

**Internet and Data Connectivity Using
Optical Fiber and RF Signal**

**An Internship report presented in partial fulfillment of the requirements for the
degree of Bachelor of Science in Electronics and Telecommunication Engineering**

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APPROVAL

This Internship titled “Internet and Data Connectivity using Optical fiber and RF Signal” submitted by Nurul Amin to the Department of Electronics and Telecommunication Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Bachelor of Science in Electronics and Telecommunication Engineering and approved as to its style and contents. The presentation was held on 27 February, 2011.

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ACKNOWLEDGEMENT

First I express my heartiest thanks and gratefulness to almighty Allah for His divine blessing makes us possible to complete this internship successfully.

I feel grateful to and wish my profound my indebtedness to Asst. Professor A.K.M Fazlul Haque Department of ETE, Department of ETE Daffodil International University, Dhaka. Deep Knowledge & keen interest of my supervisor in the field of wireless network influenced us to carry out this project .His endless patience ,scholarly guidance ,continual encouragement , constant and energetic supervision, constructive criticism , valuable advice ,reading many inferior draft and correcting them at all stage have made it possible to complete this project.

I would like to express my heartiest gratitude to Dr. Lutfur Rahman, Professor and Dean, Faculty of science and information technology, Dr. Md. Golam Mowla Chowdhury Professor and Head, Department of ETE, for his kind help to finish our internship report and also to other faculty member and the staff of ETE department of Daffodil International University.

I would like to thank my entire course mate in Daffodil International University, who took part in this discuss while completing the course work.

Finally, I must acknowledge with due respect the constant support and patients of our parents.

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Abstract

This report presents the Internet and Data Connectivity using Optical Fiber and RF Signal, especially for RANKS ITT LTD. This kind of connectivity helps the whole nation or multi-company to provide best quality of service to the consumer. Using optical fiber, it is possible to connect the clients' device by means of media converter. To perform this conversion, some essential devices such as optical fiber, media converter, OTDR and splicing machine have been used. Point to point connection by means of Canopy, Airlive has been used for client satisfaction. In this report, the requirements of installation & configuration are also described. Bandwidth controlling system has also been considered to optimize the performance of the system.

Chapter 1

Introduction

1.1 GENERAL INTRODUCTION

I have completed my internship successfully in Ranks ITT. Ranks ITT is the largest data network in terms of geographic coverage in Bangladesh, spanning 6 Divisions and 64 Districts with 30 PoPs nationwide. Operating on a single platform using RAD and Cisco technology, the Network offers a broad range of voice and data solutions to nationals and multinationals in a variety of industries. Ranks - ITT is the market leader of nation wide data communication network service with over USD 4 million investments. Under a strategic infrastructure sharing agreement with Grameenphone (GP), Ranks - ITT retails excess capacity of 1,945 km of GP Fiber Optics Network in 62 districts and operates over 30 Point-of-Presence (PoP) through out Bangladesh.

As a single integrated national network, services are fully managed from end-to-end. Offered on an unrivaled national scale, these include business intranet and Internet solutions, high performance remote access services over local fixed or dial-up lines, and many other Wide Area Network services. As the technology leader Ranks - ITT combines its carrier class technology deployment and national coverage with superior

A world-wide research network sharing a common addressing scheme and using the TCP/IP software protocol for data transfer between hosts. It is composed of many individual campuses, state, national, and regional networks. In computer science, data is information in a form suitable for use with a computer. Data is often distinguished from programs. A program is a set of instructions that detail a task for the computer to perform. First, I understood the background of the core network of the company then applied to perform the problem statement and finally checked the status of network whether it was operative. In this report, the overall all theoretical and technical details of the given company have been introduced and finally the problem solution of the project has been tested and verified using simulation tool.

1.2 Objective of the work

To provide internet and data service using optical fiber we use various devices such as media converter, OTDR, Splicing Machine.

For Clients requirement we provide wireless connectivity. In wireless system, we use various devices such as Canopy, AIRLIVE, and GPS. The require installation & configuration are describe in this report.

1.4 Organization of the Report

This internship report has seven chapters in total

Chapter 1 reviews on the Introduction of this internship report, definition of the internet and data, how to provide internet and data service.

Chapter 2 reviews of optical fiber communication, history, Application of the optical fiber, Material of optical fiber, types of optical fiber

Chapter 3 reviews Optical fiber equipment, Describer and configuration of optical fiber device, also show the process of data service

Chapter 4 reviews of RF signal, Modulation & Demodulation, types of antenna

Chapter 5 review of RF equipment, Describe about RF devices

Chapter 6 reviews of Site survey RF connectivity. In this chapter also describe how configure the radio device

Chapter 7 brings out the conclusion of the entire work

Optical Fiber Communication

2.1 Optical Fiber

An optical fiber or optical fibre is a thin, flexible, transparent fiber that acts as a waveguide, or "light pipe", to transmit light between the two ends of the fiber. The field of applied science and engineering concerned with the design and application of optical fibers is known as fiber optics. Optical fibers are widely used in fiber-optic communications, which permits transmission over longer distances and at higher bandwidths (data rates) than other forms of communication. Fibers are used instead of metal wires because signals travel along them with less loss and are also immune to electromagnetic interference. Fibers are also used for illumination, and are wrapped in bundles so they can be used to carry images, thus allowing viewing in tight spaces. Specially designed fibers are used for a variety of other applications, including sensors and fiber lasers.

2.2 History

In 1966 Charles K. Kao and George Hockham proposed optical fibers at STC Laboratories (STL) at Harlow, England, when they showed that the losses of 1000 dB/km in existing glass (compared to 5-10 db/km in coaxial cable) was due to contaminants, which could potentially be removed.

Optical fiber was successfully developed in 1970 by Corning Glass Works, with attenuation low enough for communication purposes (about 20dB/km). After a period of research starting from 1975, the first commercial fiber-optic communications system was developed.[1]

2.2.1 First-generation

This first-generation system operated at a bit rate of 45 Mbps with repeater spacing of up to 10 km. Soon on 22 April, 1977, General Telephone and Electronics sent the first live telephone traffic through fiber optics at a 6 Mbit/s throughput in Long Beach, California

2.2.2 Second generation

The second generation of fiber-optic communication was developed for commercial use in the early 1980s, operated at 1.3 μm , and used In GaAsP semiconductor. The bit rates of up to 1.7 Gb/s with repeater spacing up to 50 km.

2.2.3 Third-generation

Third-generation fiber-optic systems operated at 1.55 μm and had losses of about 0.2 dB/km. They achieved this despite earlier difficulties with pulse-spreading at that wavelength using conventional In GaAsP semiconductor lasers. These developments eventually allowed third-generation systems to operate commercially at 2.5 Gbit/s with repeater spacing in excess of 100 km.

2.2.4 Fourth generation

The fourth generation of fiber-optic communication systems used optical amplification to reduce the need for repeaters and wavelength division multiplexing to increase data capacity.. Recently, bit-rates of up to 14 Tbit/s have been reached over a single 160 km line using optical amplifiers.

2.3 Applications

Optical fiber is used by many telecommunications companies to transmit telephone signals, Internet communication, data transmission, and cable television signals. Due to much lower attenuation and interference, optical fiber has large advantages over existing copper wire in long-distance and high-demand applications.

Since 1990, when optical-amplification systems became commercially available, the telecommunications industry has laid a vast network of intercity and transoceanic fiber communication lines. By 2002, an intercontinental network of 250,000 km of submarine communications cable with a capacity of 2.56 Tb/s was completed, and although specific network capacities are privileged information, telecommunications investment reports indicate that network capacity has increased dramatically since 2004.

2.4 Technology

Modern fiber-optic communication systems generally include an optical transmitter to convert an electrical signal into an optical signal to send into the optical fiber, a cable containing bundles of multiple optical fibers that is routed through underground conduits and buildings, multiple kinds of amplifiers, and an optical receiver to recover the signal as an electrical signal..

2.5 Material & Structure of Optical Fiber

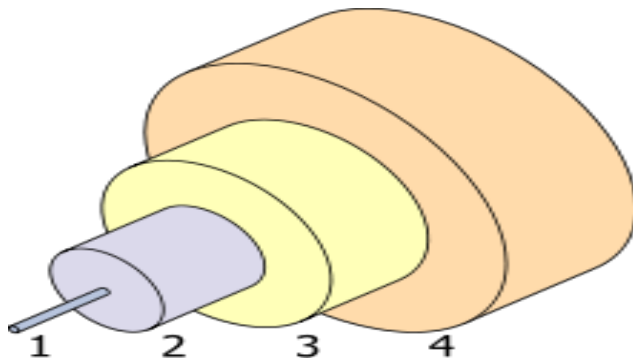
An optical fiber consists of a core, cladding, and a buffer (a protective outer coating), in which the cladding guides the light along the core by using the method of total internal reflection. The core and the cladding (which has a lower-refractive-index) are usually made of high-quality silica glass, although they can both be made of plastic as well.

The core of a conventional optical fiber is a cylinder of glass or plastic that runs along the fiber's length. The core is surrounded by a medium with a lower index of refraction, typically a cladding of a different glass, or plastic. Light traveling in the core reflects from the core-cladding boundary due to total internal reflection, as long as the angle between the light and the boundary is less than the critical angle. As a result, the fiber transmits all rays that enter the fiber with a sufficiently small angle to the fiber's axis. The limiting angle is called the acceptance angle, and the rays that are confined by the core/cladding boundary are called guided rays.

The core is characterized by its diameter or cross-sectional area. In most cases the core's cross-section should be circular, but the diameter is more rigorously defined as the average of the diameters of the smallest circle that can be circumscribed about the core-cladding boundary, and the largest circle that can be inscribed within the core-cladding boundary. This allows for deviations from circularity due to manufacturing variation. [1]

Another commonly-quoted statistic for core size is the mode field diameter. This is the diameter at which the intensity of light in the fiber falls to some specified fraction of maximum (usually $1/e^2 \approx 13.5\%$). For single-mode fiber, the mode field diameter is

larger than the physical diameter of the core, because the light penetrates slightly into the cladding as an evanescent wave.



The structure of a typical single-mode fiber

1. Core 8 μm diameter
2. Cladding 125 μm dia
3. Buffer 250 μm dia
4. Jacket 400 μm dia

Figure 2.1: Structure of Optical Fiber

2.6 Types of Optical Fiber

Two main types of optical fiber used in optic communications include multi-mode optical fibers and single-mode optical fibers. A multi-mode optical fiber has a larger core (≥ 50 micrometers), allowing less precise, cheaper transmitters and receivers to connect to it as well as cheaper connectors. The core of a single-mode fiber is smaller (<10 micrometers) and requires more expensive components and interconnection methods, but allows much longer, higher-performance links.

2.6.1 Multi-mode Optical Fiber

The propagation of light through a multi-mode optical fiber a laser bouncing down an acrylic rod, illustrating the total internal reflection of light in a multi-mode optical fiber. Fiber with large core diameter may be analyzed by geometrical optics. Such fiber is called multi-mode fiber, from the electromagnetic analysis. In a step-index multi-mode fiber, rays of light are guided along the fiber core by total internal reflection [1]

Rays that meet the core-cladding boundary at a high angle, greater than the critical angle for this boundary, are completely reflected. The critical angle (minimum angle for total internal reflection) is determined by the difference in index of refraction between the core and cladding materials

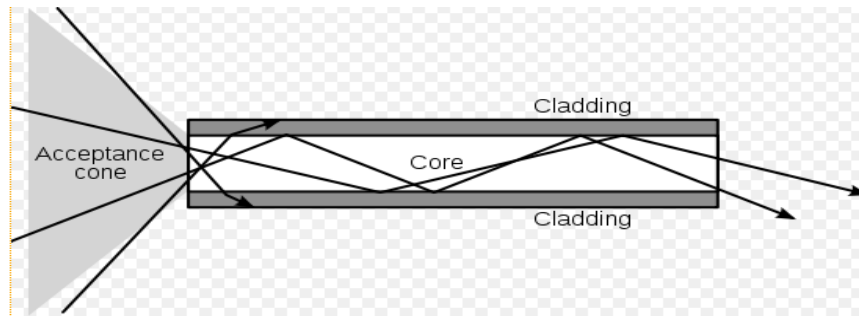


Figure 2.2: Multimode Optical Fiber

Rays that meet the boundary at a low angle are refracted from the core into the cladding, and do not convey light and hence information along the fiber. The critical angle determines the acceptance angle of the fiber, often reported as a numerical aperture. A high numerical aperture allows light to propagate down the fiber in rays both close to the axis and at various angles, allowing efficient coupling of light into the fiber.

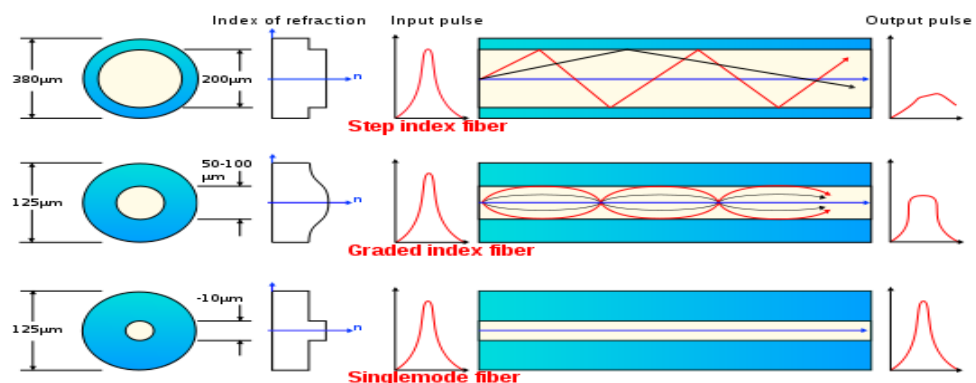


Figure2.3: Graded-index fiber

In graded-index fiber, the index of refraction in the core decreases continuously between the axis and the cladding. This causes light rays to bend smoothly as they approach the cladding, rather than reflecting abruptly from the core-cladding boundary. The resulting curved paths reduce multi-path dispersion because high angle rays pass more through the lower-index periphery of the core, rather than the high-index center. This ideal index profile is very close to a parabolic relationship between the index and the distance from the axis.

2.6.2 Single-Mode Optical Fiber

Fiber with a core diameter less than about ten times the wavelength of the propagating light cannot be modeled using geometric optics. The electromagnetic analysis may also be required to understand behaviors such as speckle that occur when coherent light propagates in multi-mode fiber. As an optical waveguide, the fiber supports one or more confined transverse modes by which light can propagate along the fiber. Fiber supporting only one mode is called single-mode or mono-mode fiber.[2]

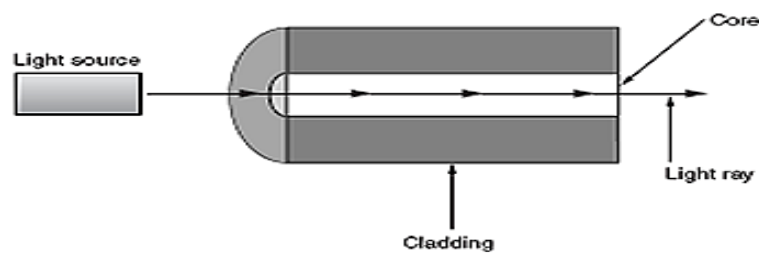


Figure2.4: Single mode Fiber

The waveguide analysis shows that the light energy in the fiber is not completely confined in the core. Instead, especially in single-mode fibers, a significant fraction of the energy in the bound mode travels in the cladding as an evanescent wave. The most common type of single-mode fiber has a core diameter of 8–10 micrometers and is designed for use in the near infrared. The mode structure depends on the wavelength of the light used, so that this fiber actually supports a small number of additional modes at visible wavelengths. Multi-mode fiber, by comparison, is manufactured with core diameters as small as 50 micrometers and as large as hundreds of micrometers.

2.6.3 Special-purpose Optical Fiber

Some special-purpose optical fiber is constructed with a non-cylindrical core and/or cladding layer, usually with an elliptical or rectangular cross-section. These include polarization-maintaining fiber

Optical Fiber Equipment & WAN Connection

3.1 Optical Time-Domain Reflect Meter

Optical Time-Domain Reflect Meter (**OTDR**) is an optoelectronic instrument used to characterize an optical fiber. An OTDR injects a series of optical pulses into the fiber under test. It also extracts, from the same end of the fiber, light that is scattered (Rayleigh Backscatter) or reflected back from points along the fiber. The strength of the return pulses is measured and integrated as a function of time, and is plotted as a function of fiber length. [2]

3.1.1 Uses of OTDR

OTDR are commonly used to characterize the loss and length of fibers as they go from initial manufacture, through to cabling, warehousing while wound on a drum, installation and then splicing. The last application of installation testing is more challenging, since this can be over extremely long distances, or multiple splices spaced at short distances, or fibers with different optical characteristics joined together. OTDR are also commonly used for fault finding on installed systems. In this case, reference to the installation OTDR trace is very useful, to determine where changes have occurred. .

3.1.2 Operation of OTDR

OTDR are available with a variety of fiber types and wavelengths, to match common applications. In general, OTDR testing at longer wavelengths such as 1550 nm or 1625 nm, can be used to identify fiber attenuation caused by fiber problems, as opposed to the more common splice or connector losses. The optical dynamic range of an OTDR is limited by a combination of optical pulse output power, optical pulse width, input sensitivity, and signal integration time.

A longer laser pulse improves dynamic range and attenuation measurement resolution at the expense of distance resolution. For example, using a long pulse length, it may possible to measure attenuation over a distance of more than 100 km, however in this

case an optical event may appear to be over 1 km long. A short pulse length will improve distance resolution of optical events, but will also reduce measuring range and attenuation measurement resolution. The "apparent measurement length" of an optical event is referred to as the "dead zone". The theoretical interaction of pulse width and dead zone can be summarized as follows

Table 3.1: The theoretical interaction of pulse width

| Pulse length | Event Dead zone |
|---------------|-------------------------|
| 1 nsec | 0.15 m (theoretically) |
| 10 nsec | 1.5 m (theoretically) |
| 100 nsec | 15 m |
| 1 μ sec | 150 m |
| 10 μ sec | 1.5 km |
| 100 μ sec | 15 km |

Dead Zone

Dead zone is classified in two ways. Firstly, an "Event Dead Zone" is related to a reflective discrete optical event

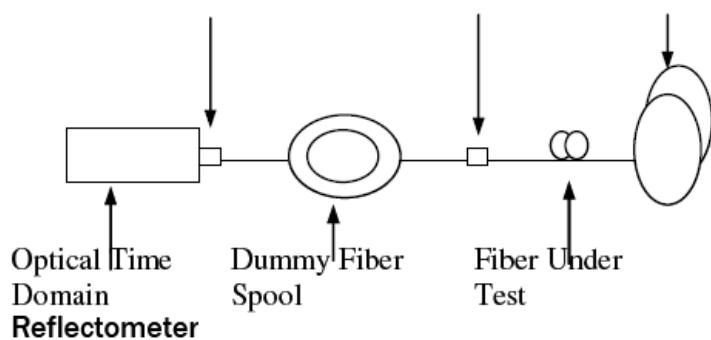


Figure 3.1: Block Diagram of OTDR

In this situation, the measured dead zone will depend on a combination of the pulse length and the size of the reflection. Secondly, an "Attenuation Dead Zone" is related to a non-reflective event.

The theoretical distance measuring accuracy of an OTDR is extremely good, since it is based on software and a crystal clock with an inherent accuracy of better than 0.01%. OTDR excels at identifying the existence of unacceptable point loss or return loss in cables. Its ability to accurately measure absolute end-to-end cable loss or return loss can be quite poor, so cable acceptance usually includes an end to end test with a light source and power meter, and optical return loss meter.

3.2 Fiber Media Converter

Fiber media converters are simple networking devices that make it possible to connect two dissimilar media types such as twisted pair with fiber optic cabling. They were introduced to the industry nearly two decades ago, and are important in interconnecting fiber optic cabling-based systems with existing copper-based, structured cabling systems.

Media conversion types

Fiber media converters support many different data communication protocols including Ethernet, Fast Ethernet, Gigabit Ethernet, T1/E1/J1, DS3/E3, as well as multiple cabling types such as coax, twisted pair, multi-mode and single-mode fiber optics.

Simple Network Management Protocol (SNMP) enables proactive management of link status, monitoring chassis environmental statistics and sending traps to network managers in the event of a fiber break or even link loss on the copper port. Fiber media converters can connect different Local area network (LAN) media, modifying duplex and speed settings. Switching media converters can connect legacy 10BASE-T network segments to more recent 100BASE-TX or 100BASE-FX Fast Ethernet Infrastructure.



Figure 3.2: Fiber Media Converter

For example, existing Half-Duplex hubs can be connected to 100BASE-TX Fast Ethernet network segments over 100BASE-FX fiber

Media converters can extend the reach of the LAN over single-mode fiber up to 130 kilometers with 1550 nm optics. As well as conventional dual strand fiber converters, with separate receive and transmit ports, there are also single strand fiber converters, which can extend full-duplex data transmission up to 70 kilometers over one optical fiber.

3.3 Splicing Machine

If you want to join two lengths of optical fiber together with the least possible loss of optical power, the method to choose is fusion splicing. In fusion splicing, the cores and claddings of the two fibers are actually melted together. Because the core has a very small diameter, it requires a very precise instrument to join the cores in a way that lets the most light pass through the point of joining. (For single mode fiber, the diameter is about 1/100 of a millimeter. For multimode fiber, the diameter is 1/16 of a millimeter.)



Figure 3.3: Splicing Machine

The new rugged construction adds improved reliability by resisting shock, dust, and rain, and can withstand a 30" drop test. The splices a fiber in 8-10 seconds and heats a 60mm splice sleeve in 30-40 seconds, for a total cycle time of only 39-45 seconds. New features, such as automatic tube heater operation, user-selectable clamping method, automated monitor image orientation, and battery charge capability during splice operation provide the end user a productivity tool they can count on. New

software included provides the ability to download splice data to a PC for splice data reporting, download splice operating software via the internet to maintain peak performance, and download video images from the splice to enhance technical support.

3.4 Splicing Method

A fusion splice is a way of joining two fiber cores by melting the ends together using an electric arc. A splicing machine is used because an extremely high degree of accuracy is needed; the machine first has to align the cores and then apply the exact amount of heat to melt the ends before pressing them together. Splicing can be carried out using a mechanical splice but these only hold the fiber ends together, precisely aligned but not permanently joined. [3]



Figure 3.4: Splicing Method of Optical Fiber

There are four basic steps to fusion splicing

1 - Strip backs all coatings down to the bare fibers and cleans using isopropyl alcohol.

2 - Cleave the fibers using a precision cleaving tool and put the heat shrink tube on to one of the ends.

3 - Fuse the fibers together in the fusion splice.

4 - Put the heat shrink protector on the fiber joint.

3.4.1 Stripping

Strip back the external sheathing of the cable using a rotary stripping tool. Cut back the agamid strength member using ceramic or Kevlar scissors. Strip the primary

buffer from the fiber using fiber strippers not ordinary wire strippers. Do this a small section at a time to prevent the fiber breaking, about 10mm (3/8 in) on each cut is fine until you get used to it. Strip back about 35mm (1.5 in).

3.4.2 Cleaving

The cleaver first scores the fiber and then pulls the fiber apart to make a clean break. It is important that the ends are smooth and perpendicular to get a good joint, this is why a hand held cleaver will not do. Basically the operation consists of putting the fiber into the groove and clamping, then close the lid and press the lever



Figure 3.5: Splicing Method of Optical Fiber

3.4.3 The Fusion Process

Once the fiber ends are prepared they are placed in the fusion splicer. Press the button and the machine takes care of the rest of the fusion process automatically. Figure 2.7 this on the photo where a much magnified image shows the two fiber ends. The display also shows how well the cleaver does its job of producing a perfect 90 degree cut. If you watch very carefully in the video you can see the X and Y alignment that takes place. The splice aligns the fibers on one axis and then from another camera angle set at 90 degrees, it aligns the other axis.

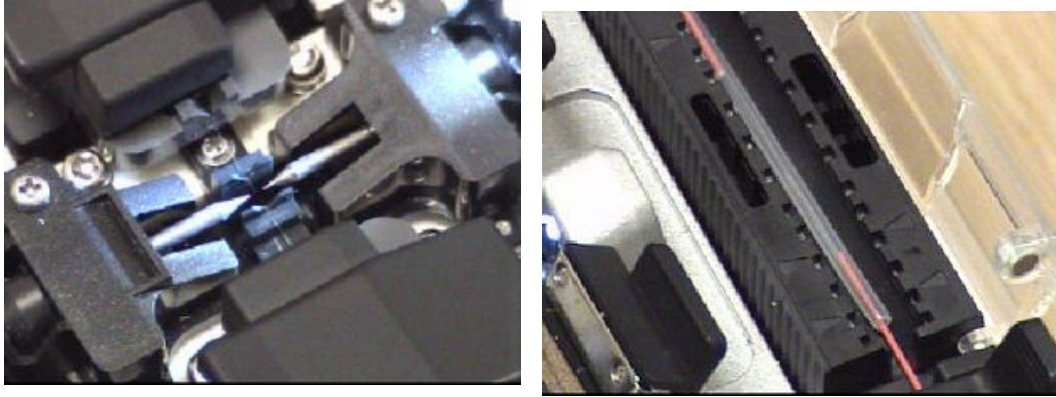


Figure 3.6: Splicing Method of Optical Fiber

Bearing in mind that we are dealing with two very small glass rods of only 125 microns in diameter, it brings it home as to how extremely accurate these machines are. Once the fibers are aligned the splice fires an electric arc between the two ends which melts them immediately and pushes them together, or fuses them into one piece of fiber. The fusion splices then tests for dB loss and tensile strength before giving the "OK" beeps for you to remove the splice from the machine

3.5 Internet & Data Connectivity Using Optical Fiber

Now Present Share Business is the most popular in Bangladesh. In this Business control By Dhaka Stock Exchange (DSE).DSE need high Speed data service for online trading. Because sell or buy signal updated in nanosecond .In this System DSE uses Main Frame Server. In DSE up to 3000 Branch & Sub Branch connected to DSE server directly or via head office main server. DSE selected 5 Vendor for provide the data service in the branch & sub branch. For Security propose DSE provide own IP series. They also provide branch & sub branch in IP Address.

Example Greenland Security head office by runs 3 pc. He has also other 3 sub branch. IP address for head office 150.1.236.3/28 (236 is the branch number 3 is the pc number).IP address for sub branch 155.236.2.1/24 (here 2 is the sub branch number &1 is the pc number)

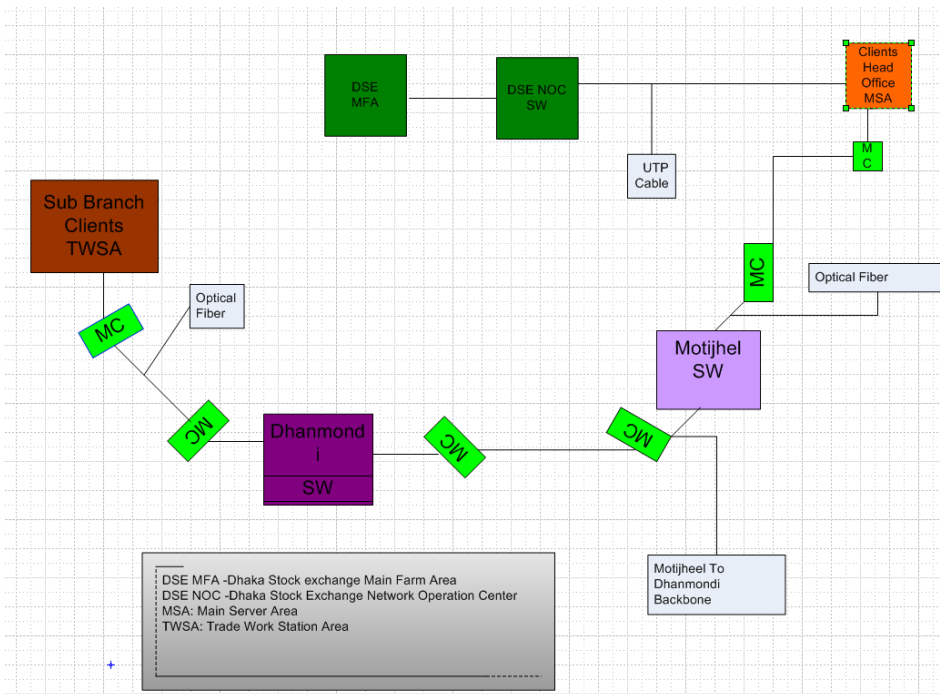


Figure 3.7: Data Connectivity using optical Fiber

1. Sub Branch to Dhanmondi Pop connected by Optical Fiber.
2. Dhanmoni to Motijheel Pop is the backbone
3. Motijheel to Clients MSA Connected By Optical fiber
4. Cliens MSA to DSE NOC Connected by UTP Cable
5. DSE NOC to DSE MFS connected by UTP Cable
6. For online trading need minimum 256 kbps speed

For path test first need check pop gateway than need to check head office MSA Gateway. If every thing then we need to test DSE MFS Server

Chapter 4

Radio Frequency

4.1 Radio Frequency

Radio frequency (abbreviated RF, rf, or r.f.) is a term that refers to alternating current (AC) having characteristics such that, if the current is input to an antenna, an electromagnetic (EM) field is generated suitable for wireless broadcasting and/or communications. These frequencies cover a significant portion of the electromagnetic radiation spectrum, extending from nine kilohertz (9 kHz), the lowest allocated wireless communications frequency (it's within the range of human hearing), to thousands of gigahertz (GHz).

Radio frequency (RF) is a rate of oscillation in the range of about 30 kHz to 300 GHz, which corresponds to the frequency of electrical signals normally used to produce and detect radio waves. RF usually refers to electrical rather than mechanical oscillations, although mechanical RF systems do exist

4.2 Radio-frequency identification

Radio-frequency identification (RFID) is a technology that uses communication via radio waves to exchange data between a reader and an electronic tag attached to an object, for the purpose of identification and tracking. Some tags can be read from several meters away and beyond the line of sight of the reader. The application of bulk reading enables an almost parallel reading of tags. Radio-frequency identification involves interrogators (also known as readers), and tags (also known as labels).

Most RFID tags contain at least two parts. One is an integrated circuit for storing and processing information, modulating and demodulating a radio-frequency (RF) signal, and other specialized functions. The other is an antenna for receiving and transmitting the signal. The first patent to be associated with the abbreviation RFID was granted to Charles Walton in 1983

4.2.1 Modulation

In telecommunications, modulation is the process of conveying a message signal, for example a digital bit stream or an analog audio signal, inside another signal that can be physically transmitted. Modulation of a sine waveform is used to transform a base band message signal to a pass band signal, for example a radio-frequency signal (RF signal). In radio communications, cable TV systems or the public switched telephone network for instance, electrical signals can only be transferred over a limited pass band frequency spectrum, with specific (non-zero) lower and upper cutoff frequencies. Modulating a sine wave carrier makes it possible to keep the frequency content of the transferred signal as close as possible to the centre frequency (typically the carrier frequency) of the pass band. When coupled with demodulation, this technique can be used to, among other things, transmit a signal through a channel which may be opaque to the base band frequency range (for instance, when sending a telephone signal through a fiber-optic strand)

4.2.2 Demodulation

Demodulation is the act of extracting the original information-bearing signal from a modulated carrier wave. A demodulator is an electronic circuit (or computer program in a software defined radio) that is used to recover the information content from the modulated carrier wave. These terms are traditionally used in connection with radio receivers, but many other systems use many kinds of demodulators. Another common one is in a modem, which is a contraction of the terms modulator/demodulator.

4.2.3 Radio communication

In order to receive radio signals an antenna must be used. However, since the antenna will pick up thousands of radio signals at a time, a radio tuner is necessary to tune in to a particular frequency (or frequency range). This is typically done via a resonator – in its simplest form, a circuit with a capacitor and an inductor forming a tuned circuit. Often the inductor or the capacitor of the tuned circuit is adjustable allowing the user to change the frequencies at which it resonates. The resonant frequency of a tuned circuit is given by the formula

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

Where f_0 is the frequency in hertz, L is inductance in henries, and C is capacitance in farads

4.3 Special properties of RF electrical signals

Electrical currents that oscillate at RF have special properties not shared by direct current signals. One such property is the ease with which they can ionize air, creating a conductive path through it. This property is exploited by 'high frequency' units used in electric arc welding, although strictly speaking these machines do not typically employ frequencies within the HF band.

Another special property is that RF current cannot penetrate deeply into electrical conductors but flows along the surface of conductors; this is known as the skin effect.

Another property is the ability to appear to flow through paths that contain insulating material, like the dielectric insulator of a capacitor. The degree of effect of these properties depends on the frequency of the signals

4.4 RF Antennas

An RF antenna is a device used to convert high frequency (RF) signals on a transmission line (a cable or waveguide) into propagated waves in the air. The electrical fields emitted from antennas are called beams or lobes. Antennas generally deal in the transmission and reception of radio waves, and are a necessary part of all radio equipment. Antennas are used in systems such as radio and television broadcasting, point-to-point radio communication, wireless LAN, cell phones, radar, and spacecraft communication. Antennas are most commonly employed in air or outer space, but can also be operated under water or even through soil and rock at certain frequencies for short distances. The physical dimensions of an antenna, such as its length, are directly related to the frequency at which the antenna can propagate waves or receive propagated waves. The physical structure of an antenna is directly related to the Shape of the area in which it concentrates most of its related RF energy.

There are three generic categories of RF antennas:

1. Omni-directional
2. Semi-directional
3. Highly-directional

Each category has multiple types of antennas, each having different RF characteristics and appropriate uses.

4.4.1 Omni-directional (Dipole) Antenna

The dipole is an omni-directional antenna, because it radiates its energy equally in all directions around its axis. Dipole antenna is Simple to design; dipole antenna is standard equipment on most access points. Directional antennas concentrate their energy into a cone, known as a "beam."

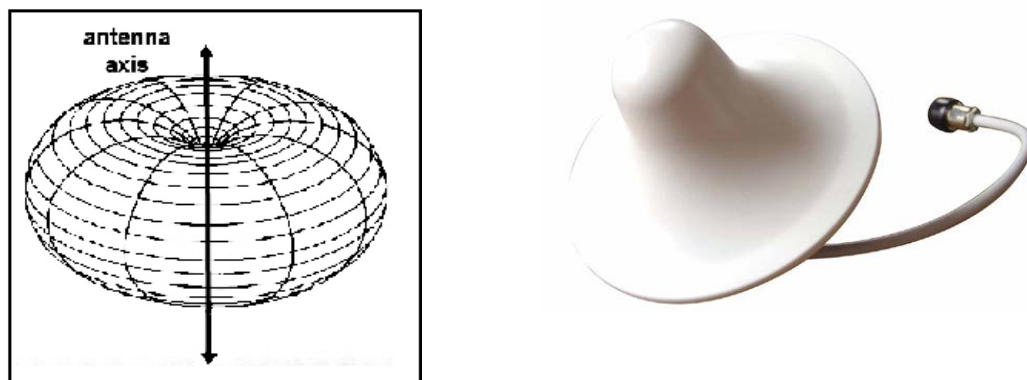


Figure 4.1: Dipole doughnut & Omni Directional Antenna

Figure shows that the dipole's radiant energy is concentrated into a region that like a doughnut, with the dipole vertically through the "hole" of the "doughnut." signal from an omni-directional antenna radiates in a 360-degree horizontal. If an antenna radiates in all directions equally (forming a sphere), it is called an isotropic radiator, which is the theoretical reference for antennas, but rather, practical antennas all have some type of gain over that of an isotropic radiator.[4]

Usages

Omni-directional antennas are used when coverage in all directions around the horizontal axis of the antenna is required. Omni-directional antennas are most effective where large coverage areas are needed around a central point. Omni-directional antennas are commonly used for point-to-multipoint designs with a hub-n-spoke topology.

4.4.2 Semi directional Antenna

Semi directional antennas direct the energy from the transmitter significantly more in one particular direction rather than the uniform circular pattern that is common with the Omni- directional antenna; Semi-directional antennas come in many different styles and shapes. Some semi- directional antennas types frequently used with wireless LANs are Patch, Panel, antennas. All of these antennas are generally flat and designed for wall mounting. Each type has different coverage characteristics. Figure 3.6(A) shows some examples of semi-directional antennas. Semi-directional antennas often radiate in a hemispherical or cylindrical coverage pattern as can be seen in Figure 3.6(B)

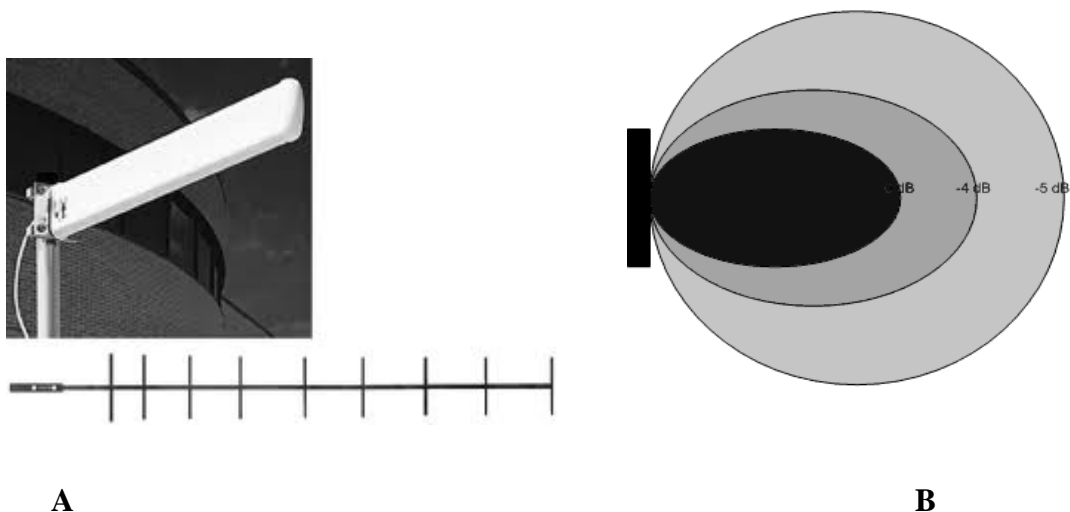


Figure 4.2 :(A& B) Sample & Coverage area semi-directional antennas

Usages

Semi-directional antennas are ideally suited for short and medium range bridging. In some cases, semi-directional antennas provide such long-range coverage that they may eliminate the need for multiple access points in a building. In some cases, semi-directional antennas have back and side lobes that, if used effectively, may further reduce the need for additional access points.

4.4.3 Highly directional antenna

Highly-directional antennas emit the most narrow signal beam of any antenna type and have the greatest gain of these three groups of antennas. Highly-directional antennas are typically concave, dish-shaped devices, as can be seen **Figures 3.3 and 3.4**. These antennas are ideal for long distance, point-to-point wireless links. Some models are referred to as parabolic dishes because they resemble small satellite dishes. Others are called grid antennas due to their perforated design for resistance to wind loading.

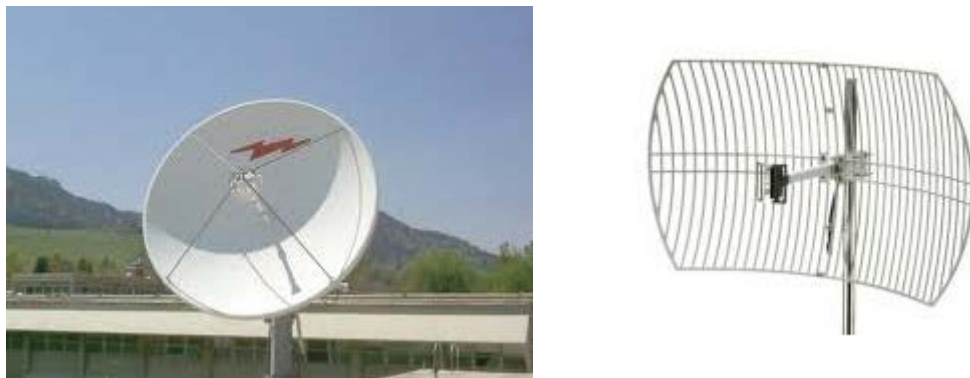


Figure 4.3: Sample of a highly directional grid antenna

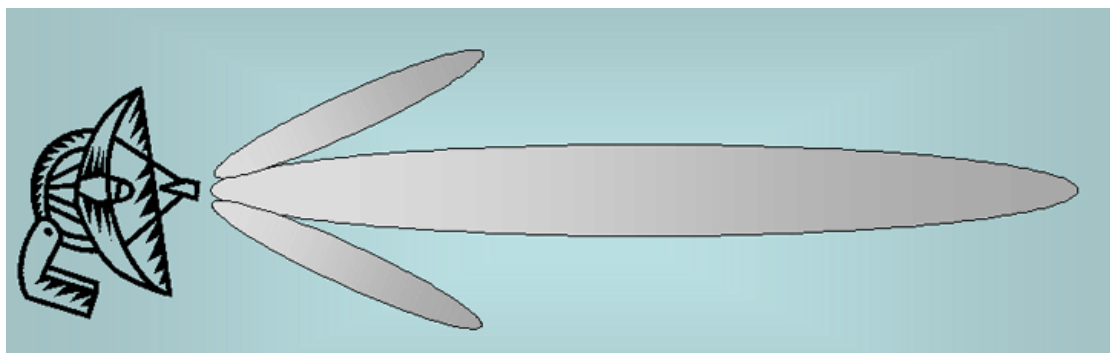


Figure 4.4: Radiation pattern of a highly directional antenna

Usages

High-gain antennas do not have a coverage area that client devices can use. These are used for point-to-point communication links, and can transmit at up to 25 miles. Potential uses of highly directional antennas might be to two buildings that are miles away from each other but have no obstructions in path. Additionally, these antennas can be aimed directly at each other within a building in order to "blast" through an obstruction.

4.5 Antenna Gain

An antenna element without the amplifiers and filters typically associated with it is a passive device. There is no conditioning, amplifying, or manipulating of the signal by antenna element itself. The antenna can create the effect of amplification by virtue of its physical shape. Antenna amplification is the result of focusing the RF radiation into a tighter beam, just as the bulb of a flashlight can be focused into a tighter beam — creating a seemingly brighter light source that sends the light further. The focusing of radiation measured by way of beam widths, which are measured in degrees horizontal and vertical. For example, an omni-directional antenna has a 360-degree horizontal beam width. By limiting the 360-degree beam width into a more focused beam of, say, 30 degrees, at the same power, the RF waves will be radiated further.

4.6 Radio Spectrum

Radio spectrum refers to the part of the electromagnetic spectrum corresponding to radio frequencies – that is, frequencies lower than around 300 GHz (or, equivalently, wavelengths longer than about 1 mm). Different parts of the radio spectrum are used for different radio transmission technologies and applications. Radio spectrum is typically government regulated in developed countries, and in some cases is sold or licensed to operators of private radio transmission systems (for example, cellular telephone operators or broadcast television stations).

A band is a small section of the spectrum of radio communication frequencies, in which channels are usually used or set aside for the same purpose.

4.6.1 ITU

The ITU radio bands are designations defined in the ITU Radio Regulations. Table 3.1 states that "the radio spectrum shall be subdivided into nine frequency bands, which shall be designated by progressive whole numbers" in accordance with the following table.

Table 4.1: ITU Radio Frequency

| Band Number | Symbols | Frequency Range | Wavelength Range | Typical sources |
|--------------------|-------------------------|------------------------|-------------------------|--|
| 1 | Extremely Low Frequency | 3 to 30 Hz | 10,000 to 100,000 km | deeply-submerged submarine communication |
| 2 | Super Low Frequency | 30 to 300 Hz | 1000 to 10,000 km | submarine communication, ac power grids |
| 3 | Ultra Low Frequency | 300 to 3 kHz | 100 to 1000 km | earth quakes, earth mode communication |
| 4 | Very Low Frequency | 3 to 30 kHz | 10 to 100 km | near-surface submarine communication, |
| 5 | Low Frequency | 30 to 300 kHz | 1 to 10 km | AM broadcasting, aircraft beacons |
| 6 | Medium Frequency | 300 to 3000 kHz | 100 to 1000 m | AM broadcasting, aircraft beacons |
| 7 | High Frequency | 3 to 30 MHz | 10 to 100 m | Skywave long range radio communication: |

| | | | | |
|----|----------------------|-----------------|--------------|--|
| 8 | Very High Frequency | 30 to 300 MHz | 1 to 10 m | FM radio broadcast, television broadcast, |
| 9 | Ultra High Frequency | 300 to 3000 MHz | 10 to 100 cm | PMR, television broadcast, GPS, mobile phone communication |
| 10 | Super High Frequency | 3 to 30 GHz | 1 to 10 cm | DBS satellite WLAN (Wi-Fi 802.11 a) |
| 11 | Extra High Frequency | 30 to 300 GHz | 1 to 10 mm | WiMAX, high resolution radar, |

Table 4.2: IEEE Frequency Band

| Band | Frequency range | Origin of name |
|---------------------|------------------------|---|
| HF | 3 to 30 MHz | H igh Frequency |
| VHF | 30 to 300 MHz | V ery H igh Frequency |
| UHF | 300 to 1000 MHz | U ltra H igh Frequency |
| L band | 1 to 2 GHz | L ong wave |
| S band | 2 to 4 GHz | S hort wave |
| C band | 4 to 8 GHz | C ompromise between S and X |
| X band | 8 to 12 GHz | Used in WW II for fire control, X for cross (as in crosshair) |
| K _u band | 12 to 18 GHz | K urz- u nder |
| K band | 18 to 27 GHz | German K urz (short) |
| K _a band | 27 to 40 GHz | K urz- a bove |
| V band | 40 to 75 GHz | |
| W band | 75 to 110 GHz | W follows V in the alphabet |
| mm band | 110 to 300 GHz | |

Chapter 5

RF Equipment

5.1 RF Equipment

1. Radio Device(AIRLIVE Canopy)
2. Reflector
3. GPS

5.2 AIRLIVE

The Airlive is a wireless outdoor multi-function device based on IEEE 802.11g/b 2.4GHz radio technologies. When installed in upright position, it is rain and splash proof. It features an integrated 10dBi patch antenna and passive POE to simplify the installation. The built-in antenna can provide up to 3km of distance depending on conditions.[7]

5.2.1 AIRLIVE Features

- 802.11g/b Hi Powered Chipset
- 4MB Flash and 16MB SDRAM
- 9 wireless multi-function modes: Access Point, Client Mode, WDS Repeater, WDS Bridge, Universal Repeater, WISP Router, AP Router, WISP+ Universal Repeater, WDS Station
- 10Bi Integrated Patch Antenna: Vertical Polarization. 70 degree Horizontal and 38 Degree Vertical coverage in the forward direction
- Power by passive PoE: 12V Adapter and injector included
- Slide out housing design for easy maintenance
- Pole Mount strap included. Optional metal mount and wall mount available
- Interface and IP/MAC Bandwidth Control
- Site Survey, Signal Survey, and Signal Strength LED indicator
- Clear Signal Interference Resistant Technology

- Emergency firmware recovery mode
- Web, HTTPS, SSH, Telnet managements

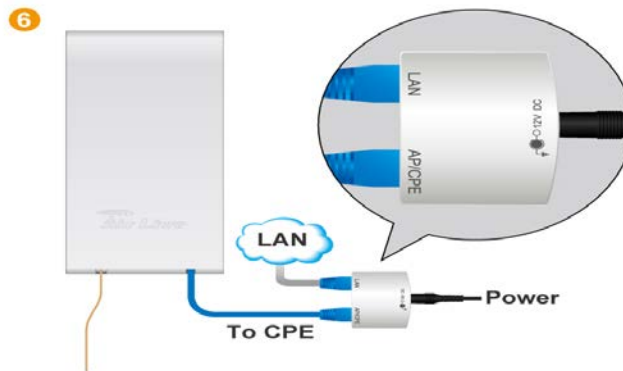


Figure 5.1: Air live setup

5.2.2 Access Point Mode

When operating in the Access Point mode, the AIR live becomes the center hub of the wireless network. All wireless cards and clients connect and communicate through AIRLIVE. This type of network is known as “Infrastructure network”. Other AIRLIVE or 802.11a CPE can connect to AP mode through “Client Mode”.

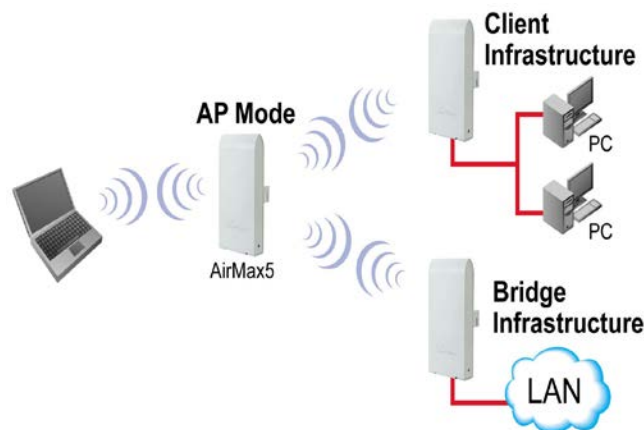


Figure 5.2: Access Point Mode

5.2.3 Client Mode

This mode is also known as “Client” mode. For AIRLIVE, there are 2 types of Client modes: Infrastructure and Ad hoc mode. In Infrastructure mode, the AIRLIVE acts as if it is a wireless adapter to connect with a remote Access Point. Users can attach a

computer or a router to the LAN port of AIRLIVE to get network access. This mode is often used by WISP on the subscriber's side.[7]



Figure 5.3: Clients mode

In Client Ad Hoc mode, AIRLIVE can connect to other wireless adapters without access point. Users can attach a computer or a router to the LAN port of AIRLIVE to get network access.

5.3.4 Bridge Mode

This mode is also known as “WDS Pure MAC Bridge mode”. When configured to operate in the Wireless Distribution System (WDS) Mode, the AIRLIVE provides bridging functions with remote LAN networks in the WDS system. The system will support up to total of 8 bridges in a WDS network. However, each bridge can only associate with maximum of 4 other bridges in the WDS configuration. This mode is best used when you want to connect LAN networks together wirelessly. If you have more than 2 AP in WDS Bridges mode, please remember to turn on the “802.1d Spanning Tree” or “STP” option on to avoid network loop. This mode usually delivers faster performance than infrastructure mode. Figure 4.4



Figure 5.4: Bridge Mode of AIRLIVE

5.4 Configuring of AIRLIVE

The AIRLIVE can be managed remotely by a PC through either the wired or wireless network. The default IP address of the AIRLIVE is **192.168.1.1** with a subnet mask of 255.255.255.0. This means the IP address of the PC should be in the range of 192.168.1.2 to 192.168.1.254.

To prepare your PC for management with the AIRLIVE, please do the following:

1. Connect your PC directly to the LAN port on the DC Injector of AIRLIVE
2. Set your PC's IP address manually to 192.168.1.100 (or other address in the same subnet)
- 3.

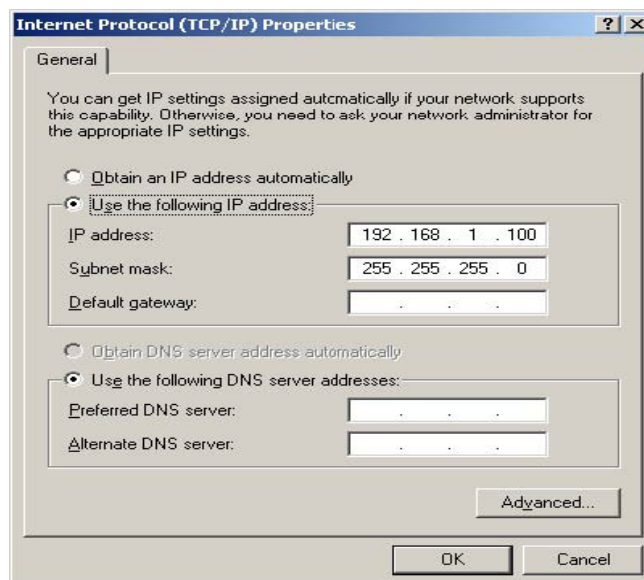


Figure 5.5: IP Setup

We can manage your AIRLIVE by simply typing its IP address in the web browser. Most functions of AIRLIVE can be accessed by web management interface. To begin, simply enter AIRLIVE's IP address (default is 192.168.1.1) on the web browser. The default username is "admin" and password is "AIRLIVE".

□ IP Settings

IP Setting page can configure system IP address. Default IP address is 192.168.1.20 and Subnet Mask is 255.255.255.0. You can manually input IP address setting or get an IP from a DHCP server. If use DHCP to get IP address, use Locator utility to find the access point later.

□ **IP Address** – The IP address need to be unique to your network. We would like to recommend you stay with default IP address 192.168.x.x. This is private address and should work well with your original environment.

□ **IP Subnet Mask** – The Subnet Mask must be the same as that set on your Ethernet network.

□ **Default Gateway** – If you have assigned a static IP address to the Access Point, then enter the IP address of your network’s Gateway, such as a router, in the Gateway field. If your network does not have a Gateway, then leave this field blank.

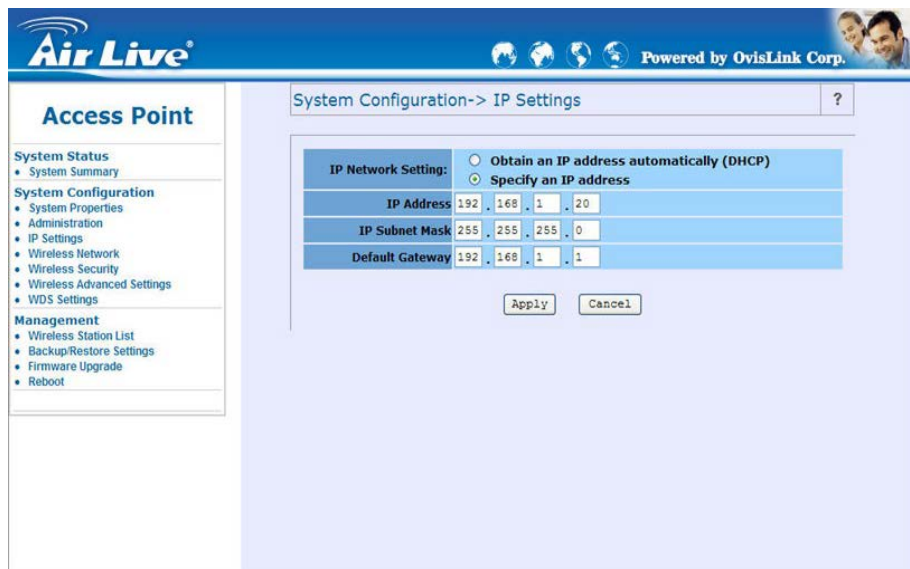


Figure 5.6: IP Setup in AIRLIVE

Bridge Mode Settings

For Bridge network, it is required to enter the Wireless MAC address of all remote bridges that is connecting directly to your AIRLIVE. The wireless MAC address is also known as BSSID that is display on your site survey result

Enable WDS

MAC Address: (xxxxxxxxxxxx)

Comment: (WDS device information)

Current WDS Device List:

| MAC Address | Comment | Select |
|---|---------|--------|
| <input type="button" value="Delete Selected"/> <input type="button" value="Delete All"/> <input type="button" value="Reset"/> | | |

Figure 5.7: Bridge Mode setting

5.5 Bandwidth Control

Bandwidth Control is a great tool to control the bandwidth of the WISP subscribers. Therefore, the WISP operators can offer different class of connection speeds for different subscription fees - just like the ADSL service! The AIRLIVE advance firmware can control the bandwidth by Interface or IP/MAC



Figure 5.8: Bandwidth Control

5.5.1 Interface Control

The interface QoS controls the data rate at the WLAN and LAN interfaces. Therefore, all traffics are controlled the same way. This type of Bandwidth Control is suitable

when AP is used as a Client AP in “Client Mode” and WISP mode. So WISP can control the maximum

5.5.2 Individual IP/MAC Control

The AP can set the maximum data rate for each IP or MAC addresses. This type of Bandwidth Control is most suitable for outdoor AP in “AP” or “Gateway” mode.

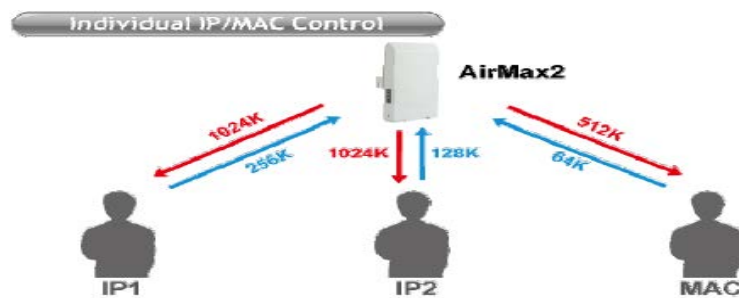


Figure 5.9: IP & MAC Control

5.5.3 Password Settings

The AIRLIVE password protection is turned off by default. To enable password protection or change password, just enter your username and password, and click on “Apply Change” button.

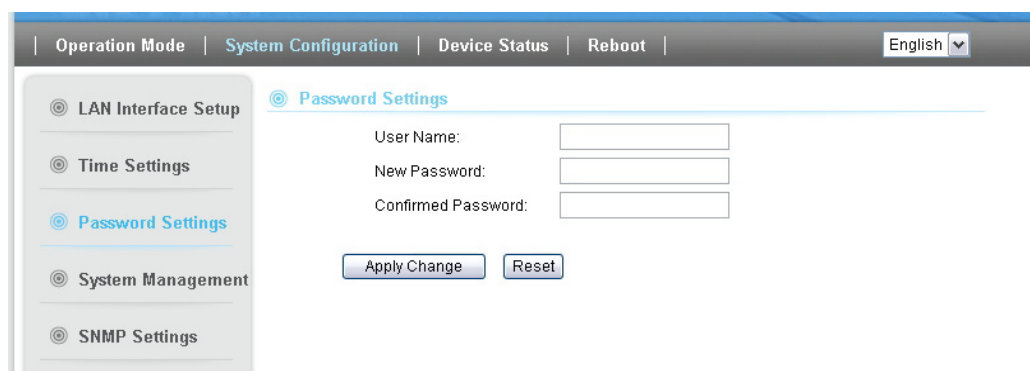


Figure 5.10: Password setting

5.6 Canopy System

Motorola Canopy Wireless system provides cost-effective high-speed Internet access to residential and business customers alike. The Canopy family of products can help service providers deliver broadband service to local customers as well as improve the utilization of their exiting network

The Canopy broadband wireless platform is highly scaleable and exhibits low susceptibility to interference requiring no elaborate frequency planning and coordination. The Canopy hardware draws little power and its packaging is unobtrusive. The equipment uses antennas of only moderate gain resulting in minimal requirements for aiming the units. Hence, installation is easy, in contrast to many of the higher frequency solutions currently available. Finally, the built-in visual feedback installation indicators allow the unit to be installed by virtually anyone. Figure 4.11 illustrates how the Canopy system with its simple equipment makes it easy to build your own Internet access network.[6]

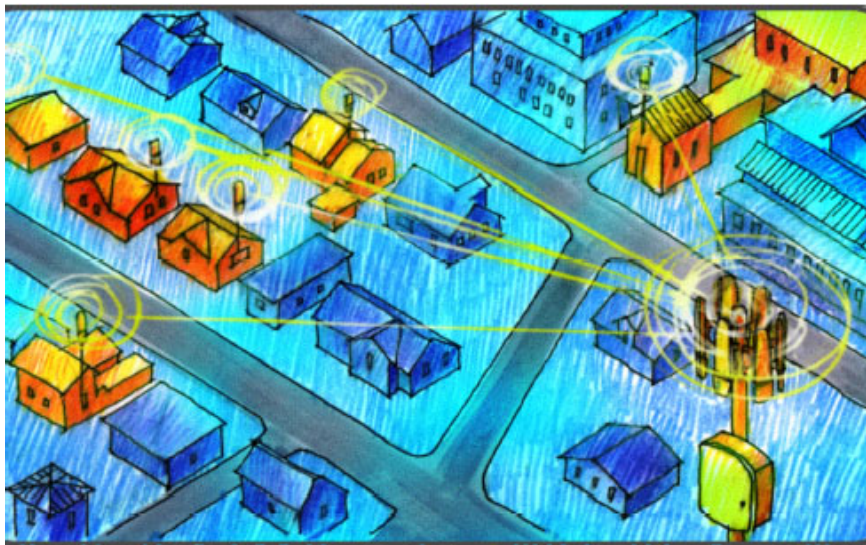


Figure 5.11: Canopy Wireless System

5.6.1 Definitions of Canopy components

| Component | Definition |
|--------------------------|---|
| Access Point Module (AP) | One module that distributes network or Internet |

| | |
|-----------------------------------|---|
| | services in a 60° sector to 200 subscribers or fewer. |
| Access Point cluster (AP cluster) | Two to six APs that together distribute network or Internet services to a community of 1,200 or fewer subscribers. Each AP covers a 60° sector. This cluster covers as much as 360°. |
| Subscriber Module (SM) | A customer premises equipment (CPE) device that extends network or Internet services by communication with an AP or an AP cluster. |
| Cluster Management Module (CMM) | A module that provides power, GPS timing, and networking connections for an AP cluster. If this CMM is connected to a Backhaul Module (BH), then this CMM is the central point of connectivity for the entire site. |
| | |

BRAID

BRAID is a stream cipher that the TIA (Telecommunications Industry Association) has standardized. Standard Canopy APs and SMs use BRAID encryption to

- calculate the per-session encryption key (independently) on each end of a link.
- provide the digital signature for authentication challenges.

DES Encryption

Standard Canopy modules provide DES encryption. DES performs a series of bit permutations, substitutions, and recombination operations on blocks of data. DES Encryption does not affect the performance or throughput of the system.

AES Encryption

Motorola also offers Canopy products that provide AES encryption. AES uses the Rijndael algorithm and 128-bit keys to establish a higher level of security than DES.

5.6.2 Types of BH Application

Backhaul modules are available in

- 2.4-GHz, 5.2-GHz, and 5.7-GHz frequency bands.
- 10- and 20-Mbps data transfer rates in each of these bands.

The planner should select BH based on desired data handling capability, desired link range, and whether the BH will either operate in a network environment or be collocated with an AP or AP cluster. 2.4- and 5.7-GHz BH can be used with a reflector on either or both ends. In the U.S.A. and Canada, regular 5.2-GHz backhauls cannot be used with a reflector, due to regulatory agency restrictions. However, Extended Range (ER) 5.2-GHz BH uses very low transmits power and are permitted with a reflector in the U.S.A. and Canada, as well as elsewhere. Where this Extended Range BH is deployed, reflectors on both ends are recommended.

5.6.3 Security Feature

Canopy systems employ the following forms of encryption for security of the wireless link

- BRAID—a security scheme that the cellular industry uses to authenticate wireless devices.
- DES—Data Encryption Standard, an over-the-air link option that uses secret 56-bit keys and 8 parity bits.
- AES—Advanced Encryption Standard, an extra-cost over-the-air link option that provides extremely secure wireless connections.

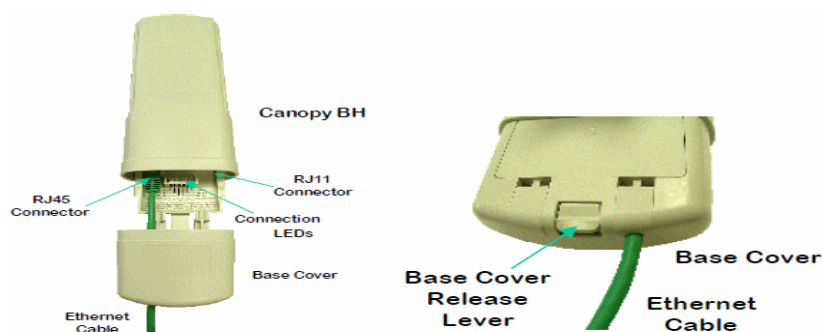


Figure 5.12: Canopy BH Base

5.7 Backhaul (BH) Module

The BH Module is a Point-To-Point radio that carries traffic to and from AP Clusters. A set of Point-to-Point BH Modules can also be used as a low latency Ethernet bridge between any two networks or between a network and a single remote computer. In the event no convenient fiber or cable connection is available for IP connectivity to an AP Cluster, a set of BH Modules can be used. Each BH Module (5700BHRF) communicates to another BH Module using a highly directional antenna. The BH Module operates with a raw data bit rate of 10 Mbps with an approximate throughput of 7+ Mbps and has a maximum range of approximately 35 miles. The BH uplink/downlink bandwidth ratio for a single BH link is configurable by the operator (i.e. 75 percent downlink and 25 percent uplink or 50 percent uplink and 50 percent downlink - set at timing master). When two BH pairs are configured back-to-back in a daisy chain configuration, they each need to be configured for symmetrical load with 50 percent allocated for uplink and downlink. Each BH Module receives its 24VDC power from a 110-power supply or the 90V-230V switching power supplies (ACPSSW-01) and associated RJ45 connector. The BH Module can also be connected to the CMM, which will supply power to the BH Module and networking with the AP Modules at the AP Cluster.

2.4 GHz Channels of Canopy

Channel selections for the AP in the 2.4-GHz band depend on whether the AP is deployed in cluster. Channel selections for the BH are not similarly limited.

2.4-GHz BH and Single AP Available Channels

A BH or a single 2.4-GHz AP can operate in the following channels, which are separated by only 2.5-MHz increments. (All Frequencies in GHz)

Table 4.1:2.4 BH Channel Frequencies

| | | | |
|--------|--------|--------|--------|
| | | | |
| 2.4150 | 2.4275 | 2.4400 | 2.4525 |

| | | | |
|--------|--------|--------|--------|
| 2.4175 | 2.4300 | 2.4425 | 2.4550 |
| 2.4200 | 2.4325 | 2.4450 | 2.4575 |
| 2.4225 | 2.4350 | 2.4475 | |
| 2.4250 | 2.4375 | 2.4500 | |

5.2-GHz Channels

Channel selections for the AP in the 5.2-GHz band depend on whether the AP is deployed in cluster. Channel selections for the BH are not similarly limited.

5.2-GHz BH and Single AP Available Channels

A BH or a single 5.2-GHz AP can operate in the following channels, which are separated by 5-MHz increments as advised in the caution above. (All Frequencies in GHz)

Table 4.2:5.2 BH Channel Frequencies

| | | | |
|-------|-------|-------|-------|
| | | | |
| 5.275 | 5.290 | 5.305 | 5.320 |
| 5.280 | 5.295 | 5.310 | 5.325 |
| 5.285 | 5.300 | 5.315 | |

5.7-GHz Channels

Channel selections for the AP in the 5.7-GHz band depend on whether the AP is deployed in cluster. Channel selections for the BH are not similarly limited.

5.7-GHz BH and Single AP Available U-NII Channels

A BH or a single 5.7-GHz AP can operate in the following U-NII channels, which are separated by 5-MHz increments as advised in the caution above. (All Frequencies in GHz)

Table 4.3: 5.7 BH Channel Frequencies

| | | | |
|-------|-------|-------|-------|
| 5.745 | 5.765 | 5.785 | 5.805 |
| 5.750 | 5.770 | 5.790 | |

| | | |
|-------|-------|-------|
| 5.755 | 5.775 | 5.795 |
| 5.760 | 5.780 | 5.800 |

5.8 Bandwidth Management (Uplink/Downlink with Access Point)

- Communications to/from AP are named the uplink and downlink
- Uplink/Downlink bandwidth is a network-operator setting
- Downlink/uplink bandwidth is stated as a ratio
- Although the default ratio is 75%/25%, the ratio is operator configurable
- Many internet applications will use a large downlink and small uplink
- This represents normal internet data flows
- Applications like surveillance will need larger uplink versus downlink
- Low-bit-rate video works well in this scenario
- Two-way video or voice services use symmetrical bandwidth
- A system can be configured to offer 50:50 ratios for bandwidth

5.9 GPS Meter

The Global Positioning System (GPS) is a satellite-based navigation system that allows land, sea, and airborne users to determine their exact location, velocity, and time 24 hours a day, in all weather conditions, anywhere in the world. . 24 GPS satellites (21 active, 3 spare) are in orbit at 10,600 miles above the earth. The satellites are spaced so that from any point on earth, four satellites will be above the horizon. Each satellite contains a computer, an atomic clock, and a radio. With an understanding of its own orbit and the clock, the satellite continually broadcasts its changing position and time.

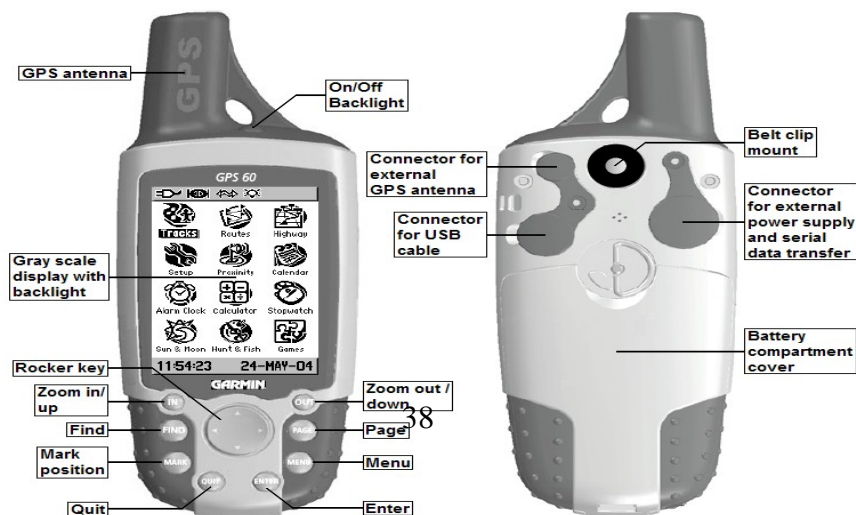


Figure 5.13: GPS meter

If the receiver is also equipped with a display screen that shows a map, the position can be shown on the map. If GPS holder is moving, his receiver may also be able to calculate his speed and direction of travel and give him estimated times of arrival to specified destinations. Some specialized GPS receivers can also store data for use in Geographic Information System (GIS) and map making.

Chapter 6

Site Survey and Radio Connectivity

6.1 Site Survey

A site survey is a task-by-task process by which the surveyor discovers the RF behavior, coverage, interference, and determines proper hardware placement in a facility. The site survey's primary objective is to ensure that RF signal strength as they move around their facility. At the same time, clients must remain connected to the host device or other mobile computing devices and their work applications. Proper performance of the tasks listed in this section will ensure a quality site survey and can help achieve a seamless operating environment every time.

During the site survey process, the surveyor will ask many questions about a variety of topics, which are covered in this chapter. These questions allow the surveyor to gather as much information as possible to make an informed recommendation about what the best options are for hardware, installation, and configuration of a RF Connection.

Though a surveyor may be documenting the site survey results, another individual (possibly the RF design engineer) may be doing the site survey analysis to determine best placement of hardware. Therefore, all of the results of the entire survey must be documented.

A proper site survey provides detailed specifications addressing coverage, interference sources, equipment placement, power considerations, and wiring requirements. Furthermore, the site survey documentation serves as a guide for the network design and for installing and verifying the wireless communication infrastructure.

6.1.1 Preparing for a Site Survey

The planning of a RF Connection involves collecting information and making decisions. The following is a list of the most basic questions that must be answered before the actual physical work of the site survey begins

- Existing Networks
- Area Usage & Towers
- Purpose & Business Requirements
- Bandwidth & Roaming Requirements
- Available Resources

6.1.2 Outdoor Surveys

Outdoor site surveys will take more time, effort, and equipment than will indoor surveys, which is another reason that planning ahead will greatly improve productivity once on site. If a survey to create an outdoor RF link is being done, obtain the appropriate antennas, amplifiers, connectors, cabling, and other appropriate equipment before arriving. Generally, the more experienced site surveying professionals do the outside site surveys because of the more complex and involved calculations and configuration scenarios that are necessary for outdoor connection.

6.2 Line of Sight (LOS)

An RF signal in space is attenuated by atmospheric and other effects as a function of the distance from the initial transmission point. The further a reception point is placed from the transmission point, the weaker is the received RF signal. [6]

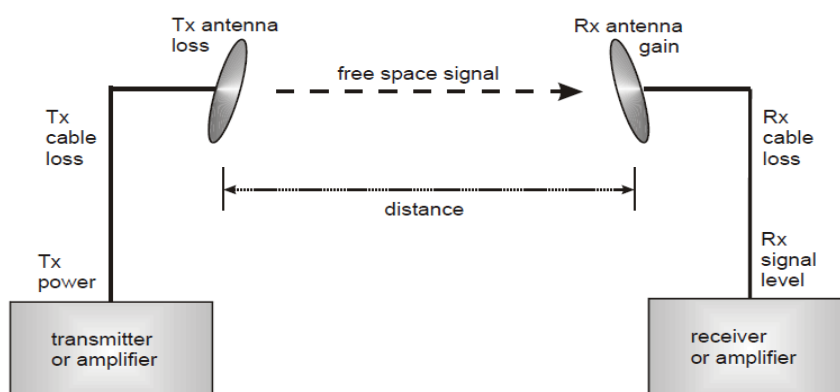


Figure 6.1: Line of Sight

Free space path loss is a major determinant in Rx (received) signal level. Rx signal level, in turn, is a major factor in the system operating margin (fade margin), which is calculated as follows:

System operating margin = Rx signal level – Rx sensitivity

6.2.1 Fresnel Loss

The Fresnel Zone is a theoretical three-dimensional area around the line of sight of an antenna transmission. Objects that penetrate this area can cause the received signal strength of the transmitted signal to fade. Out-of-phase reflections and absorption of the signal result in signal cancellation.

An unobstructed line of sight is important, but is not the only determinant of an adequate placement. Even where the path has a clear line of sight, obstructions such as terrain, vegetation, metal roofs, or cars may penetrate the Fresnel zone and cause signal loss. an ideal Fresnel zone.

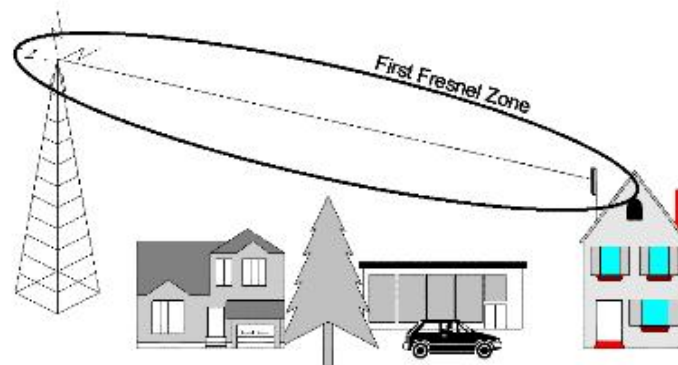


Figure 6.2: Fresnel zone

6.2.2 Loss Due to Foliage

The foliage of trees and plants causes additional signal loss. Seasonal density, moisture content of the foliage, and other factors such as wind may change the amount of loss. Caution should be exercised when a link is used to transmit through this type of environment. .

6.3 Canopy Configurations

The Motorola Canopy Wireless Internet Platform is available in two baseline configurations Point-to-Point and Point-to-Multipoint. The following sections detail these baseline configurations.

6.3.1 Point-to-Point System

The Canopy RF Platform can be configured to form a Point-to-Point network connection that can be used in wireless backhaul, bridging and other data applications. Figure 5.3 shows the point to point system, can span distances up to 35 miles using the Reflector Kit. The Reflector Kit also can significantly reduce external interference issues. Distances of greater than 35 miles can be achieved by daisy chaining the units. The Point-to-Point system operates at 5.7 GHz with a measurable data throughput rates of 2+ Mbps. Motorola also offers a 5.2 GHz Point-to-Point system which has a range of two miles without the reflector kits. [9]

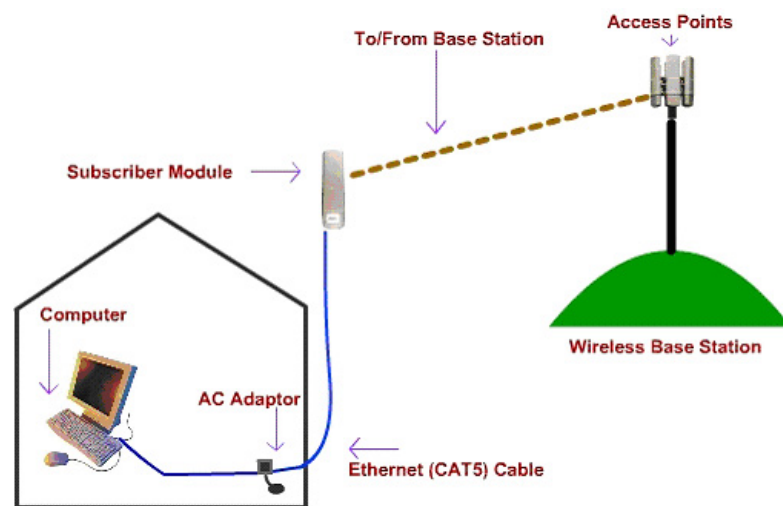
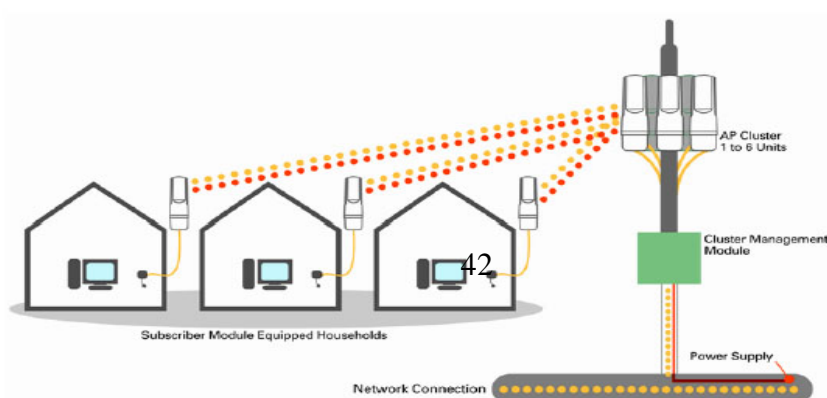


Figure 6.3: Backhaul Module of CANOPY

6.3.2 Point-to-Multipoint System



The
Canopy
Point-to-
Multipoint

configuration is available in either the 5.2 GHz or the 5.7 GHz frequency bands.

Figure 6.4: Point-to-Multipoint system of CANOPY

The 5.7 Point-to-Multipoint configurations can support a 5.7 SM with the reflector kit (27RD). The reflector kit increases the transmit and receive gain of the SM by approximately 17 dB, thereby increasing the range between the AP Module and the SM to approximately 10 miles LOS. The Point-to-Multipoint system enables the delivery of broadband access to multiple locations from a single AP Module. The figure show the point to multipoint system.

Therefore, a Canopy Point-to-Multipoint configuration can be deployed in both rural and metropolitan environments. A wireless AP Cluster can contain anywhere from one to six AP Modules. Each AP Module can deliver up to 6+ Mbps of effective data throughput with connectivity to a maximum of 200subscribers. Six AP Modules in a cluster can deliver 360-degree coverage with approximately two-mile (5.2GHz) or ten-mile (5.7GHz with a reflector) radius. A single SM is capable of a maximum effective data rate of 512+ Kbps.

6.3.3 Channel Plans

Whether utilizing 5.2 GHz or 5.7 GHz modules, frequencies should never be placed closer than 20 MHz. The Canopy modules allow the operator to choose frequencies every 5 MHz. This is so that in the event of co-location with other equipment the operator can customize the channel layout for interoperability.

6.3.4 RSSI

RSSI is initializing for Received Signal Strength Indication. RSSI is a measurement of the received radio signal strength (energy integral, not the quality). All 802.11 cards measure

RSSI in dBm or mW, then use a mathematical formula to convert that to the RSSI value required by 802.11. RSSI is not measured in any sort of unit, as are dBm and dBm

6.3.5 Custom RF Frequency Scan Selection List

Specify the frequency that the SM scans to find the Access Point. The frequency band of the SM affects what channels you should select.

In a 2.4-GHz SM, this parameter displays all available channels, but has only three recommended channels selected by default. In a 5.2- or 5.4-GHz SM, this parameter displays only ISM frequencies. In a 5.7-GHz SM, this parameter displays both ISM and U-NII frequencies. If all the frequencies are selected that are listed in this field (default selections), then the SM scans for a signal on any channel. If only one is selected, then the SM limits the scan to that channel. Since the frequencies that this parameter offers for each of these two bands are 5 MHz apart, a scan of all channels does not risk establishment of a poor-quality link as in the 2.4-GHz band.

6.3.6 Color Code

It is a means for the Canopy System operator to segregate an individual network or neighbor Canopy networks. Also, color code can be used to force a subscriber module to only register to a specific access point module even though the subscriber module may be able to see multiple access point modules, value of color code must be in the range of, 0-254. The color code on the subscriber module and the access point module must match in order for registration to occur. Color code is not a security feature. The default value for this parameter is 0 on all Canopy modules.

6.3.7 Downlink Data

Have to choose the percentage of the aggregate throughput that is needed for the downlink (i.e. going from the access point module to the subscriber). For example, if the aggregate throughput on the access point module is 6 Mbits, then have to configuring this parameter for 75% will allocate 4.5 Mbits for the downlink and 1.5 Mbits for the uplink. If the access point module is in a cluster with other modules then this parameter on all units must be set exactly the same. The default for this parameter is 75%.

6.3.8 High Priority Uplink Percentage

High Priority Uplink Percentage describes the percentage of the uplink bandwidth that will be dedicated to low latency traffic. When set, this percentage of RF link bandwidth will be permanently allocated to low latency traffic regardless of the amount of this kind of traffic present

6.4 Radio link Point To Point AP/SM Configures

Radio links Point to Point Master and slave configure

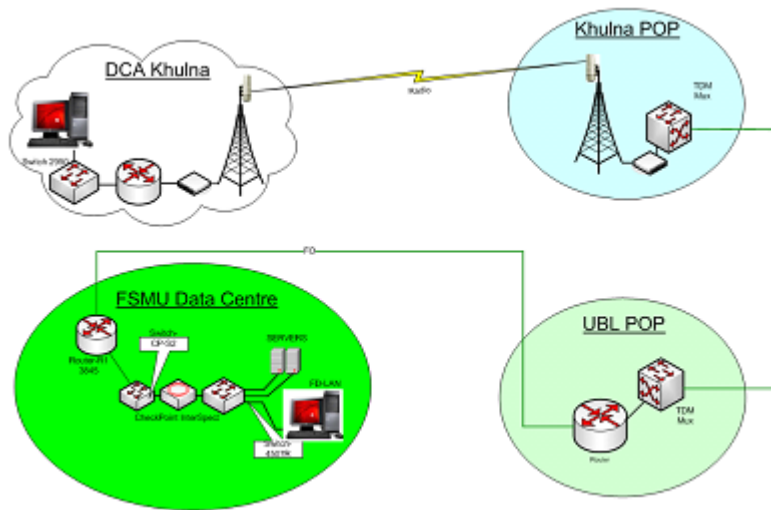


Figure 6.5: Block Diagram of RF connectivity

Configure Radio Modem, Connect it with PC using Cross Cable and set another IP of Modem Block(default = 169.254.1.1) in your LAN Card and browse modem IP from Internet Explorer (without using proxy settings).



| Device Information | |
|--|---|
| 5.2GHz - BackHaul - Timing Slave - 0a-00-3e-01-2b-98 | |
| Parameter | Value |
| Timing Mode | <input type="radio"/> Timing Master <input checked="" type="radio"/> Timing Slave |
| High Priority Data Queue | <input type="radio"/> Enable <input checked="" type="radio"/> Disable |
| Modulation Scheme | 10Mbps/Second (2 Level) |
| Link Negotiation Speeds | <input checked="" type="checkbox"/> 10 Base T Half Duplex <input checked="" type="checkbox"/> 10 Base T Full Duplex <input checked="" type="checkbox"/> 100 Base T Half Duplex <input checked="" type="checkbox"/> 100 Base T Full Duplex |
| Custom RF Frequency Scan Selection List | <input checked="" type="checkbox"/> 5275 <input checked="" type="checkbox"/> 5280 <input checked="" type="checkbox"/> 5285 <input checked="" type="checkbox"/> 5290 <input checked="" type="checkbox"/> 5295 <input checked="" type="checkbox"/> 5300 <input checked="" type="checkbox"/> 5305 <input checked="" type="checkbox"/> 5310 <input checked="" type="checkbox"/> 5315 <input checked="" type="checkbox"/> 5320 <input checked="" type="checkbox"/> 5325 <input type="checkbox"/> None |
| Color Code | 55 |
| Display-Only Access | Password: <input type="text"/> No Password Password: <input type="text"/> |
| Full Access | Password: <input type="text"/> No Password Password: <input type="text"/> |
| Authentication Key | <input type="text"/> (Using All 0xFF's Key) (Only Used if Authentication Required) |

Figure 6.5 (a): Canopy Configuration

1. Select Slave (Clients)
2. Select all Modulation Scheme
3. Set a same Color Code for both end
4. Select all frequency Channel

CANOPY
Motorola Wireless Internet Platform

| | | | |
|-------------------------|--------------------------|---|---|
| Status | Authentication Key | Password: | |
| Configuration | Webpage Auto Update | 3 | Seconds (0 = Disable Auto Update) |
| IP | SM Power Up Mode | <input type="radio"/> | Power up in Aim Mode |
| Configuration | With No 802.3 Link | <input type="radio"/> | Power up in Operational Mode |
| Event Log | Bridge Entry Timeout | 25 | Minutes (Range : 25 -- 1440 Minutes) |
| AP Eval Data | Frame Timing Pulse Gated | <input type="radio"/> | Enable (If SM out of sync then dont propagate the frame timing pulse) |
| Ethernet Stats | | <input type="radio"/> | Disable (Always propagate the frame timing pulse) |
| Copyright | Power Control | <input type="radio"/> | Low |
| Expanded Stats | | <input type="radio"/> | Normal |
| SNMP | | | |
| | Community String | Canopy | |
| | Accessing Subnet | 0.0.0.0 | / 0 |
| | Trap Address | 0.0.0.0 | |
| | Permission | <input checked="" type="checkbox"/> Read Only | |
| Site Information | | | |
| | Site Name | DCA Barisal | |
| | Site Contact | NA | |
| | Site Location | DCA, Barisal | |

Figure 6.5(b): Power Control

5. Power Control Low for Sort distance & Normal for high distance. Figure 5.5(b) Keep information in site information
6. Then start the spectrum analysis for find the low interference frequency. Which frequency is the low interface select it & select other two (preceding & following frequency of the selected frequency(Figure 6.5(c))
- 7.

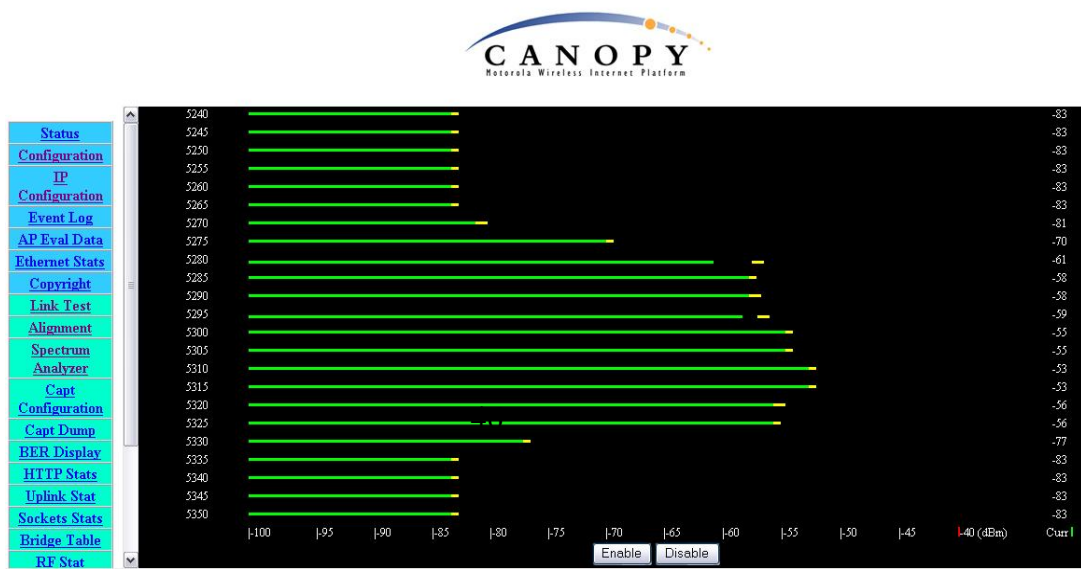


Figure 6.5 (c): Spectrum Analysis

| Device Information | |
|--|---|
| 5.2GHz - BackHaul - Timing Slave - 0a-00-3e-01-2b-98 | |
| Parameter | Value |
| Timing Mode | <input type="radio"/> Timing Master <input checked="" type="radio"/> Timing Slave |
| High Priority Data Queue | <input type="radio"/> Enable <input checked="" type="radio"/> Disable |
| Modulation Scheme | 10Mbps/Second (2 Level) |
| Link Negotiation Speeds | <input checked="" type="checkbox"/> 10 Base T Half Duplex <input checked="" type="checkbox"/> 10 Base T Full Duplex <input checked="" type="checkbox"/> 100 Base T Half Duplex <input checked="" type="checkbox"/> 100 Base T Full Duplex |
| Custom RF Frequency Scan Selection List | <input checked="" type="checkbox"/> 5275 <input checked="" type="checkbox"/> 5280 <input checked="" type="checkbox"/> 5285 <input checked="" type="checkbox"/> 5290 <input checked="" type="checkbox"/> 5295 <input checked="" type="checkbox"/> 5300 <input checked="" type="checkbox"/> 5305 <input checked="" type="checkbox"/> 5310 <input checked="" type="checkbox"/> 5315 <input checked="" type="checkbox"/> 5320 <input checked="" type="checkbox"/> 5325 <input type="checkbox"/> None |
| Color Code | 55 |
| Display-Only Access | Password: <input type="text"/> No Password Password: <input type="text"/> |
| Full Access | Password: <input type="text"/> No Password Password: <input type="text"/> |
| Authentication Key | <input type="text"/> (Using All 0xFF's Key) (Only Used if Authentication Required) |

Figure 6.5 (d): Frequency Selection

7. Select the frequency from frequency list after spectrum analysis show figure 6.5(d)
8. Change IP to 10.10.12.11 / 255.255.255.248 GW: 10.10.12.9, Save and Reboot.



| Device Information | |
|--|-----------------|
| 5.2GHz - BackHaul - Timing Slave - 0a-00-3e-01-2b-98 | |
| Lan1 Network Interface Configuration | |
| IP Address | 10.10.11.11 |
| Subnet Mask | 255.255.255.248 |
| Gateway IP Address | 10.10.11.9 |
| <input type="button" value="Save Changes"/> <input type="button" value="Undo Saved Changes"/> <input type="button" value="Set to Factory Defaults"/> | |
| <input type="button" value="Reboot"/> | |

Figure 6.5 (e): Changing IP & Subnet

9. Now have to go to client Roof with SM and face it to Alap Tower, from laptop browse modem IP and have to see the status, if status is REGISTERED then link is

UP. Now to try to increase RSSI and have to try to decrease jitter with SM tuning (RSSI >1200, Jitter <2) figure 6.5(f). For short distance RSSI must be 43db-60db. For long distance point to point link RSSI 60db to 65db acceptable



| | | |
|----------------|------------------------|--|
| Status | Device Information | |
| Configuration | Device type | 5.2GHz - BackHaul - Timing Slave - 0a-00-3e-01-2b-98 |
| IP | Software Version | CANOPY 7.0.7 Mar 02 2005 15:06:58 BH-DES |
| Configuration | Software Boot Version | CANOPYBOOT 3.0 |
| Event Log | FPGA Version | 020205 (DES) |
| AP Eval Data | Uptime | 04:20:36 |
| Ethernet Stats | System Time | 00:18:59 01/01/2001 |
| Copyright | Ethernet Interface | No Link |
| Expanded Stats | Subscriber Modem Stats | |
| | Session Status | REGISTERED |
| | Registered AP | 0a-00-3e-03-03-96 |
| | RSSI | 1658 (-41 dBm) |
| | Jitter | 2 |
| | Air Delay | 37 (approximately 0.34 miles (1813 feet)) |
| | Site Information | |
| | Site Name | DCA Barisal |
| | Site Contact | NA |

Figure 6.5 (f): Link Status

Distance Coverage

Up to 40 Km good performance, max 45-50 Km but low performance

Performance

: Half duplex, low quality bandwidth, high ping time (22 ms), low data capacity (512 kbps), single modem required because it connects with AP at ISP end.

6.5 Configure Master End

It is similar to slave end configuration

1. In master end configuration we selected the timing master
2. Put the same frequency following slave end, and same color code
3. Then test the link by link test option.
4. Put the ip address in same series
5. Download & Upload efficiency minimum 97% excitable

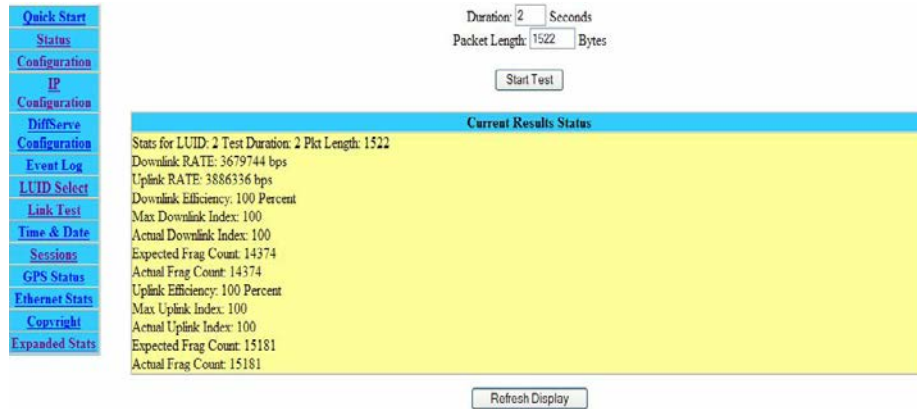


Figure 6.5 (g): Link Efficiency

6. Need to ping both Ends with load for Point to Point test. Then we through traffic in our network
7. After establish point to point link both end can change the parameter remotely

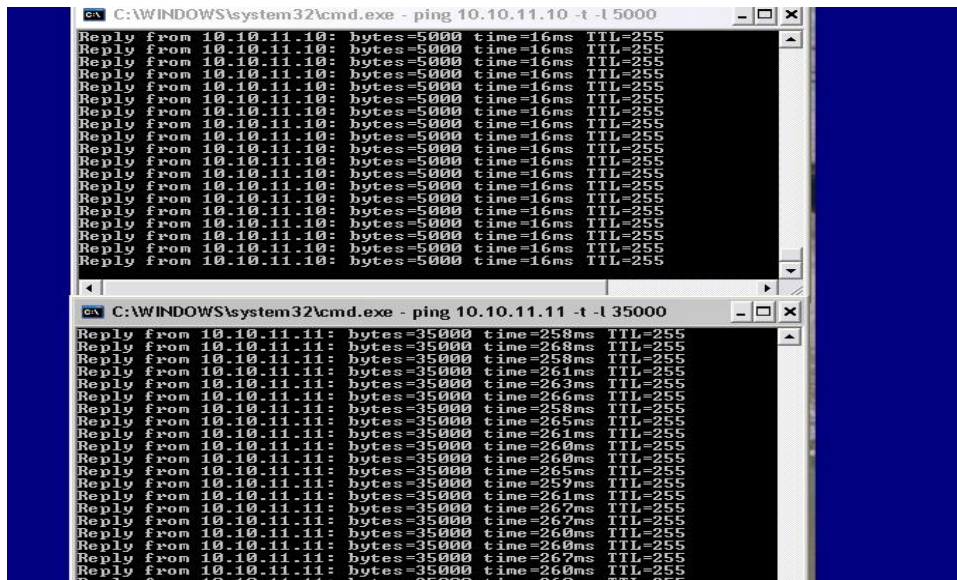


Figure 6.5(h): Point to Point test

Chapter 7

Conclusion

In this report, point to point fiber optic link, install fiber device, monitoring the optical fiber splicing process, maintenance the OTDR have been described. I have initiated the site survey, Canopy, AIRLIVE installation and install these at difference places in Bangladesh as an assistant Network Engineer in RANKS ITT Ltd. Customer support like troubleshooting, IP monitoring have also been supported by me. At the NOC (Network Operation Center) we have monitored our whole network system, and problem identification, initial support to client over phone or physically and update to the responsible supervisor time to time.

Reference

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