UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND ANALYSIS OF NUMBERING SYSTEM IN FIBRE TO THE HOME (FTTH) SYSTEM

This report is submitted in accordance with the requirement of Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Telecommunications) with Honours. The member of the supervisory is as follows:

…….

(Project Supervisor)

ABSTRACT

Fibre to the Home (FTTH) is an emerging technology that is capable of providing high speed multimedia services directly to customers at their premises. FTTH uses fibre optics entirely, which are widely used today in telecommunications to cope with the increasing demand for high speed and large capacity data transmission. In FTTH, optical fibres are connected directly to the subscribers from an operator's switching equipment, instead of using copper cables alone or hybrid technology. This study is carried out to gain more awareness regarding Fibre to the Home (FTTH), particularly its numbering or addressing system, since the current level of knowledge concerning the addressing system of FTTH is seriously lacking and FTTH addressing may be quite difficult to comprehend. In this project, a numbering or addressing format for FTTH is proposed by scrutinizing books and research papers, and subsequently creating an animation, as well as a GUI or simulation on the topic. All these data collected are then analysed to produce a guide plan on the numbering or addressing system for FTTH and subsequently, the calculations concerning FTTH addressing are also performed. The results obtained from this study will enable the proper design of FTTH addressing for all subscribers.

Keywords: Fibre to the Home (FTTH), numbering, addressing

ABSTRAK

Gentian ke rumah (FTTH) merupakan teknologi baru yang mampu menyediakan perkhidmatan multimedia berkelajuan tinggi terus kepada pelanggan di premis mereka. FTTH menggunakan gentian optik sepenuhnya, yang digunakan secara meluas pada hari ini dalam telekomunikasi untuk menampung permintaan yang semakin meningkat untuk penghantaran data berkelajuan tinggi dan berkapasiti besar. Dalam FTTH, gentian optik disambungkan terus kepada pelanggan dari peralatan pensuisan pengendali, dan bukannya menggunakan kabel tembaga atau teknologi hibrid. Kajian ini dijalankan untuk memupuk lebih kesedaran mengenai gentian ke rumah (FTTH), terutamanya penomboran atau alamat, kerana tahap pengetahuan semasa mengenai sistem pengalamatan FTTH tidak mencukupi dan mungkin agak sukar untuk difahami. Dalam projek ini, satu penomboran atau format alamat untuk FTTH akan dicadangkan dengan mencari buku-buku dan kertas penyelidikan, dan seterusnya mereka animasi, serta GUI atau simulasi mengenai topik ini. Semua data yang dikumpul kemudiannya dianalisis untuk menghasilkan pelan panduan penomboran atau sistem alamat untuk FTTH dan seterusnya, pengiraan berkaitan alamat FTTH juga dilakukan. Keputusan yang diperolehi daripada kajian ini akan membolehkan rekaan pelan penomboran atau alamat FTTH yang betul untuk semua pelanggan.

Kata kunci: gentian ke rumah (FTTH), penomboran , alamat

DEDICATION

This paper is dedicated to my dearly loved parents, lecturers and friends for their unrelenting support and encouragement during the completion of this report.

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I would like to express my gratitude to my project supervisor, Mr. Chairulsyah bin Abdul Wasli for his guidance to ensure that this project runs efficiently. I would also like to thank co-supervisor Mdm. Siti Asma binti Che Aziz for the knowledge she imparted. This report would not have been possible without the invaluable assistance that they have provided.

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AFRINIC	-	African Network Information Centre
AON	-	Active Optical Network
APNIC	-	Asia-Pacific Network Information Centre
ARIN	-	American Registry for Internet Numbers
ATM	-	Asynchronous Transfer Mode
BPON	-	Broadband passive optical network
CAPEX	-	Capital Expenditure
CO	-	Central Office
DHCP	-	Dynamic Host Configuration Protocol
DHCPv6	-	Dynamic Host Configuration Protocol version 6
DSL	-	Digital subscriber line
DSLAM	-	DSL access multiplexer
EPON	-	Ethernet passive optical network
EUI	-	Extended Unique Identifier
FBT	-	Fused bi-conic taper
FEC	-	Forward Error Correction
FTTB	-	Fibre to the building
FTTC	-	Fibre to the curb
FTTH	-	Fibre to the home
GEM	-	GPON Encapsulation Method
GPON	-	Gigabit passive optical network
GUI	-	Graphical user interface
IEEE	-	Institute of Electrical and Electronics Engineers
IHL	-	Internet Header Length
IP	-	Internet Protocol
IPv4	-	Internet Protocol version 4
IPv6	-	Internet Protocol version 6
ISP	-	Internet service provider
ITU-T	-	Telecommunication Standardization Sector
LACNIC	-	Latin America and Caribbean Network Information Centre

LAN	-	Local area network
MAC	-	Media access control
MDUs	-	Multi-Dwelling Units
NAT	-	Network Address Translation
NIC	-	Network Interface Card
ONT	-	Optical network terminal
ONU	-	Optical Network Units
OPEX	-	Operational Expenditure
OSI	-	Open Systems Interconnection
OSP	-	Outside Plant
P2MP	-	Point-to-multipoint
P2P	-	Point-to-point
PDU	-	Protocol data unit
PON	-	Passive optical network
POP	-	Point of Presence
QoS	-	Quality of Service
RIPE NCC	-	Réseaux IP Européens Network Coordination Centre
RIR	-	Regional Internet address Registry
ROM	-	Read-only memory
SFUs	-	Single Family Units
SLAAC	-	Stateless Address Autoconfiguration
SONET	-	Synchronous Optical Networking
TOS	-	Type of Service
ULA	-	Unicast local address
VDSL2	-	Very-high-bit-rate digital subscriber line 2
Wi-Fi	-	Wireless Fidelity
WiMAX	-	Worldwide Interoperability for Microwave Access

CHAPTER 1
INTRODUCTION

1.0 Project Background

Fibre to the Home (FTTH) is a rising innovation that provides rapid interactive media benefits directly to clients at their premises. FTTH utilizes fibre optics totally, which are generally utilized today as a part of information transfer to adapt to the expanding interest for rapid and vast information transmission. Users are connected directly to the switching equipment of the operator via dedicated fibres. At the moment, the level of knowledge concerning the numbering or addressing of FTTH is deficient. IP addresses have developed from IPv4 up to the latest IPv6. The current addressing format used in FTTH may be a mixture of IPv4 and IPv6, depending on the service provider. The size of an IPv4 address is 32 bits while that of an IPv6 address is 128 bits, which is four times larger (Lammle, 2011). Since IPv6 addresses are very large, they cannot be represented in binary format like its predecessor the IPv4, and thus written in hexadecimal form. In this paper, a new addressing format will be introduced especially for FTTH, although the proposed format can also be applied in other FTTx architectures. This new addressing format should be simpler and has a shorter length. The size chosen for this new address format would be based on the overall population growth and should be sufficient to deal with the demand for IP addresses for years to come.

1.1 Problem Statement

Currently, FTTH addressing technology is still difficult for students and the laymen to understand. Also, there is no addressing technology that is used specifically for FTTH. The current pool of IPv4 addresses is depleting while the size of IPv6 is considered too large.

1.2 Objective

1. To study about FTTH in terms of theory, design and measurement especially in numbering or addressing system.
2. To propose a simplified numbering or addressing format for FTTH.
3. To create an attractive animation and interactive GUI regarding FTTH numbering or addressing system.

1.3 Scope

This project will focus on studying the literature on fibre optics and Fibre to the Home (FTTH) addressing. This project also encompasses the creation of an attractive animation which will explain the basics of FTTH, and also the creation of an interactive GUI on the addressing of FTTH by using MATLAB software. In addition, the calculation related to FTTH addressing will be found in this study. Lastly, a thesis on this project will be written and submitted to the supervisor.

1.4 Structure of Report

This report consists of five chapters. Chapter 1 is the introductory chapter to this thesis. Chapter 2 contains the literature review on research papers and books related to fibre to the home and its addressing. Chapter 3 is based on the methodologies that are involved in for the completion of this project. Chapter 4 is a section on all the results gathered and a thorough discussion on them. Finally, Chapter 5 consists of a conclusion on this project and future recommendations that can be made by other researchers who wish to improve this study.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

Fibre optics function by propagating light through transparent dielectric waveguides. They are used to transmit data from one point to another. Fibre optics has become the leading communication system used due to the need for a low loss transmission medium, and lightweight transmitters and receivers. The overall duration of transmission and bit rate-distance product required have also increased (Bagad, 2013). Since the development of fibre optics, bandwidth consumption has increased. Factors that affect bandwidth consumption include culture, climate, local infrastructure and distance (Girard, 2005). To deal with this demand, FTTH can be used for high or ultra-high speed access technologies (Salgado, et al., 2016).

2.1 Fibre to the Home (FTTH)

In a fibre to the home (FTTH) network, end users are connected to an access node or point of presence (POP), which is the central point. The active electronic transmission equipment is placed in every access node in a region, which is linked to a bigger fibre network. Fibre-based access networks can connect to fixed wireless network antenna, for instance, wireless LAN or WiMAX, mobile network base stations, subscribers in SFUs (single family units) or MDUs (multi-dwelling units), big buildings for example schools and businesses, and security assemblies such as surveillance cameras and security alarms (Salgado, et al., 2016). Figure 2.1 shows a basic FTTH deployment. From the optical line terminal (OLT), fibres are split to optical network terminals (ONT) that are located at customer premises using splitters.

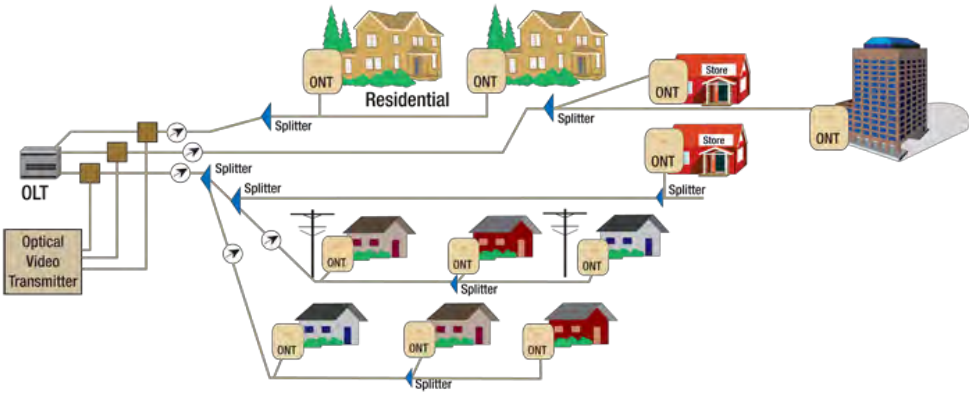

Figure 2.1: Basic FTTH deployment

2.1.1 FTTH network environment

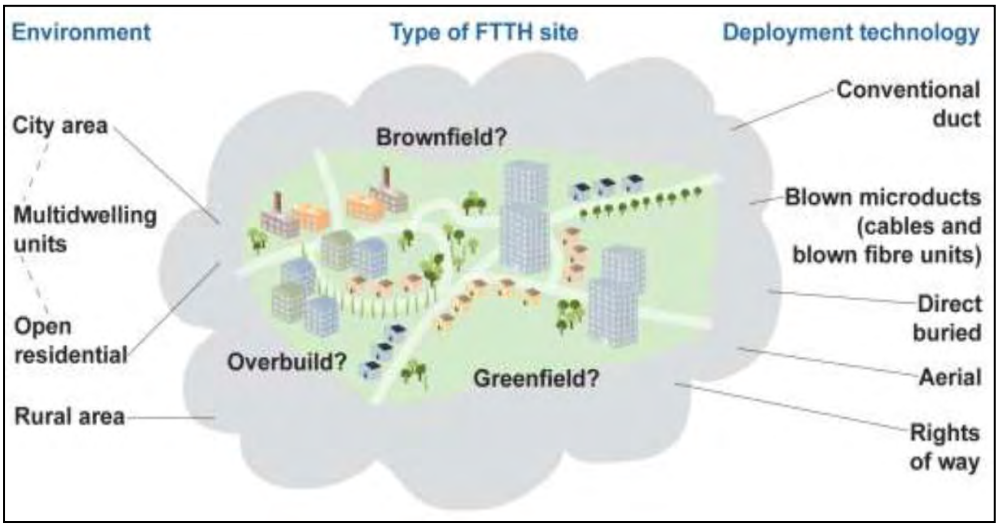

Figure 2.2: Type of FTTH site

Figure 2.2 shows the type of FTTH site. The physical environment can be divided into four main categories (Salgado, et al., 2016):

- City area
- Type of building and density, that is, multi-dwelling units or single units
- Open residential
- Rural area

Subscriber dwelling densities (per sq km) and the country conditions in which they are located must be considered. When choosing the most suitable network design and architecture, the characteristics of the site plays an important role. The three main types of sites are:

- Greenfield – a new construction where the buildings and network are installed at the same time
- Brownfield – buildings have already been built but the existing infrastructure has a low standard
- Overbuild – the existing infrastructure is added with other constructions

The method of infrastructure usage depends on the type of FTTH site, FTTH network size, preliminary expenditure of the infrastructure deployment (CAPEX), network operation and maintenance's (OPEX) management expenses, the network architecture (PON or Active Ethernet), and local conditions, such as local manpower costs, local authority limitations (traffic control).

The major requirements for a FTTH network are:

- Providing services and content with high-bandwidth to every subscriber
- A network architecture plan with a capacity that is adaptable to future requirements
- Provides support network upgrades and development
- Deployed with minimum disturbance in order to increase network operators' reception of FTTH and let subscribers enjoy its benefits

2.1.2 FTTx Network Architecture

There are a variety of network architectures, but the choice solely depends on the needs of the network provider, businesses and technical

priorities. (Salgado, et al., 2016). Figure 2.3 shows the different types of FTTx networks.

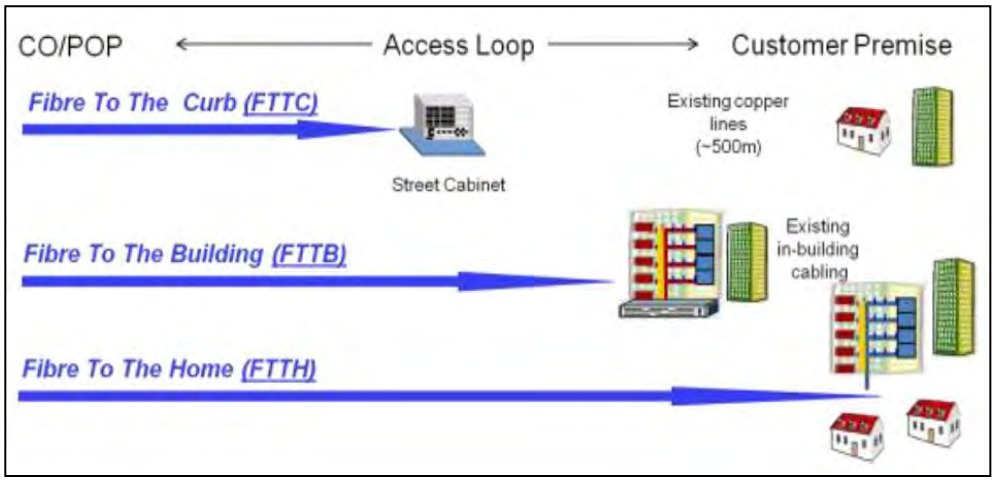

Figure 2.3: Different types of FTTx networks

Fibre to the home (FTTH) – A dedicated fibre is used to connect every subscriber to a port which is located in the POP or passive optical splitter. The feeder fibre is shared to the POP. Ethernet technology uses 100BASE-BX10 or 1000BASE-BX10 transmission while point-to-multipoint topology uses GPON (EPON) technology.

Fibre to the building (FTTB) – A dedicated fibre is used to connect every optical termination box located in the building to a port which is located in the POP or passive optical splitter. The optical termination box is usually placed in the basement of the building. Similar to FTTH, the feeder fibre is shared to the POP. Copper wires are used to connect subscribers to the building switch and Ethernet transport is used according to the medium offered in the wiring. Occasionally, building switches are interconnected using the chain or ring topology, and not connected singly to the POP. This is done to make use of the existing fibres set up in specific topologies and to reduce the fibres and ports used in the POP.

Fibre to the curb (FTTC) – A single fibre or a pair of fibres are used to connect each switch or DSL access multiplexer (DSLAM), which are located in street cabinets to the POP. The collective traffic of the locality is

sent via these fibres using Gigabit Ethernet or 10 Gigabit Ethernet connection. Copper is used in the switches in the street cabinets using VDSL2 or VDSL2 Vectoring. This architecture employs active network elements and at times is referred to as “Active Ethernet”.

Out of all these network architectures, only FTTH will be focussed on in this paper.

2.1.3 FTTH Topology and Technology

Currently, point-to-point and point-to-multipoint topologies are the two most extensively employed topologies. Point-to-multipoint is usually joined with a passive optical network (PON) technology while point-to-point normally uses Ethernet transmission technologies.

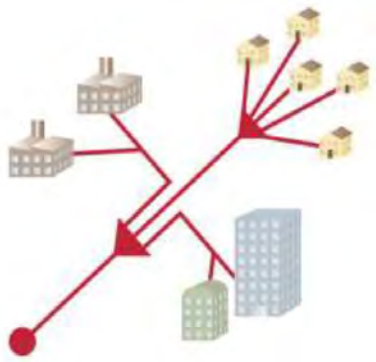

Figure 2.4: Point to Multi-Point (P2MP)

Figure 2.4 shows a basic point-to-multipoint topology. In point-to-multipoint topologies (P2MP), a “feeder” fibre is connected from the central office or POP to a splitter or branching point. From this point, dedicated fibres are deployed to every subscriber. Passive optical splitters are used in GPON and to ensure that subscribers only receive data that should be sent to them, the data is encoded. Similarly, subscriber access can be controlled in P2MP topologies by using Active Ethernet technology, which utilizes Ethernet switches (Salgado, et al., 2016). According to Girard (2005), each PON is connected with more than one ONTs through at least one splitter.