June 25, 1902. He will use it for the first time on board the Italian battleship Carlo Alberto, at his disposal from the Italian government for the famous radiotelegraphic campaign from Naples to Kronstadt in Russia, always keeping contact with Poidhu station.

In the month of October of the same year the boat was bound for Canada to Glace Bay, where MARCONI started the experiments to communicate across the Atlantic ocean from the other side, that is from America to Europe; Poidhu station worked as a receiver. For a long time every communication was impossible and from Poldhu via cable line the only message was "standard", that is "we haven't received anything". At last on December 15 the message received from Poidhu changed in "greentime", that is "we have received some signals", while on day 18 the reception became intelligible, and transmission was sure in both directions. The first transoceanic bilateral transmission was over. On September 1903 during the boat trip from England to the United States on board the steamboat Lucania MARCONI established the first press agency between

Europe and America, starting regular printing of newspapers on board during the trip across the Atlantic.

In 1904 MARCONI built the rotating oscillator, discovered the directive properties of horizontal antennas, and started to use FLEMING thermoionic valves.In 1905 he patented his directive horizontal antennas, which permitted a tremendous increase of the strength of received signals.

On December 10, 1909 GUGLIELMO MARCONI was awarded the Nobel prize for Physics.

In 1912 MARCONI invented a new way to generate continuous waves, called "multiple sparks system", a smart intermediate point between the previous spark instruments and those with continuous wave. In 1914, after the improvement of radiotelephonic instruments using triode thermoionic valves, he experimented successfully on a regular radiotelephonic service. It was the birth of radiophony. At the outburst of World War I he enrolled in the Italian Army as an officer. In March 1916, following some problems in using long waves during military operations, MARCONI started realizing the first VHF radios, opening thus a wider horizon to the development of radio communications. In 1916 he bought the boat Elettra, which became his personal laboratory, where he attended his studies and his researches. Knowing the peculiar properties of short waves, in 1922 MARCONI recommended their use instead of long waves, and between June and July 1923 he performed very important experiments between Poldhu and the Elettra, moored in the islands of Palo Verde (nearly 4000 Km.) , obtaining such results that led him to try even further. In 1924 MARCONI built numerous short wave stations, in the 30-60 Mhz band, for the British government, and on May 30 of that same year took place the first regular transmission of the human voice between England (Poldhu) and Australia (Sydney).

In October the Italian Ministry of Communications authorized the "Italian Radiophonic Union Society" to start radio auditions in Italy. On June 15 MARCONI married his second wife, the countess Maria Cristina Bozzi Scali (disappeared soon after), and on January 1, 1928 he was named president of C.N.R. (National Research Council). On March 26, 1930, from aboard the Elettra moored in the harbour of Genova, he sent a signal that, after covering 14,000 miles, lighted Sydney townhall. On September 17 he was named President of the Italian Royal Academy. Because of the start of regular raio services all throughout the world, the air was becoming more and more jammed with signals. MARCONI then opened new horizons for the radio, improving the reflecting radios, which worked on frequencies below one meter. On February 12, 1931 MARCONI, in the presence of Pope Pius IX, inaugurated the new Vatican Radio Station, and on September 13 of that same year, from his office in Rome, MARCONI lighted up the statue of the Redeemer in Rio de Janeiro, via the Coltano repeater. In this period MARCONI demonstrated the possibility of using microwaves communicating between Santa Margherita Ligure and Levanto (36 Km.). In 1932 he built the permanent radiotelegraphic connection between the Vatican and Castel Gandolfo (summer seat of the Pontifex). In the days 2-11 of August of that year he made important experiments between Rocca di Papa and the Elettra until the distance of 224 Km. (127 Km. beyond optical reach) and between Rocca di Papa and Senapro of Capo Lipari in Sardinia, at the distance of 269 Km., using a wavelength of 57 cm.

On July 26, 1934 MARCONI established the radiotelegraphic connection between the Elettra and the radio beacon in Sestri Levante with a wavelength of 63 cm., demonstrating how a ship could, in case of fog and in total blindness, find safely the entrance of a harbor. In March 1935 via Australia he performed some distant search experiments which would eventually lead to the invention of radar. Together with microwaves, he studied also television, foreseeing the future, and started research on therapeutic use of radiowaves (Marconitherapy).

GUGLIELMO MARCONI died of a heart attack in Rome on July 20, 1937. To remember his name, his multiform activity as researcher, inventor, experimenter, scientist and scholar, radios all around the world observed a long minute of silent regret.

His example, his precious work, his way to conduct experiments and trials with both exactitude and scientific method, his stubborness to lead the tests until the deep and complete understanding of the phenomenon, his devotion, his firmness, his enthusiasm, his committment are an inestimable heritage and an example that all of us radioamateurs have in our possession. It is through the work of radioamateurs that the world has been enriched by new discoveries, knowledge, positive results about radio and in all those fields that progress is related to the radio. Few men in the world had the satisfactions that MARCONI had during his life. I think of all that has been done, of all the reached goals, satisfactions that we Hams can understand, maybe better than any other.

2.2 Introduction to Radio Frequency, Waielength and How It Works!

When any electrical or mechanical actin is repeated over and over and over again, each separate action is referred to as **a** cycle. For example: A bicycle wheel going around one time completes one cycle, **at the** moon going around the earth one time completes one cycle. A cycle by it's self, nay not tell you much. If for example all you know is that the moon has gone around the earth 50 times, what have you learned ? But adding the element of time yields useful information. The complete formula would be: How many cycles in how much time, understand ? Now it just so happens that the act of counting how many cycles is happeningin how much time is called, frequency. The moon travels 12 cycles around the ear& per year in case you don't know. Or another example would be the engine of an iding car may turn at a frequency of 1,200 cycles (revolutions) per minute.

It just so happens that sound consists of repetitive air vibrations. The faster the vibration, the higher the tone.

Dictionary Term: TONE - vocal or musical sound of specific quality, a sound of definite pitch and vibration.

We the humans can hear sounds with freviencies from about 50 cycles per second (cps), to about 20,000 cps. These frequencies that we can hear are refered to as audio frequencies (AF). Radio signals are convosed of many repeating waves of electromagnetic energy. The frequency of the wavesis so high, that they have to be expressed in kilocycles (thousands of cycles) or megacycles (millions of cycles) per second! About 20 years ago it was decided to substitute Hertz (Hz) for "cycles per second", thereby honoring Heinrich Hertz, a ifth century physicist who pioneered the study of radio waves. The abbreviations for kilohertz and megahertz are (KHz) and (MHz). In order to change the KHz to MHz, jest simply move the decimal point three

(3) places to the left; 1000.0KHz — 1.0000MHz. Next time you go to the lake, on a calm day drop a rock into it and watch the water. The waves will radiate out in all directions, in a circular fashion. The measurable distance from the top of one wave to the top of the other or next wave is called the wavelength. Radio waves radiate out from a transmitter antenna the same way the water waves radiate from the rock when it drops into the water.

However this is a bigger and, Radio waves radiate much faster, at speeds of 186,000 miles (about 300,000 kilometers) per second, the sathe-as the speed of light. We the humans can not see radio waves, but trust me when I tell you they are out there and you are surrounded by them at all times. Now some of you might wonder.

We will set our imaginary transmitter to transmit just 1 Hertz (one cycle per second) to the receiver. The Transmitter is BOX A and the Receiver is BOX B. The radio wave starts it's transmittion out at the beginning of the second and ends when the second is over. How long is the radio wave ? The front end of the wave is traveling at 186,000 miles per second, and the back end of the wave was just leaving the transmitter at the end of the second.

So the radio wave has to be 186,000 miles long. If we were to transmit 2 Hertz (two cycles per second) How long would the wave be ? At one-half or in the middle of the second, the transmitter has finished sending the first wave, and started to send wave number 2. The front end of the 1st wave went 186,000 miles and the back end of wave #2 was just leaving when the second was over. The two waves traveled both at a speed of 186,000 thousand miles in (ONE - 1) second. So the speed of these waves is and will always be the same but it's length is different. Don't confuse length with speed. Each of the waves is one half that length, or 93,000 miles long.

"The higher (GREA1BRO the frequency, the shorter the wave length"

No matter what frequency the radio wave(s) are transmitting at, the length of all waves transmitted in one second will always be 186,000 miles per second or the speed of light. Each of the individual wave lengths might be a different length_

To figure out the difference between frequency and wavelength, all you have to remember is the number "300". By convention, wavelength is expressed in meters. And just in case you don't know the number off the top of your head a meter is 39.37 inches, or a little more then one yard. If you know the Frequency, divide 300 by the frequency in MHz to get wavelength in meter. If you know the wavelength in meters, divide 300 by the wavelength to get the frequency in Mhz.

In the summer months, you can and might hear stations and signals between the 30-50MHz range that are originated hundreds or even thousands of miles away. This is possible because in the summer hot months the atmospheric conditions are different, however you should keep in mind that this type of reception is unpredictable but is very interesting to listen to.

2.3 Wireless System and Technology

Wireless technology is on the verge of creating a revolution in communications. While systems such as broadcast radio and television have been around for many years, many new types of wireless communication systems are emerging such as digital cellular, personal communications services (PCS), and packet radio.

Wireless systems and technologies can be classified in to many different systems. They can be either terrestrial or satellite-based. They can be classified by the type of primary user service that can be provided such as one-way, two-way, or multiple-way voice, video, or data. Another form of classification is whether they are a traditional analog or digital system. Yet another is whether they utilize existing or emerging technologies. All of the various types of classifications have their respective merits and limitations. Wireless systems and technologies elude a single, all encompassing, universal method of classification. For this reason, the systems and technologies presented here are not classified. One exception to this, however, is that is the category of wireless telephone systems. These are wireless systems whose primary function is to provide a wireless access to the wireline telephone network.

This section presents a wide variety of both existing and emerging wireless systems and technologies. These systems and technologies include land mobile radio, transceiver radio, broadcast radio and television, and multichannel multipoint distribution service(MMDS), wireless telephone systems such as cellular and PCS systems; paging; packet radio, wireless local area networks, wireless digital modems, and satellite-based systems. Descriptions of these systems and technologies are presented with particular emphasis on applications in rural areas. Example costs of wireless systems and services are given where applicable.

2.3.1 Land Mobile Radio

Land mobile radio (LMR) consists of a wide variety of mobile radio systems, ranging from a simple pair of handheld citizen band (CB) "walkie-talkies" to elaborate radio repeater systems with paging and telephone interconnect. Land mobile radio is distinguished from other mobile radio services, such as aeronautical mobile radio (communications with aircraft), maritime mobile radio (communications with ships at sea), and the new mobile satellite service (mobile communications via satellites). LMR includes radio service between mobile units or between mobile units and a base station.

Mobile radio, CB radio, SMR, and amateur mobile radio fill a general need for mobile and personal communications that have significant implications for business productivity, personal safety, and social connection. In most rural areas, business must be conducted over a widespread area, and other forms of communication (e.g., cellular phones, paging, phone booths, etc.) are less available. This applies directly to the farmer, rancher, and forester; but it also applies to the suppliers, laborers, and buyers who need to do business with them. Traffic accidents or farm accidents often occur when other people are not present, so radio is often the first means of bringing help and notifying others of the problem.

A typical mobile radio system is purchased by a private businessman/taxi driver/rancher, who uses it to communicate with the home or office while out on the road or the farm. An investment of 10,000-50,000 baht provides a base station transmitter and a mobile or portable radio, to achieve communications over a 10-20 kilometers range. Usually, there will be no phone patch capability, though it can be done (poorly, since there is at least a push-to-talk requirement, which may require a 3rd party at the telephone to operate).

2.3.2 Simplex and Duplex Radio

There are several types of mobile radio operation, each of which is particularly suited for certain applications. The most basic of these types of operation is simplex radio. In simplex radio, all radios in a system transmit and receive on the same frequency. A person can communicate with a single listener or a group of listeners by turning on his transmitter and talking. All users who have radios turned on and tuned to that frequency will hear the person transmitting. For convenience, most radios have a push-to-talk switch on the microphone; holding the switch down activates the radio transmitter. When the person transmitting is finished talking, he releases the switch and the radio reverts to its normal receiving mode. A conversation between two people requires the observance of a certain discipline, since both people must not talk (i.e., transmit) at the same time. Instead, they must carefully alternate between listening (receive mode) and talking (transmit mode).

Simplex radio is ideal for dispatch service, where a single dispatcher at a base station provides direction to a fleet of mobile workers. Each mobile unit can hear instructions from the dispatcher, as well as all replies from other mobile units. Dispatch service is typically used in delivery, service, taxi, and police operations. If it is important that messages be delivered to a particular mobile unit, but not to the others, tone-coded squelch can be used. This technique sends a coded signal along with each transmission that causes certain radios to ignore the transmission, depending on whether the coded signal matches the code stored in each radio. Tone-coded squelch is often used when several systems share the same frequency. In particular, it prevents users of one system from being distracted by messages intended for users of another system, and vice versa.

Simplex radio is used in most mobile radio bands because it provides the cheapest and simplest system. Only a single frequency is needed (this is important when there is a shortage of frequencies), and operation is straightforward. However, simplex radio has some limitations, some of which can be solved by using duplex radio systems. Duplex radio uses two frequencies; each radio transmits on one frequency and receives on another. With full-duplex radio systems, each radio can simultaneously transmit and receive, making full continuous two-way conversations possible, without the use of push-to-talk operation. Cellular telephones and cordless phones are examples of full-duplex systems. Half-duplex radios transmit on one frequency and receive on another, but not simultaneously. Although half-duplex radios require push-to-talk operation, they offer advantages in some situations, particularly in repeater operation. When half-duplex radios are used in dispatch operations, the base station normally transmits on one frequency and all mobile units transmit on the other frequency. This means that a mobile unit can hear the base station (dispatcher), but it cannot hear the replies from the other mobile units.

Mobile radio is useful especially when it can provide service to the entire geographic area in which the user normally operates. In rural areas, markets for services can be dispersed over large areas, which make long range operation very useful. The coverage area of a transmitter can be increased by increasing the transmitter power or by raising the transmitting and receiving antennas. Usually the base station antenna is placed on a high tower, but the mobile antenna must remain low for obvious practical reasons. The mobile transmitter power may also be somewhat limited for practical reasons. Assuming, for example, operation at 150 MHz with a 300-ft antenna tower and 25-watt base station and mobile transmitters, good two-way communications can be maintained with the base station over a range of approximately 30 km. depending on terrain. Mobile-to-mobile communications would typically operate over only about 7 km. Since the coverage area is proportional to the square of the range, the coverage area from the base station tower is 20 times larger than that from a car. The high antenna tower is the key to getting acceptable operational range without using excessively high transmitter power. High power transmitters are costly, have large AC power requirements, and are prone to reliability problems. Using a high antenna tower is also quite expensive but avoids the AC power and reliability problems.

2.3.3 Repeaters

A repeater provides an excellent option for users of a mobile radio system who cannot provide their own high antenna tower. The repeater is a radio device that receives a signal on frequency F 1 and simultaneously re-transmits the signal on frequency F2. Radio User A transmits a signal to Radio User B on frequency F1. The repeater picks up the signal on frequency F 1 and retransmits the signal on frequency F2. Radio User B listens continually on frequency F2 and hears the signal on frequency F2 when it is retransmitted by the repeater.

If Radio User B wants to send a signal to Radio User A, the same procedure is followed. Thus, for all repeater customers, the rule is to always transmit messages on frequency F 1 and to listen for messages on frequency F2. As long as Radio User A and Radio User B are both in range of the repeater, the process will work. Since the repeater is located on a high tower, it can receive signals from Radio User A and Radio User B, even when they use relatively low antennas and low transmitter power. Instead of requiring each radio user to build a high antenna tower, a single tower is beneficially shared among all of them. However, the very important thing is the repeater is not allowed to be used in commercially in Thailand. It is allowed for government sectors or Government organization. Then we will not go in to details about the repeater. We will just explain how it works and how it covers more distance in communication via transceiver radio.

M. TRANSCEIVER RADIO SYSTEM

3.1 Transceivers Radio

The word transceiver is a= nhbrevintion of transmitter-receiver and indicates that these two facilities are combined into one unit. Normally the transceiver can either transmit or receive at any one time. The transceiver will only use one aerial which is switched automatically to the transmitter or receiver portion within the transceiver.

There are 3 kinds of transceiver radio:

3.1.1 Handheld Transceiver Radio. You can bring it along with you anywhere you want because it is a small set and you can use it in motion as a mobile transceiver radio, and use it at home as a base station by connecting it with a base station antenna. It is designed to be very small because the users need to bring it along with them when they want or when they go to work in the field. Then the dimension and weight are the important points in designing the handheld transceiver radio and now there are new designs for the handheld, that is, it is already shock proof to the users, that if it falls down not more than 1.5 meters the transceiver set is still in good condition. See Figure 3.1.

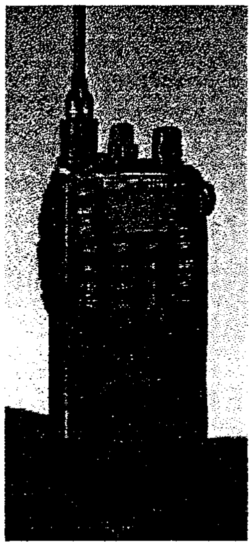


Figure 3.1. Handheld Transceiver Radio.

3.1.2 Mobile Transceiver Radio: It is designed for using in the car that is connected with a mobile antenna outside the car. The power supply comes from the car's battery a 12 volt DC, and the mobile transceiver radio can be used as a base station also, that can be connected with the base station antenna. The mobile transceiver should come with its manufacturers special mobile mount. A common place to put it is below the dashboard in front of the passengers seat This is a good location in as much as it provides some shading of the transceiver from direct sunlight and it can be operated by the passenger. Enough legroom should be left for the passenger if long duration journeys are undertaken. The mounting should allow the transceiver to be easily fitted and removed by authorized persons but some form of lock may be necessary for security reasons. A fist or hand microphone must be used and a clip for securing it, fitted on or near the transceiver. See Figure 3.2.

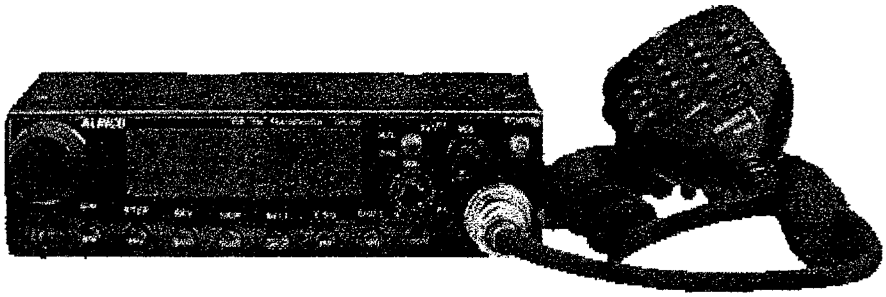


Figure 3.2. Mobile Transceiver Radio.

3.1.3 Base Station Transceiver Radio: This set is designed for using at home because the dimension of it is too large and there are many functions compared to the mobile and the handheld transceiver radio and for sure that the price is higher than those of the mobile and the handheld transceiver radio too. See Figure 3.3.

Figure 3.3. Base Station Transceiver Radio.

3.2 Transceiver Controls

The number of controls on the front of a traisceiver can vary from some 5 to 25. The more common and essential controls are described here:

Volume or audio

As found on all radios, cassette players etc. ft simply adjusts the loudness of sound from the loudspeaker and earphones.

Combined on/off and audio

These are frequently found on ordinary ratio receivers as well as transceivers. Because the action of switching off requires the **kiob** to be turned down to zero volume each time and also up again to normal level eachtime you switch on there is excessive wear on this component and it is often the first inn **to** wear out. If a separate ON/OFF switch were available then the volume control **codd be** left in its usual position.

Power light

This indicates that power is being suppliedto the set. It is usually a red bulb or Light Emitting Diode (LED).

Transmit light

This may be a red or orange light whirl► flashes when you speak into the microphone of a SSB transceiver and shows than the transmitter is generating power. The light may be labeled TRANSMIT or XMT.

R.F. Gain and attenuation

The purpose of these controls is to adjust the amount of amplification of the incoming signal in the receiver portion of the axinsceiver. The RF GAIN control is operated in a similar fashion to the volume contral. Alternatively there may be one or two switches labelled ATTENUATOR, with values of 5, 10 or 20 dB, which enable you to reduce the RF amplification by the number of ciR switched in.

Clarify

There can be a difference of several hundred cycles in the frequency of the transmitters you are listening to. So when you listen to one person speaking they may appear to have a deep bass voice whilst the next one has a high pitched and perhaps unintelligible voice. The CLARIFIER will enable you to adjust the pitch of the voice coming from the loudspeaker to your particular preference.

Squelch

On some Australian transceivers this is labeled MUTE. The control can either be a variable one like the AUDIO one or an ON/OFF switch. The purpose of the SQUELCH is to prevent any noise coming from the loudspeaker unless speech is being received. Hence you could have your transceiver left switched on receive, on your office desk, without it producing continuous hisses, crackles and bangs. The effectiveness of squelch circuits varies depending on their design. Some manufacturers offer what is called SYLLABIC squelch. This looks for the syllabic rate in speech and so it is able to differentiate between speech and other noises.

Channel selector.

This control selects the particular radio frequency which has been allocated to each channel. A rotary multi-position switch may be used for fixed frequency sets e.g. crystal controlled ones. Each switch position can have the full radio frequency beside it e.g. A 144.000 MHz., B 146.000 MHz., or the positions may simply be labeled A, B, C, etc. Synthesizer transceivers are more versatile, by selecting a channel and typing in the frequency the transceiver will store this frequency so that whenever that particular channel is selected in the future it will automatically be set up to the stored frequency.

3.3 Power Supplies

Basically there are two types of power sources. One source which can be considered to be "interruptible" e.g. a 110 or 220 volt AC mains supplied by the local electricity authority. A failure anywhere in the generation or supply system can mean that, often without notice, you will be without power. A similar loss of power can occur when your own generator fails. So you must consider the reliability of the electricity supply which you intend to use for your radio and the effect of not always being able to transmit when you wish. Such short comings can be overcome by using an "uninterruptible" supply, that is to store the electricity in your own storage battery which is automatically connected to the transceiver when the mains fail. The battery will require charging and you will have to put into the battery a little more energy than you expect to get out of it.

3.4 Type and Limitation of Using Transceiver Radio

When it is decided that your group needs some form of communication and could benefit from a radio communication network you should consider what this implies in some detail. Before you get down to choosing a transceiver from the glossy brochures there are some general aspects to be considered. What are the facilities you would like and what facilities you can actually afford to buy, license, operate and maintain? What form of radio communication, between which places will the Government of the country permit? You may plan several different systems on paper before you arrive at the one which is acceptable in all its aspects.

Who do you want to talk to?

The first stage of your planning should be to take a good look at the present method of communication between your locations and to make an assessment of their needs. Look at how long it takes to get urgent and routine information passed on, how much it costs, how far away from good roads each location is and from towns that might possibly have a telephone link or from other groups with a radio link. Then decide which locations have the highest priority for a radio link. You will probably give priority to the most isolated and distant places but there may be others which could be usefully linked by radio even though they are more accessible.

You may think that a place with a good road link does not need a radio even though it has no telephone, that in an emergency a journey by vehicle could be made. However where the costs of running a vehicle are high, where there can be risks of fuel shortages and the availability of vehicles are often in doubt, then a radio link may prove invaluable in an emergency as well as cost effective in routine matters. You must think carefully about the advantages and the possible disadvantages. For instance, while radio messages will certainly speed up your communications, it is possible that they can also put understaffed headquarters under a lot more pressure as outlying stations may come to expect instant responses to their demands.

Licenses

Licenses for radio communication equipment are usually obtained through the national post of the country concerned (license for using transceiver radio in amateur radio is needed when you want to use the transceiver radio in the part of amateur radio that is on 144.000 MHz. To 146.000 MHz. But it no need for CB 27 MHz., 78 MHz. And CB 245 MHz. And for connecting to the external antenna the license is needed) e.g. in Thailand the license will be issued by the Post and Telegraph Department. Whilst these deal with the technical aspects, approval may also be needed from the country's security. So you should have a license before you use your radio or you may be in trouble!

Applying for a license

Attempt to discover all the information you can about licensing conditions before you purchase your radio. You may be able to get information from the authorities or from other groups who are already licensed to operate. There may be a central body which is experienced in applying for licenses and may handle the applications for you. Obtaining licenses can sometimes take a long time, and you may have to fill in many forms, and supply technical specifications and circuit diagrams of the radios you intend to use, together with maps and plans of your network for each proposed station. You should obtain the technical specifications and circuit diagrams from the manufacturer of the radio you hope to use but you should not purchase or import your radios until you have the licenses for them, sometimes the condition of importing them is that you must have the license first. Also it is possible that the authorities might not give you the required permission or might impose limitations on the sort of radios you can use.

Some countries may wish to study a complete technical specification of the particular type of radio in order to give "type approval" before it is imported and used there. Sometimes "type approval" may have been given previously to another group using that particular radio so this is one stage where you may experience little delay. If "type approval" is a necessary stage in your particular country, enquire which types of radio have already been approved in this way as it could be helpful for you to choose one that has been approved. Do ask people who are already licensed for advice on all the things you can, e.g. you might learn, perhaps, that it is better to apply for more licenses than you need because it is the practice of the authorities to only grant five out of ten applications.

Limitations

However the ability to transmit on all these frequencies may not be acceptable to the licensing authorities. You may only be permitted to use a transceiver containing the frequencies for which you have been licensed.

Citizen Band

The use of CB radio is authorized by the Government of many countries. There are no international regulations for standardising the service, though the majority of countries allocate frequencies on 27 MHz. The types of modulation used in CB sets can be AM, FM and SSB. Some sets are capable of producing all three types of modulation and have a selector switch. Other sets are only for one type e.g. AM. A FM transmission cannot be understood on a AM receiver or a SSB transmission on a FM receiver. Therefore you should ensure that any CB radios you obtain all have the same modulation system.

Such contacts are often not within the terms of the CB license. CB radios are readily available and often at low cost so depending on your distance requirements CB may be an economic solution. It is a useful solution for communication within a mission or other establishment e.g. a hospital complex, where the buildings are spread over a wide area and where an internal telephone system would be impossible to install and maintain owing to its high cost and to the possible theft of overhead lines as has happened in some cases. CB has proved to be very useful within towns and for it to provide a good service some form of co-ordination is necessary.

In Thailand CB is divided into 3 parts:

(a) 27 MHz.

(b) 78 MHz.

(c) 245 MHz.

On 27 MHz., the Post and Telegraph Department is not allowed to connect with the external antennas as base station antennas or mobile antennas. But for CB 78 MHz and 245 MHz are allowed to connect with the external antennas, both base station and mobile antennas that can communicate in long distance.

And the one who wants to use CB no need to get the license from the Post and Telegraph Department that is we can buy it from the shop. The one who wants to use the external antennas need to get the license for setting up the base station antennas at home or for mobile antennas on the car, needs to pay 1,000 BART for setup station fee through the life of that CB set.

VHF

VHF can be a reliable form of communication as it is not dependent upon the fluctuations of the ionosphere but its range is limited. A rough guide is that if there is a "line of sight" between the two VHF aerials then communication is possible. Range can be extended beyond the horizon and round intervening hills by unattended automatic VHF relay stations(sometime called repeater). These can be located on a hill or high building and can greatly increase the area served by VHF transceivers. This is because there can be line of sight from each station to the elevated repeater even though stations are not visible to each other. Therefore it may be possible for all stations within a 80 kms. radius of the repeater to communicate with each other. The operational requirements for a VHF radio network should be specified with the help of a radio engineer who would then produce a plan and alist of appropriate equipment to satisfy your needs.

Repeaters are very powerful and useful tools for amateur communications. They can dramatically extend the range of a mobk transceiver and they offer extended capabilities such as autopatch, weather station access, etc. But in Thailand, a repeater is not allowed to be used in commercially.

Amateur Radio

The facilities provided by the amateur rao service should not be confused with CB or privately licensed networks. Amato frequencies are allocated on an international basis and range from 1.8 MIL/ to 10,000 MHz and enables global communication including the use of satellites. All types of communication are possible including normal speech, television, teletype and computer talking to computer. However as the name suggests the facilities areintended for the amateur enthusiast and not for commercial organisations. The rests Lions on what communication can be performed by amateur radio varies from countia to country. Most countries expect the amateur to pass certain examinations before a license is issued and some will only permit the license holder himself to speak on the radio. Others will allow anyone to speak under the supervision of the license hoick. Also others e.g. USA, will allow the amateur to connect his amateur friend from anither country into the telephone system via the radio so enabling him to speak to non-unateurs. Unfortunately, in Thailand for example this is never permitted.. The facilities of the amateur service are many and varied and are also continually increasing therefore you should enquire if the amateur service is relevant to your situation amlif so encourage some of your personnel to obtain an amateur license. Many expatriates use amateur radio for a daily or weekly talk with their friends in their home country. However it should be noted that some countries put many restrictions on amateurs, others make it difficult to obtain licenses while a few ban amateur radio completely.

Amateur Radio stations are operated for the purposes of self training in Radio communications, intercommunication using radio communications and technical investigation into radio communications by persons who do so solely with a personal aim; and= have no pecuniary interest in the outcome of the operation of the station and are operated on [specified] amateur frequencies or frequency bands. This pretty much encapsulates the spirit of amateur radio, and every country which has an amateur service, defines the service in similar words.

The central principle of amateur radio is experimentation. Alas, not every amateur does much real experimentation, but amateur radio is easily the most open radio service in the country, with minimal restrictions on what modes you can use. The regulations are deliberately open, in order to encourage experimentation.

Is Amateur Radio like CB?

One of the most common responses when you tell somebody you're a radio amateur, is "is that like CB?". To which the answer is "yes and no". Yes -- because they're both fairly open services, and you don't necessarily have to communicate with a closed group of other people (though many seem to like it that way). But, to explain the "No", there are more differences than similarities. CB permits business activities, amateur radio doesn't. There are two CB bands of 40 channels each. Amateurs have access to dozens of bands; each with as many effective channels as can be squeezed into the available space. In fact the amateur bands are not defined in terms of channels, instead they are simply defined as small segments of the spectrum, within which amateurs can use any frequency at all within reason.

Amateurs are permitted to use any of a number of modes, whereas CB operators are limited to 27 MHz, 78 MHz or FM on 245 MHz. The power levels are quite different too, 27 MHz. CB radios are limited to 5 watts of output power on AM or 12 watts on SSB and the VHF FM (245 MHz) radios are limited to 5 watts output.

3.5 Antennas System

3.5.1 Antennas

The purpose of an antenna is to launch the power from a radio transmitter into space in the form of radio waves. These waves then proceed, either by reflection from the ionosphere or along the surface of the earth, to the receiving location. Here the waves are captured by another aerial and steered to the receiver. So the antenna is a very important part of your radio system and it is essential that you use an antenna which is suitable for the particular frequency you intend to transmit. You may be told that all you require is a long piece of wire, the longer the better. Whilst such a wire could be suitable for reception, an additional unit would be necessary to tune the wire before it was suitable for transmission.

There is one kind of operation of transceiver radio called "Simplex operation" that is direct station-to-station radio communication without the use of an intermediate relay station (i.e., repeater). The range is much more dependent on antenna type, antenna height and power output than the repeater operation but significant distance can be covered. Two mobiles can contact on flat land can typically cover 15 to 20 Km. If one station is on a hill, the range can be much longer. If you happen to be standing on top of the mountain (i.e., 14,110 feet above sea level), you can contact someone several hundred Km. Away, which leads me to my next point, that simplex operation can be fun. It is a challenge to see how far your signal can go (yes, without some powerful repeater extending your range). But the important thing is the repeater is not allowed for commercial use. It allowed to be used in the government's organization , military or police department etc.

So don't forget about simplex. Some of the best contacts I have ever had were on simplex. One of the reasons is the challenge of seeing how far your signal will go. The other factor is that there are fewer people listening on simplex. There is less of the "party line atmosphere" that can exist on a repeater where everyone within repeater range will hear every word of every station. (Also, you are not tying up the precious resources of the repeater.) Often, this leads to a longer and more meaningful discussion between you and the operator on the other end.

3.5.2 Standing Wave Ratio

VSWR stands for Voltage Standing Wave Ratio and is often abbreviated to SWR. SWR is a measure of how suitable an antenna is for a particular transmitter at a particular frequency i.e. how well it is matched to the transmitter. The theoretical ideal value for SWR is 1. Some radio manufacturers specify that an antenna with a SWR of 1.5 or less should be used with their radios whilst others permit a maximum SWR of 2. The SWR of an antenna can be measured by connecting a SWR Meter between the transceiver and the antenna. The operating instructions for these meters vary according to the manufacturer. You must make sure you have the instructions and keep them with the meter and always follow them correctly, otherwise you may get inaccurate readings.

Although antennas are normally made to a length suitable for your specified frequency, the SWR should be measured after the antenna has been erected. It is desirable to tune the aerial for a minimum SWR but it is essential to do it if the SWR exceeds the manufacturer's permitted maximum e.g. 1.5 or 2.0.

3.5.3 Vertical Antennas

Another simple VHF antenna is the 1/4, 5/8 wavelength vertical. The name describes the antenna, a vertical conductor 1/4 wavelength high insulated from the ground at its base and connected to the inner conductor of a coaxial cable . Most of the vertical antennas are the omnidirection antenna. See Figure 3.4.

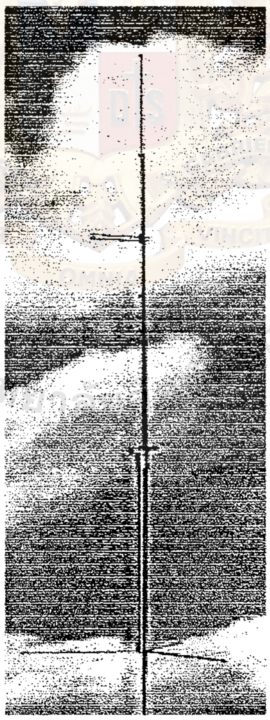


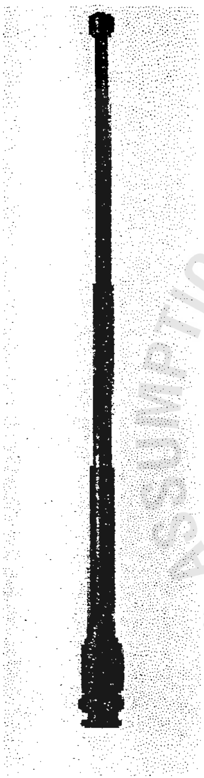
Figure 3.4. Vertical Antenna.

3.5.4 Directivity

A vertical aerial will transmit power equally in all horizontal directions and at low vertical angles (below 45 degrees). It is therefore a good choice for a central station with a network which is spread out at various angles and long distances.

3.5.5 Handheld Antennas

Almost everyone routinely uses a "rubber duck" antenna for handheld transceivers (HT). This antenna is essentially a quarter-wave which is shrunk down to about 1/4 of its usual length. Think of this antenna as a leaky dummy load, because its effectiveness is not much better than that. Its short length and the lack of a ground plane (which is required for a 1/4-wave style antenna) make its performance quite poor. Only the high sensitivity of FM repeaters make handheld radios with rubber duck antennas so useful. For hiking, public service events, and other activities where radio range is important, a longer antenna is very helpful. Although there are full-size 1/4-wave and 5/8-wave models available, experience has shown that one of the most effective handheld antennas is the end-fed 1/2-wave. The telescoping 1/2-wave antenna with a BNC connector at the end is available from several manufacturers. This type of antenna can easily make the difference between having an unreadable signal and being full-quieting into the repeater. When a good antenna is attached to a HT, the receiver often exhibits problems due to the much strong signals present. Strong signals (typically paging transmitters) will come blasting through the receiver and interfere with the desired signal. Radio amateurs usually refer to this as "intermod", short for "intermodulation". In reality, intermodulation has a specific technical definition that describes only some of these noise and interference problems. Independent of the name, the end result is that the HT receiver is overloaded by these strong signals. One solution to the problem is to use an external filter to block out signals outside the ham band. This type of filter will also block police, fire, weather and other non-ham signals, too. See Figure 3.5 "rubber duck antenna" and Figure 3.6 "telescopic antenna" These are for handheld transceiver radio.)



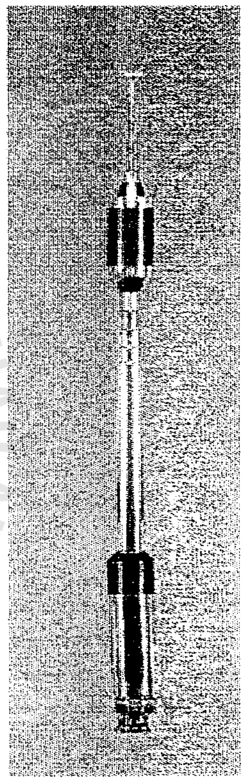


Figure 3.5. Rubber Duct Antenna.

Figure 3.6. Telescopic Antenna.

3.5.6 Mobile Antennas

There are many types of mobile antenna as 1/2, 1/4, 5/8, 7/8 of wavelength and the design of each type is dependent on each brand. You may have observed many vehicles

with antennas mounted on or near the rear "bumper" or "fender". This is not a good position because of the proximity of the vehicle body affects both the tuning of the antenna and the horizontal directions in which power is transmitted. Whilst mounting on a front wing is an improvement, the center of the roof is the most suitable location. The antenna will require tuning after installation. Follow any instructions which you have concerning the tuning up of your particular antenna .See Figures 3.7-3.8.

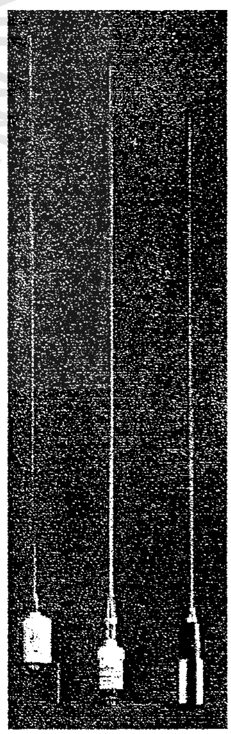


Figure 3.7. Mobile Antenna.

Figure 3.8. Mobile Antenna.

Mobile antennas need to be attached to the car by some parts that are called "mount" that you can attach the mount on your car at any location you need but the best location is on the middle of the top roof of the car as I said above. See Figure 3.9.

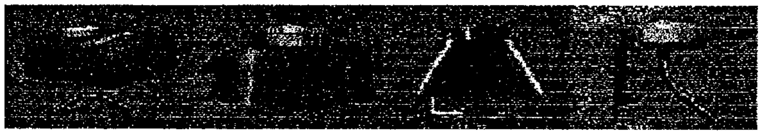


Figure 3.9. Type of Mounts.

3.5.7 Base Station Antennas

The base station antenna, is used only on the top of the house or attached with the tower or self-support because the dimensions of the base station antennas are large to increase the gain and for stability. Because when you set up the base station antennas on the top of the house that antennas need to face the wind, rain or anything that occur from nature or the carelessness of humans.

We can divide the antenna into 2 broad types:

(1) Omnidirection Antennas

(2) Directional Antennas

3.5.8 Omnidirection Antennas

Those listeners that find themselves in the middle of a metropolitan area, or very near to several nearby cities up to 30 or 40 Km. away can benefit mostly from an omnidirectional antenna. This type of antenna will be of no help, however, if you are trying to receive a more distant, low power, or translator station. For these type of stations, a good directional antenna will be needed.

In the case of the omnidirectional antennas, the very name implies "from all directions eqaully". The two antenna types have roughly circular polar patterns. Neither type has gain (over a standard dipole), in fact, both types have a slight loss. This can be an advantage in areas where a lot of strong stations are available. If the antenna had too much gain, the received signals might overload your receiver, especially if it is older. The effect of placing the antenna higher than you could place a folded dipole will give you an effective gain, and is the main benefit from this type of antenna. See Figures 3.10-3.11.

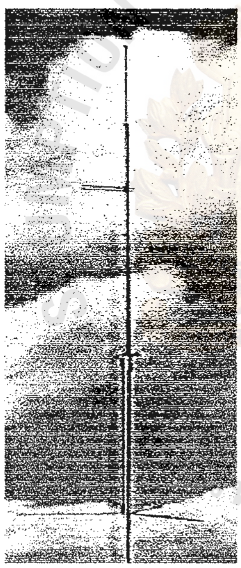


Figure 3.10. Omnidirection Antenna.

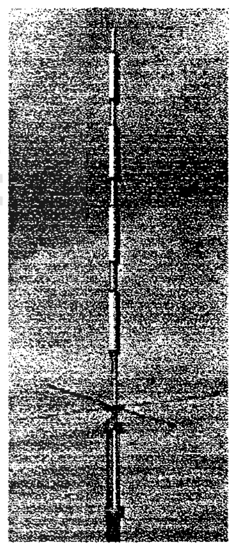


Figure 3.11. Omnidirection Antenna.

3.5.9 High Gain Directional Antennas

A high gain directional antenna is needed for weak distant stations. Not only does it dd gain, but its beamwidth can serve to reject other stations on the same or adjacent frequencies - coming from directions outside the beamwidth. It can also reject sources of noise the same way. Noise can include reflections from nearby buildings or mountains, automobile ignition, large electrical installations or motors, or harmonics of CB and other types of communications.

Directional antennas come in two basic types — Yagi. Yagi's are recognized by elements that extend the entire width of the antenna, Yagi's tend to have higher gain and narrower beamwidths. A generalization that applies to types of antennas is that the larger they are (and the more elements they have), the more gain and narrower beamwidth they will have but I have found that large Yagi's are an absolute necessity for really weak or distant stations (100 Km. is possible but rare). See Figures 3.12 - 3.14.

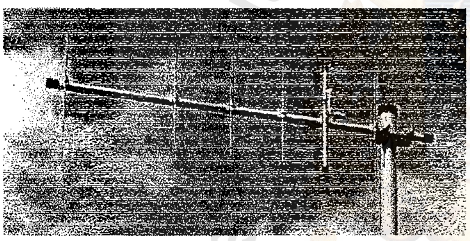


Figure 3.12. Directional Antenna.

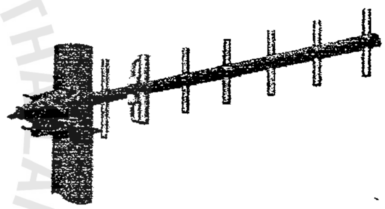


Figure 3.13. Directional Antenna.

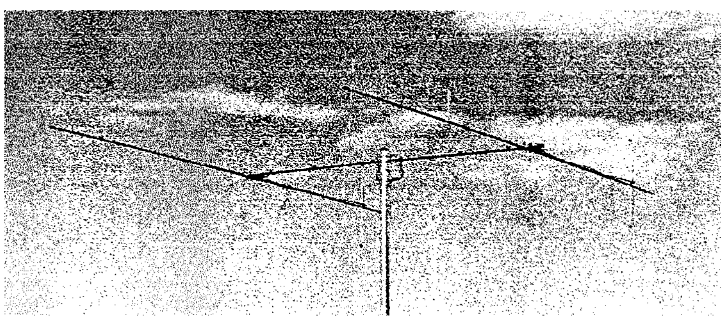


Figure 3.14. Directional Antennas.

15.10 Rotators

For those yagi antennas that are directional antennas the propagation is directly point to point that is best for fixed position contact. As we said previously that directional antennas get more gain and can contact in longer distance than omnidirectional antennas but the advantage of omnidirectional antennas is, it spreads the frequency in all directions as a circle around itself.

So, if a directional antenna need to contact the mobile station or other base stations that are more than 1 station and we need to switch direction between them, the "Rotator" is needed. It must be chosen with due regard to the weight it will have to carry. If one or more beam antennas are to be carried, then a sizeable rotator such as in Figure (b) below is required.

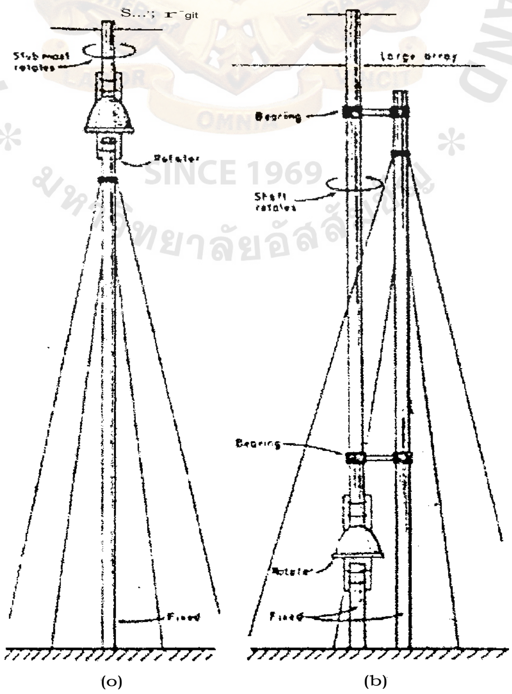


Figure 3.15. a and b the method of Installing Rotator.

Commercially made rotators are normally supplied with a control box that permits stopping at a pre-selected point and/or continuous rotation through 360 degrees with automatic stop at the zero/360 degree mark, according to the direction of rotation. Some rotators (like that shown in Figure 3.15) are arranged so that the under section is clamped to the top of the mast as in Figure 3.15(a) with the upper section carrying a stub mast long enough to mount one or two beam antennas of relatively light weight and small dimension, such as vhf/uhf arrays. The stub mast section should be of insulating material, particularly if the beam antenna is operated vertically. A metal stub mast can seriously distort the radiation pattern as well as reduce the efficiency of the antenna. If large beams are to be carried then a better method could be used, as shown in Figure 15(b), to take the strain from the radiator.

And Figure 3.16 will show you about rotator controllers that are used to control the direction of the antenna.

Figure 3.16. Rotators and Controllers.

3.6 Protection System

3.6.1 Protection Against Lightning

Another point to consider before commencing installation which many people are not aware of is lightning protection. When broadcast receivers first came into use in the early days of the radio they used a long piece of wire for an antenna. This antenna had always to be disconnected from the receiver during storms to protect it from lightning strikes. So most people who used radios were aware of the problem. Today people are used to having portable transistor sets which have their antennas built into the set so that the question of disconnecting antennas during thunderstorms never arises. When it comes to transceivers the users must be made aware of the damage that can be caused by lightning and must be instructed in the necessary precautions. Where there is no such official advice and help available it is absolutely necessary to alert the radio communications users to the possible dangers and how to cope with them. Lightning can cause the failure of costly transistors and other components within a transceiver and can even destroy it altogether. It can also cause injury to the operator who attempts to use it during thunder or even to someone who happens to be by a radio at the moment of a lightning strike. The lightning reaches your transceiver by way of the antenna cable and in some cases by the power supply cable. We will now look at some of the ways lightning protection can be provided.

3.6.2 Arrestors:

If you are not familiar with lightning arrestors take a look at the highest point of any building in your area. You may see lightning arrestors with several spikes pointing upwards and connected to the earth by a thick metal conductor. The expectation is that lightning will take the easiest path to the earth via the arrestor thus safeguarding the building etc. on which it is mounted. Arrestors can be mounted near to but higher than solar panels to give them protection. The conductor to the earth should be capable of carrying 50 amps. A good earth can be made by burying a 6 foot water pipe or metal rod and keeping the ground damp.

3.6.3 Antennas

There are several methods of stopping lightning passing through the antenna and reaching the transceiver. The safest method and the most simple which has not been known to fail is to always disconnect the transceiver from the antenna after it has been used and never to use it during a thunderstorm. After disconnecting the antenna it can either be connected to the earth or just left "floating" i.e. not connected to anything, but it should not be left within 30 cms. of the transceiver. Other methods of protection include gas discharge lightning arrestors which can be screwed into the coaxial cable between the antenna and its transceiver.

3.6.4 Antenna Supports

Survey the site and decide the best location for the antenna and what sort of support you are going to use e.g. existing buildings and trees or poles.

(1) Anchor points on buildings: Make sure that they are strong and secure enough to hold the weight of the antenna. Facia boards are not normally satisfactory. If metal hooks are fitted to wooden beams be aware of the fact that some woods rot rapidly in the tropics. Ensure that the antenna or its associated wire or rope will not rub against adjacent walls or overhanging roofs whilst swinging about in strong winds.

(2) Metal masts: Where no suitably located buildings are available then antenna masts can be erected. Masts can be made from metal tubing e.g. galvanized steel, aluminium etc. depending on what is available. They will require guy wires about every 4 metres, depending on the strength of the pole material

used. At least 3 guy wires are necessary at each point to give all round support. Barbed wire has been successfully used for antenna guys. If it is thought that the antenna will remain in the same place for many years then the mast and the anchor points for the guy wires can be set in concrete.

(3) Wooden poles: 12 metres wooden poles set into 2 metre holes in the ground has been used as antenna supports. Although the poles were painted with used engine oil some rotted after 3 to 5 years and had to be replaced. If set firmly into the ground these should be self-supporting and not need guys.

(4) Movable bases: A mission of using portable transceiver radio has found that they have had to relocate antennas because the radio room has had to be changed to different buildings. Hence they are trying out a movable antenna base made from pieces of steel e.g. two 1 metre steel bars in a cross and also old vehicle wheel hubs as anchor points for guys. These bases are all buried several feet underground but can be dug up when necessary.

(5) Guidelines: The following should be aimed at but may not be achieved. Do not put the antenna parallel to electric power lines or other long pieces of metal wire. Do not suspend the antenna above a tin roof. Have some 20 metres of clear ground in front of the antenna, that is in the direction, the power in it is to be transmitted

3.6.5 Antenna Adjustment

The antenna will have been cut either to the correct length or if you have so specified too long to allow for tuning after erection. Ideally it should be possible to raise and lower the antenna by means of halyards of nylon rope and pulleys. One disadvantage of nylon rope was that after several years of exposure to the sun in equatorial regions the rope broke easily. Also in some places a rope halyard is an attractive item and could well be stolen. Hard-drawn wire has been used instead as it is more durable and less noticeable than white rope. An alternative is to use an antenna clamp of the type. This was developed to serve the special requirements of being able to raise and lower for initial tuning then to leave the antenna erected whilst being able to recover the ropes.

3.6.6 Erection

Do not attempt to erect an antenna if lightning can be seen or thunder heard. The length of the antenna together with its required direction and height will be determined . Now comes the task of putting these theoretical ideals into practice. If the antenna is not going to be lowered for tuning then it should be the calculated theoretical length before erection. Having decided how and where the antenna will be erected uncoil it and its coaxial cable ensuring that there are no twists or kinks in it. If possible lay it out on the ground below where it is to be raised. This will confirm that the antenna supports are sufficiently far apart. Measure the length of each piece of antenna wire as a final confirmation that the antenna length is correct. These checks are necessary as shown by the following experience.

Check the length of the coaxial cable on the antenna although you know how long it should be, 25 to 30 meters are typical lengths fitted by manufacturers unless you specify a special length. Also ensure that the coaxial cable is secured to the center insulator and not left to hang only from its coaxial plug. Wire or nylon rope can be used between the antenna insulators and the tree, pole or building on which it is suspended.

3.6.7 In the Radio Room

When routing the coaxial cable to the radio room ensure that it does not rub on any rough surface or sharp edge e.g. the edge of a tin roof. Do not put too much pressure on the cable when making a bend rather let it be in a gentle curve. If there are several meters of antennas able spare when it reaches the transceiver do not cut off the cable as it may be required if the radio is moved in the future. Do not coil up the excess cable but try to lay it out straight, in the roof space for example. Where the installation involves more than one coaxial cable, label each one immediately you bring it into the room to avoid future confusion.

3.7 Transmission System

3.7.1 Transmission Lines

A transmission line is a pair of conducting wires held apart by an insulator or dielectric. They come in a variety of construction geometrically. The simplest and least expensive form is two-wire (ribbon) cable. Twisted pair cable consists of two wires sheathed in an insulator and twisted together. Shielded pair cable contains two wires surrounded and separated by a solid dielectric. The dielectric is contained within a copper braid, that shields the conductors from external noise sources. The entire construction is housed in a flexible, waterproof cover.

The use of this kind of cable is limited by two factors: attenuation and cross-talk. There are three principle sources of attenuation. Resistance (or impedance) losses are simply the loss resulting from the resistance of the wires. This loss is minimized by the choice of a metal with low resistivity. Copper is chosen for this reason. (Gold is even better, and is in fact used on satellites to reduce losses.) Dielectric losses are caused by the heating effects when a varying electric field passes through a dielectric (insulator). Radiation losses occur because the cable acts as an antenna. All these losses increase with frequency.

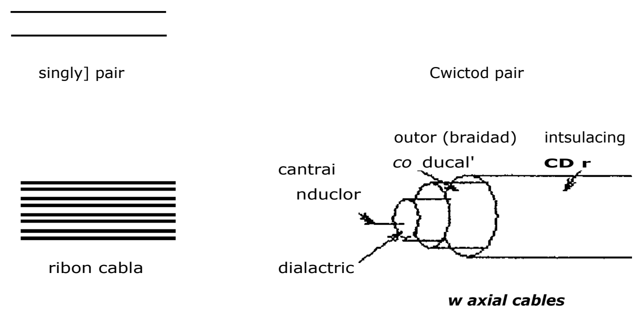


Figure 117. Some Different Types of Transmission Lines.

When a transmission line can act as an antenna, it can also act as a receiver. Lines prone to radiation loss which are also susceptible to pick-up, or cross-talk. The first two types described above are particularly prone to this fault. The shielded pair is designed to reduce this pick-up.

All these lines have strong attenuation at frequencies above 1MHz. They are generally used for low bit-rate communication. Two-wire ribbon cable is standard for the connection of individual telephone receivers. Twisted pair(s) is the normal method of connection for computer terminals and short high bit-rate connections.

Attenuation increases with both frequency and length. It is usually specified in dB/m at a particular frequency. Because of this fact, it is not possible to give hard-and-fast rules concerning the bandwidth availability of transmission lines. A twisted pair can support rates of several Mb/s over short distances (meters), but over long distances (kilometers) will be completely unsuitable at these data-rates.

For communication through transceiver radio, coaxial cable is used. Coaxial cable has a central wire, surrounded by a dielectric, in turn concentrically sheathed in a braided conductor. The cable is finally surrounded in a water-proof, flexible sheath. Coaxial cable is familiar to you -- it is the cable used to connect your television antenna.

The supreme advantage of this method of construction is its resistance to radiation loss. The outer conductor acts to shield out any external fields, whilst preventing any internal fields escaping.

Until the advent of optical fiber, coaxial lines were the standard method of long-distance, high bit-rate communication. They are expensive (but getting cheaper, especially as demand rises), and only used where necessary. Typical attenuation values for coaxial cable are 10dB/Km at 10KHz, 50dB/Km at 500MHz. For very long-haul routes, repeaters and equalizers are necessary.

Virtually any cable that carries power from a source to a load can be regarded as a `transmission' line. For example, a pair of wires connected to a battery at one end and a lamp at the other could be regarded as such. If the transmission line is long, power will be lost because of the self-resistance of the line and this applies equally when feeding power from a transmitter to an antenna. In this case however, we are also dealing with alternating current and not pure D.C., so the problems arise because at radio frequencies especially, transmission line have self-inductance and capacitance which present reactance. With the combination of inductive and capacitive reactance plus resistance all transmission lines therefore have what is known as characteristic impedance. Since we are dealing with transference of power at different frequencies, other factors such as wavelength and velocity also come into the physical properties of transmission lines.

Table 3.1. Loss or Gain in Decibels from the Ratio of 2 Powers.

Power ratio (-dB)	dB	Power ratio (+dB)
1.000	0	1.000
0.977	0.1	1.023
0.995	0.2	1.047
0.933	0.3	1.072
0.912	0.4	1.096
0.891	0.5	1.122
0.871	0.6	1.148
0.831	0.8	1.202
0.794	1.0	1.259
0.707	1.5	1.413
0.631	2.0	1.585
0.562	2.5	1.778
0.501	3.0	1.995
0.398	4	2.512
0316	5	3.162
0.251	6	3.981
0.199	7	5.012
0.158	8	6.310
0.125	9	7.943
0.100	10	10.000
0.079	11	12.59
0.063	12	15.58
0.050	13	19.95
0.039	14	25.12
0.031	15	31.62
0.025	16	39.81
0.019	17	50.12
0.015	18	63.10
0.012	19	79.43
0.010	20	100.00

From Table 3.4 shown that loss or gain in decibels from the ratio of 2 powers, e.g. it shows that at 3 dB the power loss at the antenna would amount to half of what was fed into it at the transmitter end -dB = 0.501 dB then e.g.

(1) Power 10 watts input at 3dB loss of transmission line then we get:

0.501 x 10 = 5.01 watts

So we got only 5.01 watts or almost half of the power input before reaching at the end on the other tip of the transmission line.

(2) And if we set up the antenna at 3dB gain from the table 4 (+dB = 1.995) then we get:

1.995 x 5.01 watts = 9.9949 watts

From calculation we knew that the important factors that we need to consider are gain of the antenna and loss of the use of the transmission line.

Then we will show the table of Coaxial cable data. In this table it will show the

(1) Type of service number of each type of transmission line

(2) Impedance group

(3) Nominal velocity ratio

(4) Nominal attenuation

(5) Maximum power rating etc.

Table 3.2. Coaxial Cables Data.

Impedance group	50	50	50	50	50	50	50
Service No. RG/U Type	RG58U	RG8U	RG I 7U	RG8AJU	RG59U	RG11U	RG11
Impedance	53.3	52	52	50	73	75	75
Nominal velocity ratio	0.659	0.659	0.659	0.75	0.659	0.659	0.666
Nominal attenuation at							
(dB/10011/MHz) 144MHz	6	2.5	1	2	4.2	2.8	2.8
(dB/30m/MHz) 220MHz	7	3.5	1.3	2.75	5	3.7	3. 7
420MHz	15	5	2.3	3.9	8	5	5
Maximum Power Rating	Watts	Watts	Watts	Watts	Watts	Watts	Watts
At (watts/in air/MHz)144	175	800	2300	800	250	800	800
220MHz	135	650	1900	650	180	650	650
420MHz	90	400	1200	400	125	400	340
Cable outside diameter							
(Inches)	0.195	0.405	0.87	0.405	0.242	0.405	0.405
(mm)	5.0	10.3	22.1	10.3	6.1	10.3	10.3

Transmission line for transceiver radio that is connected between transceiver radio antennas is 50 S2 impedance and from table 5 we consider

(1) RG 58U

(2) RG8U

(3) RG8AU(FOAMED)

(4) RG17U

RG 58U is the smallest size of outside diameter that is 5.0 mm., when we use CB 245 MHz 5 watts output power in communication The loss of this transmission line at 100ft. is 7 dB(from table 5 coaxial cable data). We can calculate power output at the 100ft. transmission line e.g.

CB245 MHz powers 5 watts loss 7dB at 100ft.(from table 5). From table 4 loss 7dB in the side of power ratio —dB we get 0.199 then we will get the solution:

$$5 \times 0.199 = 0.995 \text{ watt}$$ (at the end of the other tips of 100ft. transmission line)

But we can solve this problem by using the lower loss transmission line as RG8U, RG8AU, RG17U etc.

For calculation loss of those low losses transmission lines are

RG8U at 100ft. CB 245 MHz powers 5 watts, from table 5 loss 3.5 dB. From table 4 loss 3.5dB(say = 4dR) in the power ratio —dB side we got 0.398 then we get the solution:

$$5 \times 0.398 = 1.99 \text{ watts}$$ (at the end of the other tips of 100ft. transmission line)

For RG8AU (foamed) at 100ft CB 245 MHz power 5watts, from table 4 and 5 we got loss 2.75 dB then we get:

5 x 0.501 = 2.505 watts (at the end of the other tips of 100ft. transmission line)

For RG17U at 100ft using CB245 MHz power 5 watts, from table 4 and 5 we get 1.3 dB loss at 100ft transmission line then we get:

5 x 0.707 = 3.535 watts (at the end of the other tips of the transmission line)

This calculation show that RG17U is the best solution because it is the lowest loss among those 4 type of transmission line. But there are some limitations of the RG17U because the outside diameter of it is about 22.1 mm. That is too big and it is not convenient for bending to go along the way from the antenna to the transceiver radio. And another factor is the price of the RG17U is too high to compare with RG8U or RG8AU.

Then we consider RG8U to set up the communication system. And about the loss of power in the transmission line we can solve this loss by using the high gain antenna to substitute that loss as folded dipole antenna, or yagi antenna etc.

For example, for folded dipole we get 6dB gain so when we use RG8U that output at the end of the transmission line is 1.99 watts from table 4 at 6 dB we get:

1.99 x 3.981 = 7.922 watts

This shows that gain of the antenna and loss of the transmission line are very important thing for transceiver radio communication.

3.7.2 Fitting a Plug to a Coaxial Cable

The cable from your antenna will normally be a coaxial cable of which there are 2 common sizes. A thick one which is approximately 10 mm diameter and includes types RG 8/U, RG 213/U and URM 67. A thin one which is approximately 5 mm diameter and includes types RG 58/U and URM 43. The plug in common use is a PL-259, an additional adapter being required for fitting a thin cable. If you have never soldered a plug to coaxial cable before, it is recommended that you practice preparing the cable end using an extra piece of cable. Do not actually solder the plug on the practice cable.

IV. TRANSCEIVER RADIO AND BUSINESS MANAGEMENT

4.1 Benefits of Wireless Communication

Companies can realize the following benefits by implementing wireless communication.

(1) Mobility

(2) Ease of installation in difficult-to- wire areas

(3) Reduced installation time

(4) Increased reliability

(5) Long-term cost saving

Mobility

User mobility indicates constant physical movement of the person and their network appliance. Many jobs require workers to be mobile, such as inventory clerks, healthcare workers, policemen, emergency care specialists, and so on. Wire-line communication require a physical tether between transmitter and receiver. As an analogy, consider talking on wired phone having a cord connecting the handset to the telephone base station. You can utilize the phone only within the length of its cord. With a wireless communication, however, you can walk freely within your office, home, or even talk to someone while driving a car. Wireless communication offers mobility to its users much like the wireless phone, which provides a constant connection to information on the network control station. This communication can be extremely useful if you are delivering emergency care to a crash victim, or in a hotel security. You cannot become mobile unless you eliminate the wire through the use of wireless communication.

Ease of Installation in Difficult-to-Wire Areas

The implementation of wireless communication offers many tangible cost saving when performing installation in difficult-to-wire areas. If rivers, freeways, or other obstacles separate buildings you want to connect, a wireless solution may be much more economical than installing physical telephone cable or lease line. Some organizations spend hundreds, thousands of Bahts to install physical cable with nearby facilities. If you are facing this type of obstacle, consider wireless communication as an alternative. The development of wireless communication in this situation costs thousands of Bahts, but will result in a definite cost saving in the long run.

In some cases, it might be impossible to install cabling. Some municipalities, for example, may restrict you from permanently modifying older facilities with historical value. This could limit the drilling of holes in walls during the installation of telephone cable. In this situation, a wireless communication might be the only solution.

Reduced Installation Time

The installation of telephone cabling is often a time-consuming activity. For wire-line of telephone we must pull the wires above the ceiling and drop cables through walls that they must affix to the wall. These tasks can take days or weeks, depending on the size of the installation. The development of wireless communication greatly reduces the need for cable installation, making the communication network available for use much sooner. Thus many countries lacking a communication infrastructure have turned to wireless communication as a method of providing connectivity among their groups without the expense and time associated with installing physical media.

Increase Reliability

A problem inherent to wired communication is downtime due to cable faults. Moisture erodes metallic conductors. These imperfect cable splices can cause signal reflections that result in unexplainable errors. The accidental cutting of cables can also bring a wire-line communication down quickly. The advantage of wireless communication, then, is experiencing fewer problems because less cable is used.

Long-term Cost Saving

Companies reorganize, resulting in the movement of people, new floor plan, office partitions, and other renovations. These changes often require re-cabling the telephone line, incurring both labor and material costs. In some cases, the re-cabling cost of organizational changes are substantial, especially with large enterprise. The advantage of wireless communication is again based on lack of cable.

4.2 Wireless Communication Concerns

The benefits of a wireless communication are certainly welcomed by companies and organizations. Network managers and engineers should be aware, however, of the following concern that surround the implementation and use of wireless communication;

(1) Radio signal interference

(2) Power management

(3) Health risks

4.2.1 Radio Signal Interference

The purpose of radio-based communication is to transmit and receive signals efficiently over airwaves. This process, makes these systems vulnerable to atmospheric noise and transmissions from other persons. In addition, these wireless communication could interfere with other radio wave equipment. Interference may be inward or outward.

(1) Inward Interference

Most of us have experienced radio signal interference while talking on wireless telephone, watching television, or listening to a radio. Someone close by might be communicating with another person via a short-wave radio system, causing harmonic frequencies that you can hear while listening to your favorite radio station. Or, a remote control car can cause static on a wireless phone while you are attempting to have a conversation. These types of interference might also disturb radio-based wireless communication in the form of inward interference

(2) Outward Interference

Inward interference is only half of the problem. The other half of the issue, outward interference, occurs when a wireless communication signal disrupts other systems, such as navigation equipment on aircraft, and so on. This disruption results in the loss of some or all of the system's function.

4.2.2 Technique for Reducing Interference

When dealing with interference, You will want to coordinate the operation of radio-based wireless communication products with your company's management organization, if one exists. Frequency management officials is mandatory before operating radio-wireless communication devices.

Another tip, especially if no frequency management organization exists within your company, is to run some tests to determine the propagation patterns within your expected area. These tests let you know if the existing system may interfere with, and thus block and cause delay to, your network. You will also discover whether your signal will disturb other systems.

4.3 The Wireless Communication Market

Wireless communication is applicable to all industries with a need for communication usage or when the installation of physical media is not feasible. Such networking is especially useful when employees must process communication on the spot such as security system, doctors, nurses, warehouse clerks, inspectors, claims adjusters, and insurance claims adjusters.

4.3.1 Retail

Retail organizations need to order, price, sell, and keep inventories of merchandise. A wireless communication enables clerks and storeroom personnel perform their functions directly from the work floor. If they got some errors they can report or ask at once authorized persons.

4.3.2 Healthcare

Healthcare centers, such as hospitals and doctors' officers, must maintain accurate reports to ensure effective patient care. A simple mistake can cost someone's life. Doctors and nurses are also extremely mobile, going from room to room caring for patients or in an accident case, for example, can place an order for a blood test by asking through a hand-held transceiver radio and the laboratory will run the tests requested by the doctors at once. And the doctors can ask for the record while they stay beside the patients.

4.3.3 Hospitality

Hospital establishments check customers in and out and keep track of needs, as room service orders and laundry requests. Restaurants need to keep track of names and numbers of people waiting for entry, table status, and drink and food orders. Restaurant staff must perform these activities quickly and accurately to avoid patrons becoming unhappy. Wireless communication satisfies these needs very well. Someone can greet patrons at the door and ask their name, size of party, and smoking preference and then the greeter can report to the query management person to determine the availability of an appropriate table. After obtaining a table, the waiter will transmit the order to the kitchen via a wireless device, eliminating the need for paper order tickets.

4.4 Security Management Using Transceiver Radio

We can use transceiver radio in security system as in campus, hotel, hospital, condominium etc.

In this project we will talk about the security system. We will apply the transceiver radio in the condominium project that has six buildings and each building has sixteen floors.

We use transceiver radio system because it is convenient to bring along with the guardian when he is on working hours. We use the wireless communication because it is more convenient than the wire-line system as PABX system and more cost saving than the mobile phone.

4.5 Model and Case of Prestige Condominium Project

This is the model and case of the security system of "Prestige Condominium" on Bangna-Trad Road. Prestige Condominium is one of the Thana City projects.

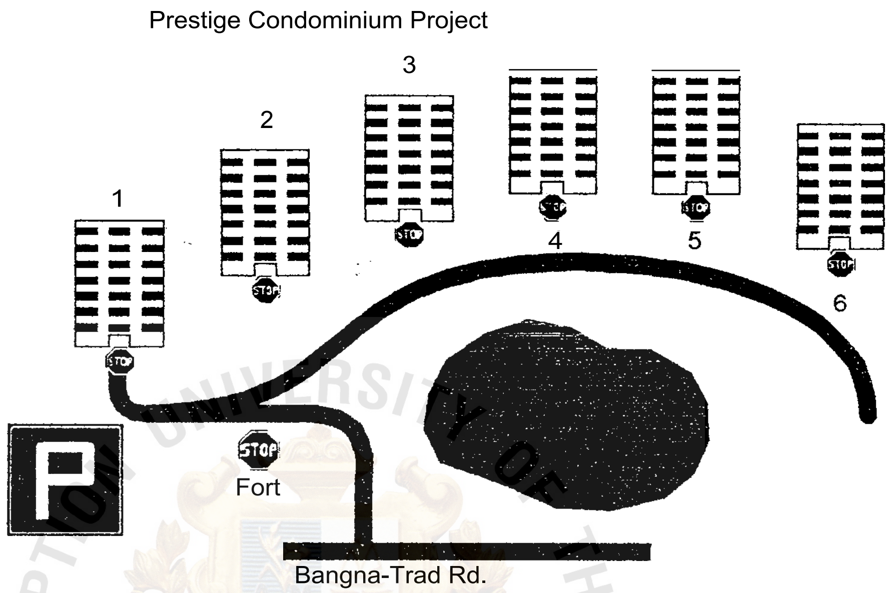


Figure 4.1. Prestige Condominium Map.

4.5.1 Existing System

At first, in case of an examination of the existing system, there are 24 check points inside the condominium. Every check point has the "Watchman's Time Recorder" that the guardian needs to use the key at every check point to key in, and the watchman's time recorder will record the time and the check point number on the record tape.

(1) Method of using

The guardian carries the watchman's time recorder with him to each check point, he takes the station numbered key out of the station key box installed at the point and records the checking time by inserting and turning the station key in the watchman's time recorder.

Thus the station number, Date, Hour, and Minute are recorded in plain figure on the paper tape.

ELECTRONIC WATCHMAN'S TIME Ig.,CORDER

Durable QuavC, 7ns(Base With Imprinted IDatu

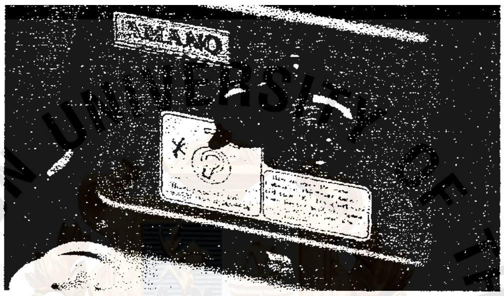


Figure 4.2. Watchman's Recorder.

Specifications

Dimensions: 6-13/16" (w) x 2-13/32" (d) x 4-21/32" (h)

Weight: 1.7 lbs

The cost of the watchman's recorder is about 28,300 Bahts and the cost of the station key numbered is 520 Bahts each. We have five guardians per shift and there are two shifts (day shift and night shift)- in each building to be responsible three floors each and we installed 24 stations in each building.

= 23,800 Bahts x 5 guardians

= 119,000 Bahts

And the station numbered key box is 520 Bahts at each check point. Because each guard has to carry the watchman's time recorder with him to each check point. There are 24 stations, so we get

119,000 + (520 x 24)

131,480 Bahts (installation cost for each building)

But there are 6 buildings so the total installation cost is

131,480 x 6

= 788,880 Bahts

There are six buildings in the Prestige Condominium Project. Five persons per shift hold in each building. Then six building use thirty guardians to work. We assume that the standard of their salary will be 5,500 Bahts . The cost of hiring these sixty guardians will cost approximately 3,960,000 Bahts per year

60 Guardians x 5,500 Bahts of salary

= 330,000 Bahts

330,000 Bahts x 12 Months

= 3,960,000 Bahts per year

Total cost of the existing system is the cost of watchman's time recorder plus the salary of the guardian

788,880 + 3,960,000 = 4,748,880 Bahts per year

4.5.2 When We Apply the Transceiver Radio to the Security System

The benefit and cost analysis is divided into 2 parts, the first part is about the cost of the transceiver radio system and the second part is about the cost and benefit of the transceiver radio system in "Prestige Condominium Project" .

(1) Costs Analysis

First impressions of the cost of a radio network can be deceptive. You may know that a basic transceiver can cost around 80,000 Bahts but before that transceiver and its associated equipment is installed and working, the total cost can be up to 200,000 Bahts. The cost of introducing a radio network can be divided into two parts. First there is the capital cost of the equipment to gether with the installation which are "once only costs". Secondly there are the "recurring costs" of operating, maintaining and licensing the network

(2) Capital Costs

The 80,000 Bahts mentioned above is the cost of a basic transceiver. There are many additional items necessary. which gives an indication of the approximate prices in 1999. Whilst not all the items listed will be necessary, you may require some of the additional facilities. The cost of the additions will need to be discovered at that time because they vary considerably with manufactures and time etc. An adequate selection of spare parts should be purchased with the transceivers. The manufacturers may have a recommended a list of spares based on experience. Allow about 10% of the basic transceiver price for spares for each set you buy. Technical manuals of the transceivers must be obtained, preferably in the language of the country where they will be operated.

We will show you the set-up cost that needs to be prepared before using the transceiver radio system into the "Prestige Condominium Project".

Table 4.1. Estimate Cost of Transceiver Radio.

Items	Cost in Bahts
Transceiver Radio	24,800
Spare Parts	5,000
AC Power Supply	2,500
Desk Microphone	1,000
Earphones	250
Antennas System	38,500
Antennas Selector Switch	1,500
12 Volt Battery	850
Main Battery Charger	3,500
Total Cost	77,900

(3) Recurring Cost

Recurring costs are for operating, and maintenance. These cost can occur after setting up the transceiver radio system. So we will go in detail.

(4) Operating

Who will operate the radio? How long will they spend each day sending and receiving messages and getting answers to messages and passing on requests for help or information? At a small station the extra demand on people's time due to the introduction of the radio may be low so that it can be absorbed with no extra cost. At the Headquarter station (Radio Center) of a large network it will be different. Here it may be necessary for someone to be available all day both to operate when required and to deal with messages such as Prestige Condominium. The question of employing and training a radio operator and the responsibility of who should pay his wages ought to be carefully thought out beforehand. There will also be a small cost involved in the provision of "log books" to keep a record of all messages both sent and received and record the situation that has been got from the guard around the area.

(5) Maintenance

You should decide how you are going to maintain your network Before you buy your equipment. There are many factors which will determine the annual maintenance costs and therefore this is a difficult figure to estimate The need for maintenance will be minimized by certain factors which include good quality control during manufacture, having safeguards built into the equipment, by good design of installation at each station and by having good operating procedures. If your network will have five or more stations, you should consider having your own radio technician and workshop unless you are in an area where good reliable repair facilities are available at reasonable cost from other sources. The initial cost of equipping a workshop with the basic test equipment can start at 50,000 Bahts. To this you may need to add the cost of providing a building and work benches and seats, lights and fans or an air conditioner. Then there is the annual cost of employing the technician. This is one area of cost in which certainly church missions and to a lesser extent aid agencies have an advantage over commercial concerns. Once you have established a repair facility you will usually find that other groups will come to you, requesting available to do this then this could be a source of income to help with your costs.

"Prestige Condominium Project" the objective of using transceiver radio system is to try to protect and solve the problems as fast as possible. When we use the transceiver radio to work with the existing system (Watchman's Time Recorder), three guardians will be enough for the inspection of the working area in each building. So the cost of the system is:

Table 4.2. Cost of Transceiver Radio in Prestige Condominium Project.

Items		Cost in Bahts
1.Mobile transceiver radio	1 set	15,000
2.Hand-held transceiver radio	18 sets	153,000
3.Antennas system and erection is included		35,000
4.Power supply	1 set	8,500
5.Extemal speaker for base station	1 set	850
6.Transceiver radio's spare parts		10,000
7.Antennas selector switch	1 set	1,000
8.Antennas's spare parts		3,000
9.12. volt battery	1 set	1,000
10.Main battery charger for 12 volt battery	1 set	2,500
11.Battery charger for hand-held transceiver radio	5 sets	5,000
TOTAL COST		234,850

The transceiver radio application into the Prestige Condominium Project can reduce the guardian's salary from thirty persons into thirty-six persons. We assume that the standard of their salary will be 5,500 Bahts. So the cost of hiring these thirty-six persons will cost approximately 2,376,000 Bahts for the first year.

36 guardians x 5,500 Bahts of salary

= 198,000 Bahts per month.

198,000 Bahts x 12 months

= 2,376,000 Bahts per year

And we can reduce the cost of the watchman's time recorder from 788,880 Bahts to 503,280 Bahts

23,800 Bahts per set x 3 Guardians

= 71,400 Bahts

We have to pay for the station numbered key 520 Bahts each station, we have 24 stations installed then we get

= 71,400 Bahts + (520 x 24)

= 83,880 Bahts per building

But we have six building to response then

= 83,880 Bahts x 6 buildings

= 503,280 Bahts

The total cost of the transceiver radio application with the existing system is the cost of transceiver radio system and the guardian salary and the watchman's time recorder. Then we get

234,850 + 2,376,000 + 503,280

= 3,114,130 Bahts

There is no on-air cost of using the transceiver radio so there's no need to calculate the present value for using the transceiver radio unlike the mobile phone.

4.5.3 And the other choice is the mobile phone system

If weusethe mobile phone, the recurring cost of the mobile phone is almost the same as the transceiver radio such as maintenance and operating cost. But the very important factors are for mobile phone we have to pay monthly fee and air time cost per minute per area. Then it incurs a high cost per month that the transceiver radio system does not incur.

So we will show you the mobile phone cost:

Table 4.3. Cost of Mobile Phone.

Items		Cost in Bahts	
1.Mobile phone sets	18 sets	(18,500 Bahts each)	333,000
2.Batterries spare part	10 sets	(550 bahts each)	5,500
3.Electronics spare part for own fixing			10,000
TOTAL COST			348,500

We see that the initial cost of transceiver radio is just only 234,850 Bahts and there is no additional monthly fee and air time fee. But the initial cost of the mobile phone is 348,500 Bahts which is greater than the transceiver radio system and the mobile phone system. We have to pay for the monthly fee 500 Bahts each month and the air time cost is 3 Bahts per minute at the same area.

Then after we pay for the initial cost of the mobile phone system, the operating and the maintenance cost are almost the same but the differences are:

(1) If we have to communicate about 24 times per day in the same area then we get

24 X 3 Bahts = 72 Bahts per day

and for 1 month we get 72 X 30 = 2,160 Bahts per month plus monthly fee 500 Bahts, then we have to pay 2,660 Bahts a month. So this cost is the recurring cost that incurs only in the mobile phone system but not in the transceiver radio system.

(2) We cannot control the cost of using the mobile phone because the guard can use the mobile phone for private calls.

So, for the transceiver radio system we need not pay for the monthly fee and air time cost of the transceiver radio communication. So the transceiver radio system is suitable for the security service of the Prestige Condominium Project.

The records of the interest rate in Thailand since 1994 is as shown below:

Year 1994:	8.0%
Year 1995:	8.7%
Year 1996:	9.3%
Year 1997:	10.8%
Year 1998:	8.3%

$$MA_4 = \frac{\sum_{i=1}^{5} D_i}{\quad}$$

[8% (Year 1994) + 8.7% (Year 1995) +

9.3% (Year 1996) + 10.8% (Year 1997)]+

8.3(Year 1998)]/5

9.02 %

By the forecasting method, the interest rate in the year 1999 should be 9.02%. But actually the interest rate in Thailand is now dropped to 5.0% in the second quarter which is the lowest rate that has ever been since 1994. Although the interest rate of the 1999 is not taken into the calculation, we cannot ignore it. This is a sign showing the trend of the interest rate in Thailand. This is not the same as the inflation rate. Some banks were taken over by foreign companies, so the interest rate will depend on the policy of the head office of foreign companies. Instead of using the interest rate of 9.02% for this example, I take the interest rate that is most frequently used since 1994, which is nearly 8%. Assuming that the interest rate is 8% for these five years.

i_t = interest rate

8 % per annum.

Cost of using the mobile phone system (on-air cost):

According to the average use of the mobile phone per day we can estimate at least 24 times a day, and the on air expense occurs in each call about 3 Bahts.

24 times x 3 Bahts

72 Bahts per day

72Bahts x 30 days

= 2,160 Bahts per month

But there is a monthly fee of 500 Bahts each month, cost of the mobile phone processed is approximately 2,660 Bahts a month.

= 2,660 Bahts x 12 months

31,920 Bahts per annum.

But we have 18 guards to use the mobile phone so we get the cost:

31,920 Bahts x 18 persons

= 574,560 Bahts per annum.

Now we estimate the useful life of a mobile phone is five years (the average useful life of the mobile phone set). And we estimate the number of calls per day is at least twenty-four, We see that we can save the cost of calling about 574,560 per annum. Then we can apply the transceiver radio system into this communication system and calculate the Net Present Value to find the Accept or Reject of the transceiver radio system.

The first year = 574,560 Bahts

The second year = 574,560 Bahts

The third year = 574,560 Bahts

The fourth year = 574,560 Bahts

The fifth year = 574,560 Bahts

From the interest record above, we assume the interest rate is 8 % for these five years.

I = interest rate

8 % per annum.

For the first year $574,560 \times \frac{1}{(1+I)}$

$= 574,560 \times \frac{1}{(1+0.08)}$

= 532,000 Bahts

For the second year $\dfrac{574{,}560 \times 1}{(1 + 0.08)^2}$

492,592.593 Bahts

For the third year $\dfrac{57\text{^},560 \times 1}{(1 + 0.08)^3}$

- 456,000 Bahts

For the fourth year $574{,}560 \times \dfrac{1}{(1 + 0.08)^4}$

- 422,470.588 Bahts

For the fifth year $574{,}560 \times \dfrac{1}{(1 + 0.08)^5}$

- 391,123.213 Bahts

Then for five years we get the present value (PV) of future cash flow:

532,000 + 492,592.593 + 456,000 + 422,470.588 + 391,123.213

- 2,294,186.394 Bahts

The mobile phone application into the Prestige Condominium Project can also reduce guardian's salary from thirty persons into eighteen persons. We assume that the standard of their salary will be 5,500 Bahts. So the cost of hiring these thirty-six persons will cost approximately 2,376,000 Bahts for the first year.

36 guardians x 5,500 Bahts of salary

= 198,000 Bahts per month.

198,000 Bahts x 12 months

= 2,376,000 Bahts per year

And we can reduce the cost of the watchman's time recorder from 788,880 Bahts to 503,280 Bahts like a transceiver radio application, then we get:

23,800 Bahts per set x 3 Guardians

= 71,400 Bahts

We have to pay for the station numbered key, 520 Bahts for each station, we have 24 stations installed then we get:

71,400 Bahts + (520 x 24)

83,880 Bahts per building

But we have six buildings

83,880 Bahts x 6 buildings

= 503,280 Bahts

Then the total cost of the mobile phone application with the existing system, is the cost of the mobile phone plus present value of on-air cost and the guardian salary and the watchman's time recorder. Then we get:

348,500 + 2,294,186.394 + 2,376,000 + 503,280

= 5,521,966.394 Bahts

This is the comparison of the suitable systems in the Prestige Condominium Project. So we will compare the cost of the three systems

(1) Existing system

= 4,748,880 Bahts

(2) Existing system with the transceiver radio

= 3,114,130 Bahts

(3) Existing system with the mobile phone

= 5,521,966.394 Bahts

From this cost analysis we choose the second system that is the existing system with the transceiver radio because it has the lowest investment cost amongst the three systems.

Total Cost of the Three Systems.

	Existing System	Existing System With Transceiver Radio	Existing System With Mobile Phone
Equipment Cost		[illegible]	[illegible]
On-air Cost(Present Value for The Next 5 Years)	-	-	2,294,186.394
Guardian's Salary	[illegible]	[illegible]	2,376,000
Watchman's Time Recorder Cost	[illegible]	[illegible]	503,280
Total Cost	4,748,880	[illegible]	5,521,966.394

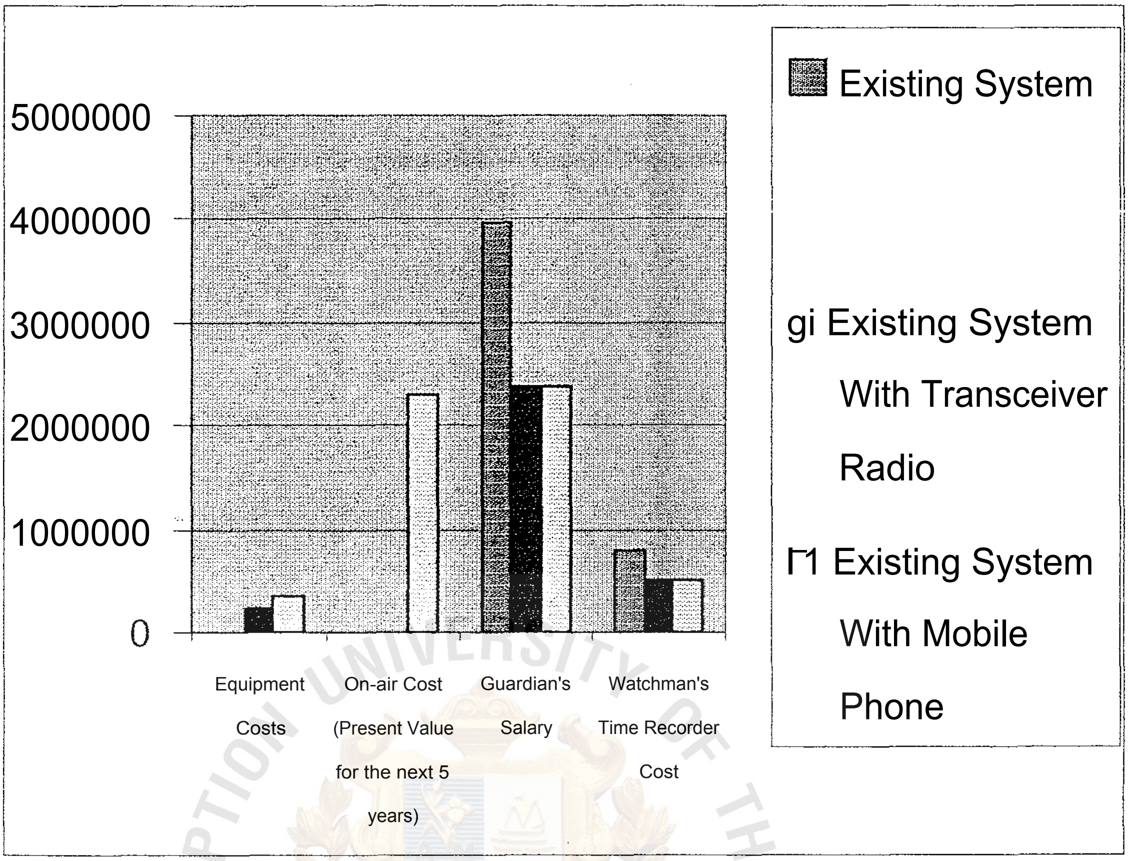


Figure 4.3. Total Cost of Three Systems.

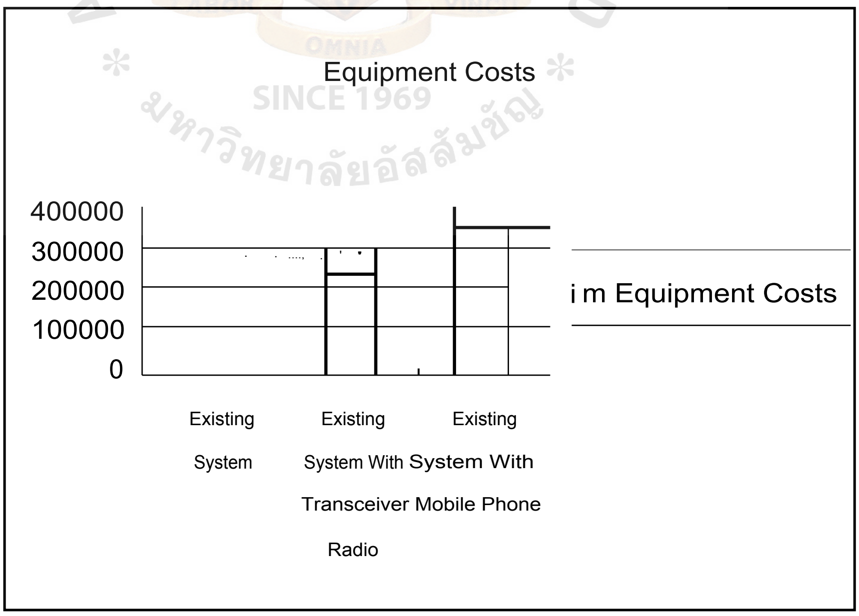


Figure 4.4. Equipment Costs of Three Systems.

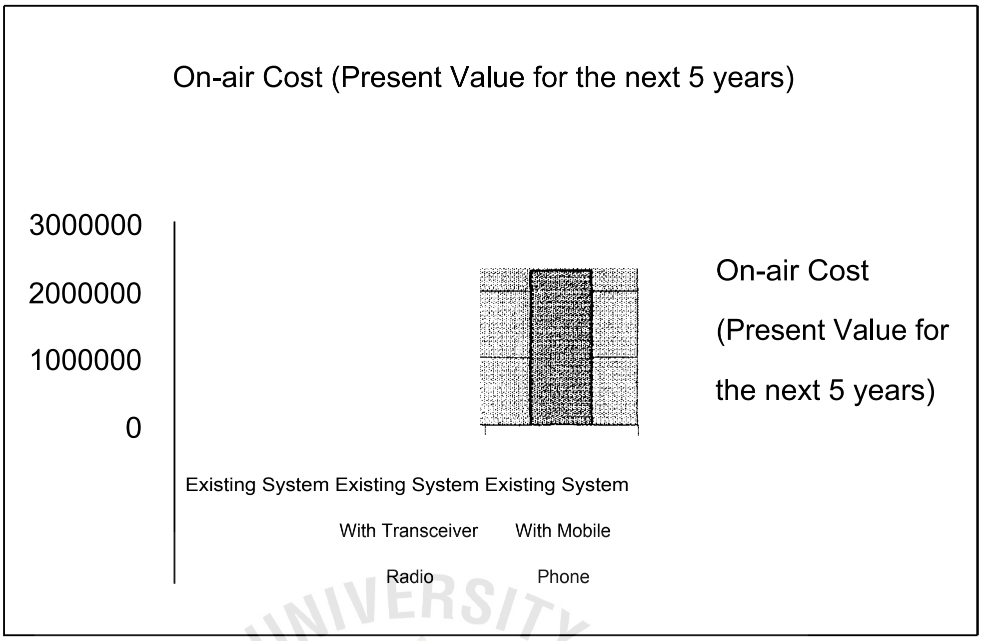


Figure 4.5. On-air Cost (Present Value for the Next Five Years).

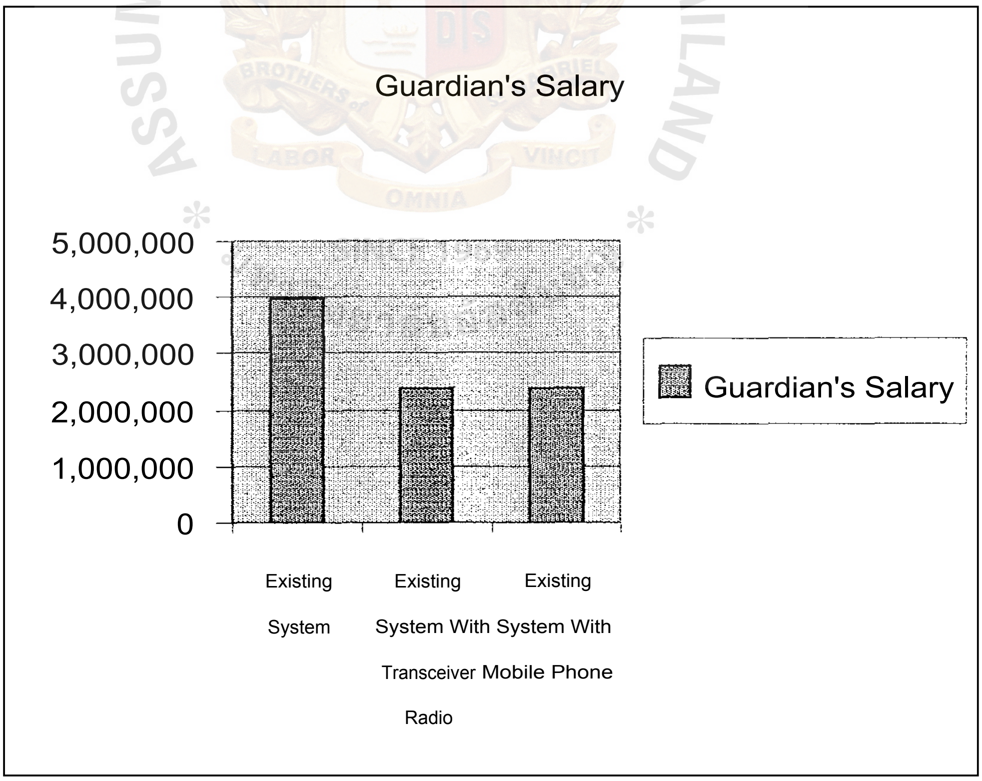


Figure 4.6. Guardian's Salary.

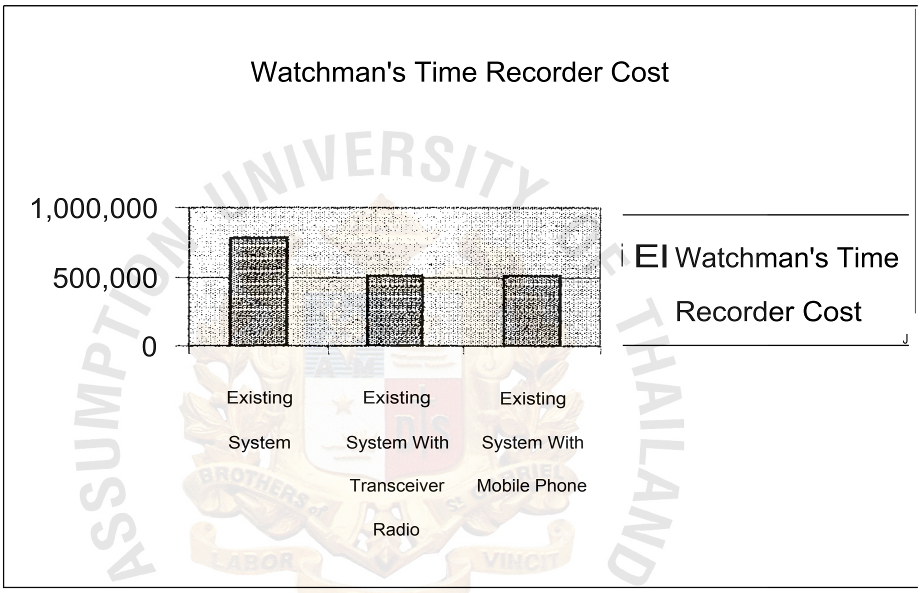


Figure 4.7. Cost of Watchman's Time Recorder.

V. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

There are three kinds of transceiver radio systems in Thailand:

(a) For Government sectors such as Police Department, Military, and High way Police etc.

(b) For the amateur radio, the one who wants to use the transceiver radio in this part needs to pass the examination that is set by the Post and Telegraph Department to test the knowledge of the people that want to use the transceiver radio set because the objective for the amateur radio is to test and experiment as I said in the previous chapter.

(c) For CB (citizen band), nowadays, there are 27 MHz., 78 MHz, and 245 MHz., that is allowed in Thailand. Those frequencies above are allowed for use by the Post and Telegraph Department, and CB 78 and 245 MHz., are allowed to be connected to the external antennas both at home and in the car. The other CB frequencies are not allowed because it will disturb the television signal.

Commercially CB is better because there is no complication in using and the Post and Telegraph Department allows the use of CB in any business. The examination is not needed for using CB unlike the amateur radio that needs a pass in the examination before using the transceiver radio. The difference between CB and the amateur radio is the objective of using the transceiver radio. The main objective of using CB radio is for commercial use, and the main objective of the amateur radio is for experiment and research.

We can apply the transceiver radio (CB radio) in any business that we want because there is no limitation for using it, and most businesses now try to apply the transceiver radio into their business for retail sales, in hospitals, security, restaurant etc. Those business needs to use the transceiver radio because of the convenience and cost saving which are the main factors such as, the security service in case of emergency, the operator at the radio center can tell every guard through the transceiver radio that there is something wrong, so we need to check and solve it. Every guard can get the message from 1 time broadcast from the radio center, and this is the advantage of the transceiver radio. There is no time wasted and every guard or the guard that stands near by that point can reach as fast as he can.

Transceiver radio can help us in the communications such as:

(1) Mobility

(2) Ease of installation in difficult-to-wire areas

(3) Reduced installation time

(4) Increased reliability

(5) Long-term cost saving

And we calculate the cost of investment of the three systems:

(1) Existing system

(2) Existing with transceiver radio system

(3) Mobile phone system

Finally, we conclude that the existing system with the transceiver radio is the best choice because we pay less investment cost than the other two choices, and the transceiver radio will offer convenience like we said above.

5.2 Recommendations

The popularity of using the CB 245 MHz comes from the performance of its signal strength or power output etc. That can make the CB 245 MHz cover long distance especially in the obstacle location such as high buildings, underground floors, mountains, etc. and the cost of the CB 245 MHz is not too high for the people to use.

Then the CB 245 MHz is popular because of its performance that can cover long distance not less than 25 Km, and can use the external antennas. There are a lot of accessories available for the CB 245 MHz.

The advantage of the transceiver radio communication is, it is cost saving when compared to the mobile phone system because for the mobile phone system we have to pay the monthly fee and air time cost, so this is the disadvantage of the mobile phone system compared to the transceiver radio system.

We recommended the "Packet Radio" to the transceiver radio to communicate in the near future because now is the time for the information technology.

The word "Internet" is very familiar and the electronic commerce also. The data transmission now, uses the modem (Modulate Demodulate) to send and receive the data. The modem needs to work with a computer set as you already know.

But for the "Packet" radio cabling there is no need in the transmitting and receiving of the data. By using the TNC (Terminal Node Controller) to convert the Digital Signal into the Analog Signal this data will be sent through the Antenna from the sender to the receiver.

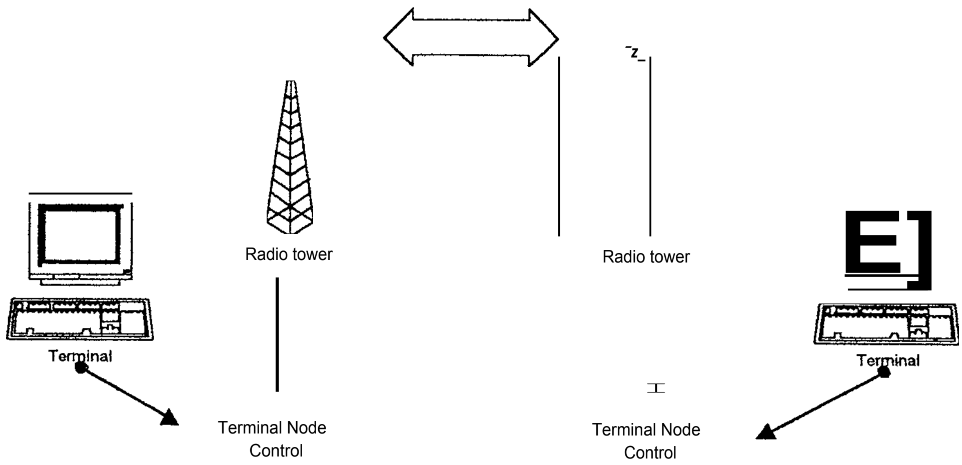


Figure 5.1. Packet Radio System.

Packet Radio - What It's All About

All you need is a transceiver, a computer, and a TNC or a special packet modem and software. A two-meter rig is preferred, since that's where most of the packet activity is located. You probably already have the rig and the computer, so all you need to buy is the TNC, which costs just over 4,000 bahts, or the special modem and software, which is sold together for about 2,500 bahts.

The TNC (Terminal Node Controller) is a "little black box" that's wired between the computer and the radio. It contains a software for controlling the outgoing and incoming transmissions for your station and a modem that converts the data from the computer into AFSK tones for transmission and changes the tones that are received by the radio into data for the computer. The TNC modem works much like a modem that's used to connect your computer to the telephone lines. It's a simple matter of wiring up a plug and a couple of jacks to become fully operational on the packet. If you prefer to use the small modem instead of a INC, you'll need special software for your computer to replace the software in the TNC. Either method works equally well.

Packet is communications between people either direct or indirect. You can work from "keyboard to keyboard" or use electronic mailboxes or bulletin board systems to leave messages. Due to the error checking by the TNC, all of it is error free, too. (That is, as error free as the person at the keyboard types it!) As the data is received it's continuously checked for errors, and it isn't accepted unless it's correct. You don't miss the information if it has errors, however, because the information is resent until it is correctly received.

The data that is to be transmitted is collected in the TNC and sent as bursts, or packets, of information, hence the name. Each packet has the record or address of who it's going to, who it's coming from and the route between the two stations included, along with the data and error checking. Since up to 256 characters can be included in each packet, more than three lines of text can be sent in a matter of a couple of seconds. There is also plenty of time between packets for several stations to be using the same frequency at the same time.

So in the near future the wireless communication will be the part or the important part of communication and wireless communication will still go on developing.

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