UNIVERSITI TEKNIKAL MALAYSIA MELAKA

A ANALYSIS AND SIMULATION OF FIBER TO THE HOUSE (FTTH) AS AN ACCESS TECHNOLOGY IN FIBER OPTIC COMMUNICATION LINK

This report submitted in accordance with requirement of the UniversitiTeknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Electronic Engineering Technology (Telecommunication) with Honours.

by

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DECLARATION

I hereby, declared this report entitled "Analysis and Simulation of Fiber to the House (FTTH) As an Access Technology in Fiber Optic Communication Link." is the results of my own research except as cited in references.

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Date	:	10 DEC 2015

ABSTRACT

This project proposes the design, analysis and measurement of Fiber to the Home (FTTH) then compare the result of calculation, simulation and measurement. The basic principle to design FTTH is Passive Optical Network (PON). The project is mainly focus on the difference of FTTH's parameter between calculation, simulation and measurement. The calculation was considered the power loss, loss budged, splitter loss and coupler performance. The project outcome is to overcome the lack of knowledge about FTTH in UTeM.

ABSTRAK

Projek ini mencadangkan reka, analisis dan pengukuran tentang Fiber to theHome (FTTH) dan kemudianya membandingkan hasil perhitungan, simulasi dan pengukuran. Prinsip rekaan FTTH ini adalah berdasarkan Passive Optical Network (PON). Pengukuran yang terlibat ialah power loss, loss badged, splitter loss and coupler performance. Terutamanya, projek ini adalah fokus pada perbezaan parameter FTTH di antara perhitungan, simulasi dan pengukuran. Keputusan projek untuk mengatasi kurangnya pengetahuan tentang FTTH di UTeM..

DEDICATIONS

This humble effort specially dedicated to my beloved parents, family, lecturers and friends, whose love can never be forgotten for their support, guidance and encouragement upon completing this project and report.

Special dedicated to my parents

MAT KILA BIN ABAS

And

ZAMILAH BINTI MAT IL

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LIST OF SYMBOLS AND ABBREVIATIONS

FTTH	-	Fiber-To-The-Home
CATV	-	Cable TV
UTP	-	Unshielded Twisted Pair
PVC	-	Polyvinyl-Chloride
BER	-	Bit Error Rate
STP	-	Shielded Twisted Pair
LED	-	Light Emitting Diode
SMF	-	Single Mode Fiber
LAN	-	Local Area Network
WAN	-	Wide Area Network
MMF	-	Multimode Fiber
AON	-	Active Optical Network
ODN	-	Optical Distribution Network
EFM	-	Ethernet In The First Mile
IEEE	-	Institute Of Electrical And Electronics Engineers
PON	-	Passive Optical Network
CO	-	Central Office
OLT	-	optical line terminal
ONU	-	optical network units
EPON	-	Ethernet-based Passive Optical Network
FTTx	-	fiber to the x'
FTTC	-	fiber to the curb
FTTN	-	fiber to the node
FTTP	-	fiber to the premises

DSL	-	digital subscriber line
Wi-Fi	-	wireless fidelity
HDTV	-	High-definition television
GEM	-	GPON encapsulation method
WDM	-	wavelength division multiplexing
ONT	-	Optical Network Terminals
MAC	-	Media Access Controller
GUI	-	Graphic user interface
PT	-	transmitter power
PB	-	power budget
PR	-	Power receiver
PM	-	Powe Margin
PB	-	Power budget
LL	-	Link Loss
LD	-	Laser Diode

CHAPTER 1

INTRODUCTION

1.0 Project Background

Fiber-to-the-home is a relatively new and fast-growing growing method of providing vastly higher bandwidth to consumers, and thereby enabling more robust video, internet and voice services. Generally, the Fiber-Optic cable is recognized as an excellent transmission medium in telecommunication especially in connection between exchanges. Nowadays, the access links still use copper cable where this hybrid technology would not give optimum performance especially in bit rate. The Fiber to the House (FTTH) is a new technology that covers Fiber-Optic cable from exchanger to user home. With this method, it will give many advantages to the user and provider. This project will analyse the FTTH from the theoretical, design, and measurement aspect. Also, including the analysis of area that is suitable for development of FTTH. The measurements presents including power loss, Bit-rate, and other parameter that play a main role in this project. The task is study literature of FTTH, design consideration of FTTH, animation of FTTH, simulation and measurement of FTTH. FTTH the delivery of a communications signal over optical fiber from the operator’s switching equipment all the way to a home or business, thereby replacing existing copper infrastructure such as telephone wires and coaxial cable.

1.1 Problem Statement

Nowadays, in Malaysia, optical fiber is not fully developed in telecommunication link. Still copper cable is being used between the central office and the subscribers. When copper cable as the telecommunication link, it will be have a problem for people today. Because today it looks like everyone want high speed data, dependable voice service, and high quality video. The speed data was slow and low capacity of data will happen when we used the copper cable.

1.2 Objective

1) To gain more knowledge about FTTH through animation, calculation, design, and simulation.
2) Able to design FTTH network for specific area given.

1.3 Scope

1) Make a demonstration of FTTH in order to explain the FTTH as an access Technology in Fiber-Optic Communication Link by using animation.
2) Design a FTTH with An area specify to parameter by calculation.

1.4 Structure of Report

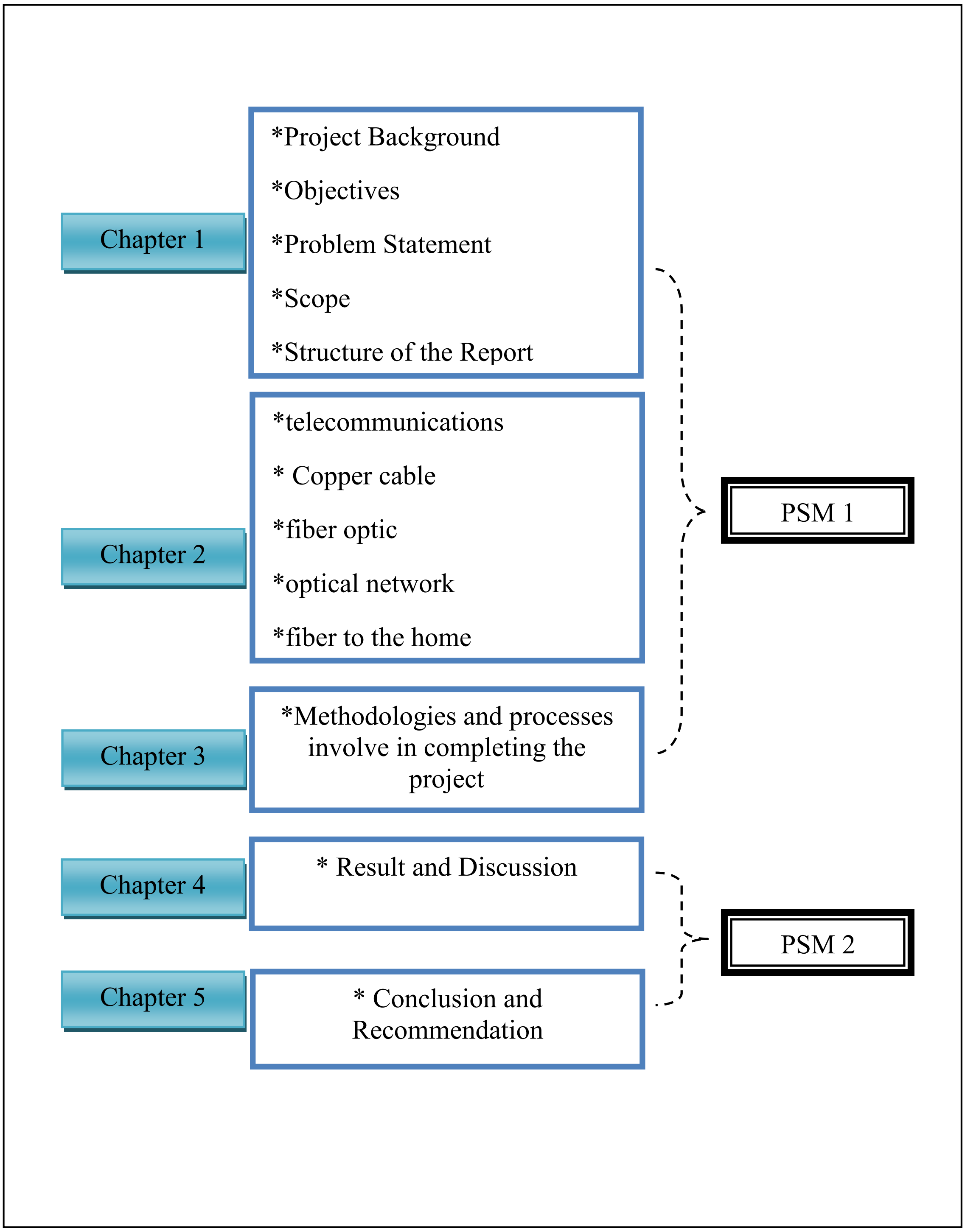

Figure 1.1: Structure of the Report

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction of Telecommunications

The physical path over which the information flows from transmission to receive is called the transmission medium or the channel. Transmission media can be classified into two major categories: wired and wireless. Wired includes different types of copper and fiber optic cables, while wireless includes infrared, radio, microwave and satellite transmission. The performance specifications of cable are important when selecting a specific type of cable to determine its suitability for specific applications (Anu A. Gokhale).

2.1 Copper cables

Copper wire is the most commonly used medium for communications circuits; the oldest installed cables were copper and it is still the most used material for connecting devices. The cost of a cable is a function of the cost of the materials and of the manufacturing process. Thus, cables with larger diameter, involving more copper conductor and more insulation, are more expansive than those with small diameter. The three main types of copper cables include coaxial, unshielded twisted pair (UTP), and shielded twisted pair (STP) (Anu A. Gokhale).

2.1.1 Theory of Shape Based Matching Application

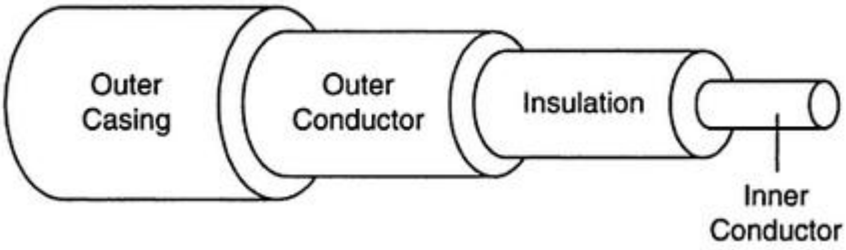

Figure 2.1: Coaxial Cable

Coaxial cable is a two-conductor cable in which one conductor forms an electromagnetic shield around the other; the two conductors are separated by insulation. This is a constant impedance transmission cable. It is primarily used for CATV since it provides a bandwidth of nearly 1GHz into the home. Coaxial cable is used for long distance, low attenuation, and low noise transmission of information (Anu A. Gokhale).

2.1.2 Unshielded Twisted Pair (UTP)

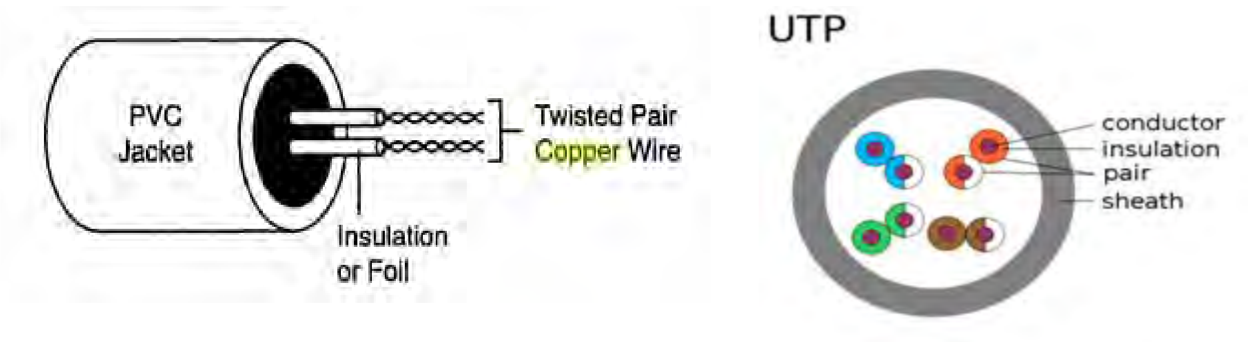

Figure 2.2: Unshielded Twisted Pair (UTP)

Unshielded Twisted Pair (UTP) is the copper media inherited from telephony that is being used for increasingly higher data rates. A twisted pair of copper wires with diameter of 0.4 to 0.8 mm those are twisted together and protected by a thin polyvinyl-chloride (PVC) or Teflon jacket. The twisting increase the electric noise immunity and reduces crosstalk as well as the bit error rate (BER) of the data transmission. UTP is a very flexible, low-cost media and can be used for either voice or data communications. Its greatest advantage is the limited bandwidth, which restricts long distance transmission with low error rates (Anu A. Gokhale).

2.1.3 Shielded Twisted Pair (STP)

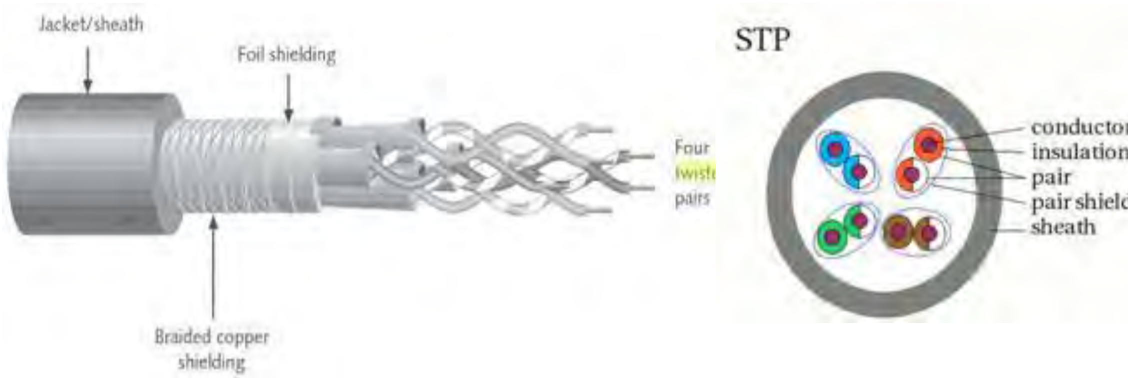

Figure 2.3: Shielded Twisted Pair (STP)

Shielded Twisted Pair (STP) cable consist of twisted wire pairs that are not only individually insulated, but also surrounded by a shielding made of a metallic substance such as foil. Some STP uses a braided copper shielding. The shielding acts as a barrier to external electromagnetic forces, thus preventing them from affecting the signals travelling over the wire inside the shielding. It also contains the electrical energy of the signal inside. The shielding may be grounded to enhance protective effects. The effectiveness of STP's shield depends on the level and type of environment noise, the thickness and material used for the shield, the grounding mechanism, and the symmetry and consistency of the shielding (Tamara Dean, 6th). STP is similar to UTP but with each pair covered by an additional copper braid jacket or foil wrapping. This shielding helps protect the signals on the cables from external interference. STP is more expensive than UTP but has the benefit of being able to support higher transmission rates over longer distances. STP is used in IBM token ring networks (Tamara Dean).

2.1.4 Comparing STP and UTP

The following list highlights their similarities and differences:

1. Throughput
   - STP and UTP can both transmit data at 10Mbps, 100Mbps, 1Gbps, and 10Gbps, depending on the grade of cabling and the transmission method in use.
2. Cost
   - STP and UTP vary in cost, depending on the grade of copper used. Typically STP is more expansive than UTP because it contains more materials and it has a lower demand (Tamara Dean).
3. Noise immunity
   - Because of the shielding, STP is more noise resistance rather than UTP. On the other hand signals transmitted over UTP may be subject to filtering and balancing technique to offset the effect of noise (Tamara Dean, 6th).

2.2 Fiber optic

Optical fiber uses light instead of electricity to carry a signal. It is unique because it can carry high bandwidth signals over long distances without degradation. Copper can also carry high bandwidth, but only for a few hundred yards – after which the signal begins to degrade and bandwidth narrows. Optical fiber has been used in communications networks for more than 30 years, mostly to carry traffic from city to city or country to country.

2.2.1 Fiber Optic Cable

Figure 2.4: A Fiber optic cable

Fiber-optic cable, or simply fiber, contains one of several glass or plastic fibers at its cebter, or core. Data is transmitted via pulsing light sent from a laser or an LED (light emitting diode) through the central fibers. Surrounding the fiber is a layer of glass or plastic called cladding. The cladding has a different density from the glass or plastic in the strands. It reflects light back to the core in pattern that varies depending on transmission mode. This reflection allows the fiiber to bend around corner without diminishing the integrity of the light-based signal. Outside the cladding, a plastic buffer protects the cladding and core. Because the buffer is opaque, it also absorbs any light that might escape. To prevent the cable from stretching, and to protect the inner core further, strand of Kevlar (a polymeric fiber) surround the plastic buffer. Finally, a plastic sheath covers the strands of Kevlar. Fiber cable variations come into two categories: single mode and multimode (Tamara Dean, 6^{th}).

2.2.1.1 Single mode fiber (SMF)

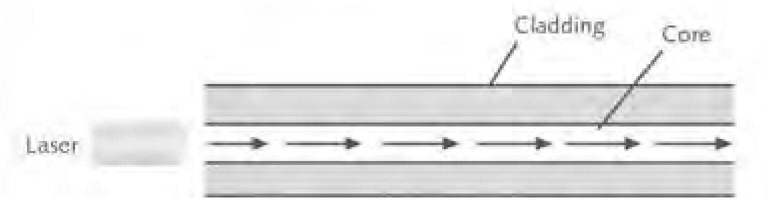

Figure 2.5: Transmission over single mode fiber optic cable

Single mode fiber (SMF) uses a narrow core (less than 10 microns in diameter) through which light generated by a laser travel over one path, reflecting very little. Because it reflects little, the light does not disperse as the signal travels along the fiber. This continuity allows single mode fiber to accommodate the highest bandwidth and longest distance (without requiring repeaters) of all transmission media. Single mode fiber may use to connect a carrier's two facilities. However, it cost too much to be considered for used on typical LANs and WANs.

2.2.1.2 Multimode fiber (MMF)

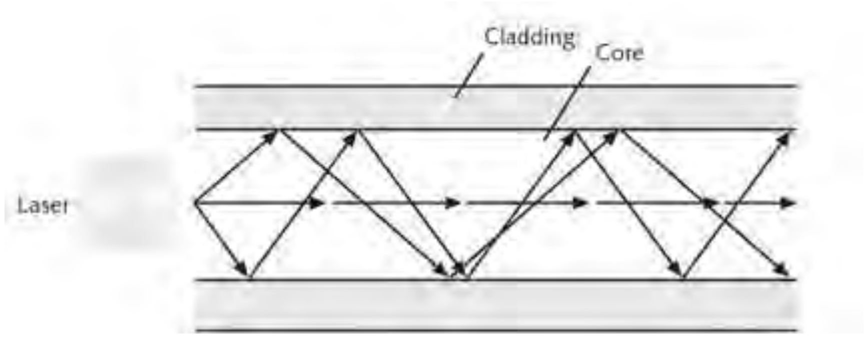

Figure 2.6: Transmission Over Multimode Fiber Optic Cable

MMF (multimode fiber) contains a core with a larger diameter than single mode fiber(between 50 and 115 microns in diameter; the most common size is 62.5 microns) over which many pulses of light generated by laser or LED travel at different angles. It is commonly found on cables that connect a router to a switch or a server on the backbone of a network. Because of its reliability, fiber is currently used primarily as a cable that connects the many segments of a network (Tamara Dean).

Table 2.1: Comparison Single Mode Fiber & Multimode Fiber

Characteristic	Single Mode	Multimode
Bandwidth	Virtually Unlimited	Less than virtually unlimited
Signal Quality	Excellent over long distances	Excellent over short distances
Primary Attenuation	Chromatic Dispersion	Modal Dispersion
Fiber Types	Step Index & Dispersion Shifted	Step & Graded Index
Typical Application	Almost anything (including Ethernet)	Analog Video; Ethernet; Short Range Communications

2.3 Advantages to Choosing Fiber Over Copper Cable

Fiber optic cable is one of the most popular mediums for both new cabling installations and upgrades, including backbone, horizontal, and even desktop applications. Fiber offers a number of advantages over copper.

1. Greater bandwidth

Fiber provides more bandwidth than copper and has standardized performance up to 10 Gbps and beyond. More bandwidth means fiber can carry more information with greater fidelity than copper wire. Keep in mind that fiber speeds are dependent on the type of cable used.

2. Speed and distance

Fiber optic signal is made of light, very little signal loss occurs during transmission, and data can move at higher speeds and greater distances. Fiber does not have the 100-meter (328-ft.) distance limitation of unshielded twisted pair copper (without a booster). Fiber distances depend on the style of