

**EMPIRICAL STUDY ON GPON TECHNOLOGY & GPON OLT
CONFIGURATION WITH TROUBLESHOOTING**

By
TOUFIQUR RAHMAN
ID: 182-19-2039

This Report Presented in Partial Fulfillment of the Requirements for the
Degree of Bachelor of Science in Electronics and Telecommunication
Engineering

Supervised By
Ms. Tasnuva Ali
Assistant Professor
Department of ICE
Daffodil International University



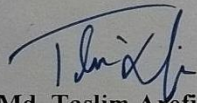
DAFFODIL INTERNATIONAL UNIVERSITY
DHAKA, BANGLADESH
AUGUST 23 2023

APPROVAL

APPROVAL

This Internship Report Titled “**Empirical study on GPON technology & GPON OLT configuration with troubleshooting**” is submitted by Toufiqur Rahman 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 B.Sc. in Electronics and Telecommunication Engineering and approved as to its style and contents. The Presentation was held on 24-09-2023.

BOARD OF EXAMINERS



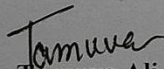
Md. Taslim Arefin
Associate Professor & Head
Department of ETE, DIU

Chairman



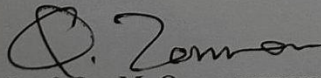
Prof. Dr. A. K. M. Fazlul Haque
Professor
Department of ETE, DIU

Internal Examiner



Ms. Tasnuva Ali
Assistant Professor
Department of ETE, DIU

Internal Examiner



Prof. Dr. M. Quamruzzaman
Professor & Head
Department of EEE, WUB

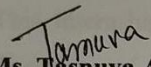
External Examiner

DECLARATION

DECLARATION

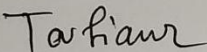
I hereby declare that this Internship Report has been done by me under the supervision of Ms. Tasnuva Ali, Assistant Professor, Department of ICE, Daffodil International University & IQRA Technologies Ltd.

Supervised by:


Ms. Tasnuva Ali

Assistant Professor
Department of ICE
Daffodil International University

Submitted by:


Toufiqur Rahman

ID: 182-19-2039
Department of ETE
Daffodil International University

ACKNOWLEDGEMENT

First, I would like to express my gratitude to Almighty Allah for guiding me on the right path while trying to fulfill my responsibilities. The real spirit of achieving any goal must fulfil responsibility with the way of quality, dedication and austere castigation. I would have never thrived in affecting my task without the teamwork, help of team members & support provided to me by many personalities.

This internship report would not possible to complete without the provision and direction of Ms. Tasnuva Ali. Lecturer, Department of Information and Communication Engineering, Daffodil International University, Dhaka. Under whose direction I chose this topic. I would like to pay my heartiest gratitude to Md. Taslim Arefin, Associate Dean & Associate Professor & Head, Department of Information and Communication Engineering. For his kind help to surface this internship report and also to other faculty participants, the staff of the ICE Department of Daffodil International University must grant with due esteem the perpetual support and endurance of my family members for final this internship.

ABSTRACT

As a fresher network support engineer, Network management is a very challenging career. In telecommunication network management, Network engineers face the challenge of designing a whole network with layer, timely monitoring its performance, and ensuring its security for unexpected threat. This entails dealing with intricate vendor-specific configurations at a granular level to successfully execute sophisticated network policies at a higher efficiency level. Despite numerous prior suggestions aimed at simplifying network management, it is worth noting that several approaches to address network management issues can be considered temporary fixes due to the inherent challenges associated with altering the fundamental infrastructure. Iqra Technologies Ltd stands out as a notable entity within the landscape of prominent corporations in Bangladesh. The primary emphasis of this practicum report is on the central branch of optical fiber communication.

This report comprehensively analyzes the current FTTx network architecture, communication protocols, support and maintenance procedures, security measures, troubleshoots and development strategies employed by Iqra Technologies Ltd.

The current network is adequately structured and has been recently updated. However, this report also acknowledges and discusses certain limits that can be resolved. The issue of network administration is significantly complicated. Build and monitor a network to ensure security; network engineers must deploy cost-effective devices and expert skills to implement high-level network regulations effectively. Nowadays, it's a challenge to maintain additional remedies for addressing network management challenges to avoid temporary solutions. Temporary solutions are not solutions. FTTx network needs a long-term reliable solution.

Table of Contents		Page
Approval		i
Board of Examiners		i
Declaration		ii
Acknowledgement		iii
Abstract		iv

SL.	CHAPTER	Page
Chapter 1 - Introduction		
1.1	Introduction	1
1.2	Internship Objectives	2
1.3	Introduce with IQRA Technologies Ltd.	2
1.4	Mission & Vision of IQRA Technologies Ltd.	3
1.5	IQRA Technologies Ltd. Services	3
1.6	Address of IQRA Technologies Ltd.	4
Chapter 2 - Brief Overview of Networking		
2.1	History of Networking	5
2.2	Hierarchical Network Model	6
2.3	Cabling & Connectors	7
2.4	OSI & TCP/IP Model	9
2.5	Operation of OSI & TCP/IP Model	9
2.6	Layer wise Devices & Protocols	15
2.7	Importance of IP addressing	15
2.8	IPv4 & IPv6 Overview	16
2.9	IPv4 Sub-netting	18
2.10	IPv6 Sub-netting	20
2.11	Topologies	20

Chapter 3 - Brief Overview Modern FTTx Networking

3.1	What is FTTx	24
3.2	EPON & GPON Technology	25
3.3	FTTx Devices	26
3.4	FTTx Accessories	29
3.5	FTTx Tools	31

Chapter 4 - Brief Overview of GPON technology

4.1	GPON Technology	33
4.2	Exclusive features of GPON	33
4.3	GPON working Principle for upstream & downstream	33
4.4	GPON Profiling mechanism	34
4.5	Advantages of GPON	37

Chapter 5 - Troubleshoot & Remotely Client Support

5.1	Default Configuration of New GPON OLT	39
5.2	OLT/ONU Hang and Not working	40
5.3	PON Port/ PON Module Not Working Properly	40
5.4	Configure PON based Services	41
5.5	Check & Find ONU/ONT Status	41
5.6	Check Which ONU Defected & not working properly	42
5.7	ONU Not Passing Traffic	42
5.8	Clear ONU MAC	42
5.9	Bind ONU With a Specific PON Port	43
5.10	Check All The Connected Devices	43
5.11	Firmware Upgradation for OLT	44
5.12	Firmware Upgradation for ONU	44
5.13	VLAN Create, Delete & Assign	44
5.14	Port Wise VLAN For Certain Service	45
5.15	ONU Wise VLAN For Certain Service	45
5.16	Configure Native VLAN Service	45
5.17	Management IP Setup for Remote Access	46

5.18	Loop-back Protection for OLT & ONU	46
5.19	Loop-back Detection and Prevention	46
5.20	Back Laser Warning Activation	47
5.21	Cooling Fan Speed Controlling	47
5.22	OLT CPU Temperature Threshold	47
5.23	Log report Service on for Future Troubleshoot	47
5.24	Check Laser Power for OLT & OLU	48
5.25	Check Log & Find Issues	48
Chapter 6 - Remotely Monitor With NMS		
6.1	What is NMS	49
6.2	Install NMS	49
6.3	Configure NMS	50
6.4	Monitor Devices in NMS	52
Chapter 7 - Conclusion		
7.1	What I've Learned	54
7.2	Overall Experience	54
7.3	Carrier Scope in Future	55
References		56

Figure no.	Table of Figures	Page
Table 2.1	History of internet	5
Figure 2.2	Hierarchical Network Model	6
Figure 2.3	Hierarchical Network Model detail	7
Image 2.4	Coaxial Cable	7
Image 2.5	Twisted-Pair Cable	7
Image 2.6	Optical Fiber	8
Image 2.7	DAC Cable	8
Image 2.8	AOC Cable	8
Images 2.9	Ethernet & Optical cables connectors	9
Table 2.10	Comparison of OSI & TCP	9
Table 2.11	OSI Layer wise device & protocol	15
Table 2.12	Classful IPv4 address	16
Table 2.13	IPv4 Octet calculation	17
Table 2.14	IPv4 range for private usage	17
Table 2.15	IPv4 example calculation	17
Table 2.16	IPv6 Conversion	18
Table 2.17	IPv4 Subnet calculation	19
Figure 2.18	IPv4 Distribution Diagram	19
Figure 2.19	IPv6 Calculation	20
Figure 2.20	Point to Point Topology	20
Figure 2.21	BUS Topology	21
Figure 2.22	RING Topology	21
Figure 2.23	STAR Topology	22
Figure 2.24	TREE Topology	22
Figure 2.25	MESH Topology	23
Figure 2.26	HYBRID Topology	23
Table 3.1	EPON & GPON Specifications	25
Table 3.2	EPON & GPON Power Standard	25
Image 3.3	ECOM 8 port GPON OLT (CDATA OEM)	26

Image 3.4	BDCOM 8port GPON OLT	26
Image 3.5	Dasan 8port GPON OLT	26
Image 3.6	BDCOM Switch	27
Image 3.7	ECOM xPON ONU (CDATA OEM)	27
Figure 3.8	Media Converter SET	27
Image 3.9	BDCOM 4 port HGU	28
Figure 3.10	MikroTik CCR1036-12G-4S	28
Image 3.11	PON Module (EPON)	29
Image 3.12	SFP Module (10G)	29
Image 3.13	Patch cord (SC-SC)	29
Image 3.14	CONSOLE cable with Converter	30
Image 3.15	Splitter (PLC and Cassette type)	30
Image 3.16	TJ Box	30
Image 3.17	Fiber-optic Distribution Box	31
Image 3.18	Splicer Machine	31
Image 3.19	Optical Power Meter	32
Image 3.20	OTDR meter	32
Image 3.21	Crimper Tool	32
Figure 4.1	GPON OLT to endpoint communication	33
Figure 4.2	GPON OLT to ONU communication	33
Figure 4.3	GPON ONU to OLT communication	34
Figure 4.4	GPON profiling	34
Image 4.5	DBA Profile	35
Image 4.6	Type Function	35
Image 4.7	LINE Profile	36
Image 4.8	T-CONT in LINE profile	36
Image 4.9	GEM in LINE profile	36
Image 4.10	SRV (service) Profile	37
Image 4.11	Service port Configure	37
Image 5.1	Default Configuration of GPON OLT	39
Image 5.2	Checking all ONU aspects	40

Image 5.3	Checking PON state	40
Image 5.4	Configure PON Based Services	41
Image 5.5	Checking End Device MAC with ONU	41
Image 5.6	Checking the reason of defected ONU	42
Image 5.7	Checking ONU passing traffic	42
Image 5.8	Clearing all (offline/online) MAC	42
Image 5.9	Binding ONU MAC manually	43
Image 5.10	Checking end users device addresses	43
Image 5.11	Firmware (OLT) Upgrade on WEB	44
Image 5.12	Firmware (ONU) Upgrade on WEB	44
Image 5.13	VLAN Create, Delete & Assign	44
Image 5.14	Port wise VLAN assign	45
Image 5.15	ONU wise VLAN assign	45
Image 5.16	Native VLAN on PON	45
Image 5.17	Setup management IP	46
Image 5.18	Enable Loopback protection	46
Image 5.19	Loopback monitoring	46
Image 5.20	Back laser checking	47
Image 5.21	Cooling FAN configure	47
Image 5.22	Checking CPU temperature	47
Image 5.23	Enable LOG report	47
Image 5.24	Checking ONU laser power	48
Image 5.25	Checking event report	48
Figure 6.1	Install NMS	49
Figure 6.2	Browse localhost:8888	50
Figure 6.3	Configure NMS into OLT	50
Figure 6.4	NMS dashboard	50
Figure 6.5	Configuring OLT in CLI	51
Figure 6.6	Add device into NMS	51
Figure 6.7	Adding info of the OLT into NMS	51
Figure 6.8	Showing the OLT if online	52

Figure 6.9	Access OLT by using NMS	52
Figure 6.10	Inside the OLT by NMS	52
Figure 6.11	All configuration of OLT inside NMS	53
Figure 6.12	Available function of OLT into NMS	53

Chapter 1

Introduction

1.1 Introduction:

Network communication, or Inter-networking are one of the most important parts of every sector of technology. Now these days it's a mandatory element for our daily life. For every business, organizations, research, learn, teach etc in this world today mostly needs a stable & quality computer network communication. In this particular point of view, only reliable equipment can ensure a reliable network communication for smooth operations, user friendly interface to handle, on demand communication, and quickest time to access to information.

Just imagine how difficult it'll be, to communicate with each other if school, college, university campuses, police stations, fire services, hospitals, multinational institutions, and educational institutions etc have no network connection. Whatever changes today's modern worlds scenario is only the enhancement of Network communication technology. Modern telecommunication technology and availability of network rapidly changed the way of business, concept of money transactions, theory of knowledge exchange, security and almost everything. Now, they are highly dependent on Network communication, or Inter-networking.

When a few set of device connects as nodes via wireless or wired medium is called network. Basically, a node is a device that can transmit and receive data to other nodes in a network. There any various types of nodes, such as bridge, switch, hub, modem, computer, printers, and servers computers, printers etc. Using a computer network we can share data with another computer or device anywhere in the globe if the device connected with global network. The best example of a computer network is the Internet.

This report is intended to complement the practice as a Bachelor of Electronics and Telecommunication Engineering requirement at Daffodil International University under IQRA Technologies Ltd. From September 8, 2021, to January 15, 2022. IQRA

Technologies Ltd. Sell FTTx products, Computer accessories, along with the FTTx networking system. Through this work it was possible to gain practical knowledge on Network Management of IQRA Technologies Ltd. With Richerlink OLT and other types of network infrastructure during the internship.

1.2 Internship objective

The main objectives of this internship are:

- Basic configuration of L2 & L3 switches and it's accessories
- Communicate with company clients
- Identify networking issues
- Remotely troubleshooting
- Remotely resolve
- Remotely configuration
- Remotely monitoring

1.3 Introduce with IQRA Technologies Ltd.

IQRA Technologies Ltd. was established on September 5, 2019. IQRA Technologies Ltd. focused on wholesale and the retail business of FTTx products. Also provide solution of FTTx products and it's accessories. We have partnership with Dasan, Richerlink, Syrotech, ZOOOK, Enter, HP, Cisco, PrintPals, Signal Fire, Poly cable, Comfast, LV Switch and many more upcoming. We sell optical fiber, OLT, ONU, OPM, OTDR, Splicer machine, Splitter, Patch cord, and all of it's accessories. Also, we've Monitor, SSD, RAM, Sound Systems and computer accessories. We also provide after sell service and solutions on demand.

We import all of the products directly to ensure quality, minimal cost and high availability. The customer benefits from quality, minimal cost and high availability with reliable throughput of committed content. To ensure original quality of products we directly communicate with every company and make deal.

Recently we're collaborating with HP storage's and Cisco switch's. We're constantly modifying our method just to get the clients satisfactions & grow bigger.

1.4 Mission & Vision of IQRA Technologies Ltd.

Mission:

The major following factors of missions of IQRA Technologies Ltd. just to provide best FTTx & related accessories products and solution with highest quality with minimal cost. That is the main mission of IQRA Technologies Ltd. Also we've focused on more things, such as:

- Build strong customer relationships to support to our community.
- Provide cutting-edge tech, experience & solutions to our clients and partners.
- Ensure the quality of product service.
- To reduce cost we import directly and distribute to local market.
- Maintain a consistently high level of efficient service.
- Maximum return on investment from new Total Cost of Ownership.
- Provide Outstanding support for our products.
- After selling service and warranty issue provide as the manufacturer company.
- From the Social responsibility, Provide paid internship opportunity to students.

Vision:

Provide readily available service for any FTTx products is our vision. That's why our slogan is "Quality is our Mission. Service is our Vision".

1.5 IQRA Technologies Ltd. Services

The services offered by IQRA Technologies Ltd. are shown below:

- OLT Troubleshoot
- ONU Troubleshoot
- Manageable Switch Troubleshoot
- Unmanageable Switch Troubleshoot
- L2 & L3 Switch Troubleshoot
- Splicer Machine Troubleshoot
- Security Surveillance Implement & Troubleshoot
- Sound System Solution
- NIC Card Solution

- OTDR Troubleshoot
- OPM Troubleshoot

1.6 Address of IQRA Technologies Ltd.

Corporate Office:

308 Shaheed Janani Jahanara Imam Shoroni, Elephant Road, Dhaka-1205

Email: iqratechbd@gmail.com

Call: +8801318313837-38

IQRA Technologies Ltd.

Showroom:

Shop #319 (2nd Floor), Bangabandhu National Stadium Super Market, Dhaka-1000

Call: +88 01318344 874

Support:

Email: support@iqratech.com.bd

Call: +8809170010

Chapter 2

Brief Overview of Networking

2.1 History of Networking

The history of modern computer networking technology started with ARPANET (Advanced Research Projects Agency Network). It was established in 1969, marking the beginning of modern computer networking technology. It put into practice the TCP/IP protocol family, which later developed into the Internet. The Internet is regarded as having its official birthday on January 1, 1983.

Table 2.1 : History of internet

Year	Milestone
1881	Twisted-pair cable first invented by Alexander Graham Bell
1957	Advanced Research Project Agency formed by US
1965	Fiber-optic demonstrated for transmitting data by German physicist Manfred Börner at Telefunken Research
1969	ARPANET became functional. Telenet is invented
1970	ARPANET connected to BBNs, TCP/IP model first introduced
1971	Ray Tomlinson invented & developed E-Mail
1973	ARPANET connected to Royal Radar Network of Norway
1974	ARPANET became commercial. Also, Telenet is approved to use widely
1980	ISP companies were formed. Companies like PSINet, UUNET, Netcom etc
1982	TCP/IP introduced as standard protocol on ARPANET
1983	DNS & OSI model first introduced
1986	NSF Foundation brings connectivity to more people with its NSFNET
1989	Web 1.0 first introduced
1990	ARPANET decommissioned, Web browser Nexus & HTML developed
2004	Web 2.0 first introduced
2006	Web 3.0 first introduced
2020	Sum of global mobile users data traffic reached at 588 exabytes per second

2.2 Hierarchical Network Model

A hierarchical network model in networking separates a vast network into definitive parts of layer. Where, every individual layer has certain type of functionality. Which define it's vital key role in any type of network infrastructure. With this hierarchical network model limited resources can utilize perfectly by any network designer.

Resource like as layer 3 and layer 2 hardware, software implementation, advance features, power consumption calculations, link budget calculations, maintenance cost issues, security issues, redundancy facilities, quality of service will take a vital role for any network layer. Also, this hierarchical network model standard model for telecommunication network.

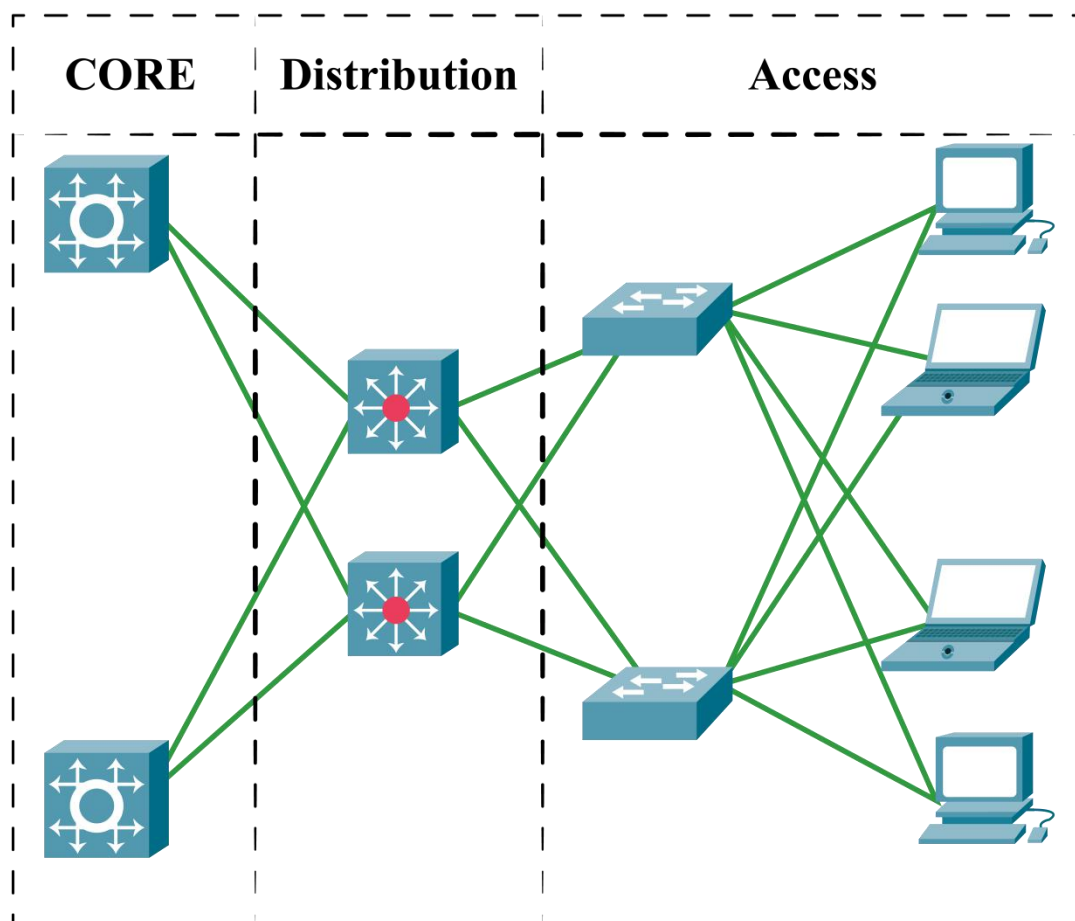


Figure 2.2 : Hierarchical Network Model

The following table shows the Hierarchical Network Model:

Table 2.3 : Hierarchical Network Model detail

Layer	Description	Device
Core	It's backbone of a network. It's responsible for fast transport between distribution switches in the network	Firewall, Router
Distribution	Here endpoints & local servers access the network. Sometimes it referred as the Workstation layer	Router, Switch
Access	Here endpoints & local servers access the network. Sometimes it referred as the Workstation layer	End devices

2.3 Cabling & Connectors

Coaxial Cable: Contains a conductor, insulator, braiding & sheath. Sheath covers braiding, braiding covers insulation, and insulation covers conductor. 2 types of Coaxial Cable:

Single core - uses a single central metal (usually copper) conductor

Multi core - uses multiple thin strands of metal wires



Image 2.4 : Coaxial Cable

Twisted-pair Cable: Also known as Ethernet cable. 2 types of twisted-pair cable:

UTP - Unshielded, all pairs are wrapped in a single plastic sheath.

STP - Shielded, each pair is wrapped with an additional metal shield, then all pairs are wrapped in a single outer plastic sheath.

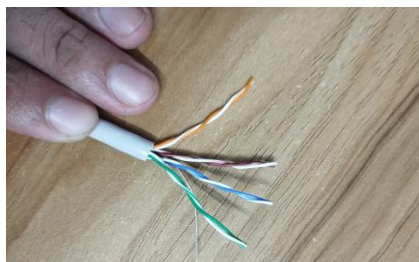


Image 2.5 : Twisted-Pair Cable

Fiber optic cable: It has a core, cladding, buffer, and a jacket. The core is made from thin glass. Core is wrapped in cladding, Cladding wrapped in buffer, buffer wrapped in jacket. 2 types of Fiber optic cable:

SMF - Single mode. Carry 1 beam of light. Transmits 1300/1550nm wavelengths.

MMF - Multi mode. Carries multiple beams. Transmits 850 or 1300nm wavelengths.

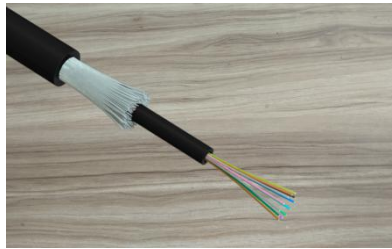


Image 2.6 : Optical Fiber

Also there's more special types of cable:

DAC Cable - Direct Attach Copper cable.



Image 2.7 : DAC Cable

AOC Cable - Active Optical Cables.



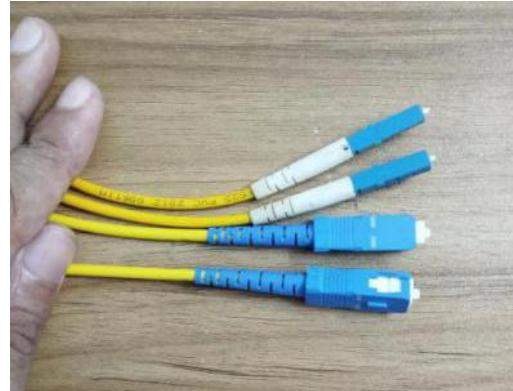
Image 2.8 : AOC Cable

Connectors:

Ethernet cable uses RJ45 & Optical fiber mostly use LC, SC, FC & ST connectors.



(A) RJ-45



(B) LC, SC, FC, ST

Image 2.9 : Ethernet & Optical cables connectors

2.4 OSI & TCP/IP Model

The OSI Reference model is the main model. But still whole world's networking follow TCP/IP. The table shows OSI & TCP/IP model & it's comparison of layers.

Table 2.10 : Comparison of OSI & TCP

SL	OSI Model		TCP/IP Model	
	Layer	PDU	Layer	PDU
L7	Application	Data	Application	Data
L6	Presentation	Data		
L5	Session	Data		
L4	Transport	Segment (TCP) Datagram (UDP)	Transport	Segment (TCP) Datagram (UDP)
L3	Network	Packet	Network	Packet
L2	Data Link	Frame	Data Link	Frame
L1	Physical	Bit	Physical	Bit

2.5 Operation of OSI & TCP/IP Model Layers

Here we will describe elaborately that what the responsibility of every layer of OSI & TCP/IP model.

Application Layer:

The Application Layer is identified as the seventh layer within the Open System Interconnection (OSI) model. This layer offers multiple methods for the management of data or information. This feature facilitates seamless network accessibility for users of all types. This layer further generates a request to its first layer. The application layer facilitates user access to the network. This system offers a user interface that facilitates interaction with any data-generating application.

Presentation Layer:

The Presentation Layer is identified as the sixth layer within the Open System Interconnection (OSI) model. This particular layer is commonly referred to as the Translation layer. In network communication, this layer functions as a data translator. The data this layer receives from the Application Layer is retrieved and processed in the necessary format for transmission across the network. The primary role of this layer entails the provision and specification of the data format and encryption. The presentation layer is commonly referred to as the Syntax layer because it ensures the correct syntax of the data it receives or transmits to other layers.

Major function of the Presentation Layer is to determine the compatibility of data format the recipient can interpret. This layer also facilitates data encryption, decryption, and compression and error correction.

Session Layer:

The Session Layer is identified as the fifth layer within the Open System Interconnection (OSI) model. This layer facilitates active communication sessions between users on separate devices. This entity is responsible for establishing, maintaining, synchronizing, and terminating sessions between end-user applications. Within the Session Layer, data streams are received and subsequently segmented, ensuring adequate re-synchronization to prevent initial truncation of message boundaries and subsequent data loss. This layer primarily serves the purpose of establishing a link between the session components. The function of this layer

involves the reception and manipulation of data received from both the Session Layer and the Presentation Layer.

Establish a session that remains active until the transmission or reception of data is fully completed. This layer is responsible for establishing a seamless and error-free transmission of data while maintaining a record of the data for error checking. In the event of an error, the data can be resent from the point at which it was last transmitted.

Transport Layer:

The Transport Layer is identified as the fourth layer within the Open System Interconnection (OSI) model. Firstly, it is necessary to partition the data into segments designed explicitly for Transmission Control Protocol (TCP). Additionally, it is necessary to partition the data into Datagrams when utilizing the User Datagram Protocol (UDP). The Transmission Control Protocol (TCP) receives input regarding the successful transmission of data. However, the User Datagram Protocol (UDP) does not get feedback upon data transmission.

At the sender's end, the transport layer gets the prepared data from the higher layers, carries out segmentation, and incorporates flow and error control mechanisms to ensure accurate data delivery. Additionally, the transport layer incorporates Source and Destination port numbers within its header and transmits the segmented data to the Network Layer.

Typically, the destination port number's assignment is determined through default settings or custom configuration. When a web application initiates communication with a web server, it commonly employs port number 80, the usual port designated for web applications. Numerous apps are assigned default ports.

At the recipient's end: The Transport Layer extracts the port number from its header and transmits the received Data to the appropriate application. Additionally, it undertakes the tasks of sequencing and reassembling the fragmented data.

The transport layer performs several vital functions, which can be summarized as follows:

- Segmentation and reassembly is a process that occurs at this layer when the message received from the session layer is divided into smaller components. Every individual segment that is generated is accompanied by a corresponding header. At the destination station, transport layer reassembles the message.
- Service Point Addressing: The transport layer header incorporates a form of address known as a service point address or port address to ensure accurate message delivery to the intended process. Therefore, with the specification of this address, the transport layer ensures the accurate delivery of the message to the intended process.

Network Layer:

The Network Layer is identified as the third layer within the Open System Interconnection (OSI) model. The network layer facilitates data transfer between hosts situated in disparate networks. In addition, it performs the packet routing function, which involves determining the most efficient method for transmitting a packet among the several accessible routes. The network layer is responsible for including the sender and receiver's IP addresses in the header.

The main role of the Network Layer are:

- Routing refers to the process by which network layer protocols find the most appropriate route for data transmission from a source to a destination. As mentioned earlier, the operation performed by the network layer is commonly referred to as routing.
- Logical addressing is a crucial aspect of inter-networking, as it enables the unique identification of each device. Basically, OSI network layer plays a master role to establishing an addressing scheme. The network layer is responsible for including the sender and receiver's IP addresses in the header. This type of address serves to differentiate each device uniquely and universally.

Data Link Layer:

The Data Link Layer is identified as the second layer within the Open System Interconnection (OSI) model. The data link layer assumes the responsibility of facilitating the delivery of messages between nodes. The main responsibility of this OSI layer is to ensure the integrity of data transmission between nodes over the physical layer, hence minimizing errors. Upon the arrival of a packet within a network, the Data Link Layer (DLL) assumes the responsibility of transmitting the packet to the designated Host by utilizing the corresponding Media Access Control (MAC) address. The Data Link Layer is partitioned into two distinct sub-layers:

1. Logical Link Control (LLC)
2. Media Access Control (MAC)

Any packets will receive from the OSI Network layer is further partitioned into frames based on the frame size of the Network Interface Card (NIC). The Data Link Layer additionally incorporates the Media Access Control addresses of Sender & Receiver input into the header.

The MAC address of the Receiver is acquired through initiating an Address Resolution Protocol (ARP) request on the network, inquiring, "Which entity possesses this specific IP address?" The destination host will respond with it's Media Access Control (MAC) address.

The primary functions of the Data Link Layer are:

- Framing constitutes a fundamental operation executed within the data connection layer. This system enables the efficient transfer of a cohesive set of binary digits from a sender to a recipient, ensuring their meaningful interpretation by the recipient.
- During the frame creation process, the Data Link layer includes physical addresses, specifically known as Media Access Control (MAC) addresses.
- Error Control: The data link layer provides error control techniques, encompassing the detection and subsequent re-transmission of frames.

- **Flow Control:** It is crucial to maintain a consistent data rate at both ends to mitigate the risk of data corruption. The function of flow control is to regulate the amount of data that can be transferred before getting acknowledgment.
- **Access control** pertains to the procedure of ascertaining the device that possesses authority over a mutually utilized communication connection. Within this particular scenario, the MAC sub-layer of the data connection layer assumes a pivotal function in supporting the determination process. This functionality facilitates the determination of the device that now exercises authority over the communication channel.

Physical Layer:

The Physical Layer is identified as the first layer within the Open System Interconnection (OSI) model. The initial stratum of the (OSI) Open Systems Interconnection reference model is called Physical Layer. The physical link between devices is responsible for facilitating their communication. The physical layer encompasses data represented in the binary form of bits. The converted binary digits are then transmitted to the Data Link layer, where the frame is reconstructed.

The primary functions of the Physical Layer are:

- **Bit Synchronization:** The physical layer facilitates the synchronization of bits through the provision of a clock mechanism. The aforementioned clock effectively governs both the sender and receiver, so facilitating synchronization at the level of individual bits.
- **Bit Rate Control:** The Physical layer is responsible for determining the transmission rate, which refers to the quantity of bits transmitted within a given time frame, typically measured in bits per second.
- **Physical Topologies:** The physical layer of a network describes the layout of the many devices and nodes that make up the network. Topologies such as Ring, Bus, Star, and Mesh are only one example.
- **Transmission mode:** The data transfer protocol used between two linked devices is another aspect defined by the physical layer. Many forms of transmission may take place, including simplex, half-duplex, and full-duplex.

2.6 Layer wise Devices & Protocols

Not all devices, like Switch, Router, OLT, ONU, SFP, PON, etc., can be used on all layers. Different layers are used on different layers. Every layer has a specialty. The following table shows networking devices used by OSI Model Layer:

Table 2.11 : OSI Layer wise device & protocol

Layers	Devices	Protocols
Application	Host, Firewall, Gateway, Next-Gen Firewall	SOAP, SSDP, TCAP, UPnP, DHCP, DNS, BOOTP, HTTP, HTTPS, NFS, POP3, SMTP, SNMP, FTP, NTP, IRC, Telnet, SSH, TFTP, IMAP, Gemini
Presentation		TLS, SSL, MIME, AFP, ICA, LPP, NCP, NDR, Tox, XDR, X.25
Session		PPTP, SAP, L2TP, 9P, ADSP, ASP, H.245,iSNS, NetBIOS, NetBEUI, NCP, PAP, RPC, RTCP, SDP, SMB, SMPP, SOCKS, ZIP
Transport		TCP, UDP, AEP, AH, DCCP, ESP, FCP, NetBIOS, IL, iSCSI, NBF, SCTP, TUP, SPX, NBP, QUIC
Network	Router, L3 Switch, OLT	IP, CLNP, IPX, NAT, SCCP, HSRP, VRRP, ARP, ICMP, IPSec, IGMP, RIP, OSPF, AppleTalk, DECnet, IPS/SPX
Data Link	L2 Switch, Bridge, AP	IEEE.802.3, ARP, CSMA/CA, CSMA/CD, CSLIP, HDLC, PAP, PPP, PPPoE, PPTP, X-25, SLIP, ATM, SDLS, PLIP, L2F, L2TP, DTP, NDP, LLDP, CDP, CHAP, DACP, Frame Relay, LACP, FDDI, MAC, VTP, STP, Token Ring, VLAN, MPLS, TIPC
Physical	Hub, NIC, Cable, Repeater, Wireless	IEEE.802.3, IEEE.802.11, Bluetooth, PON, OTN, L431, TIA 449, SS7, IrDA, USB, DSL, ISDN, TransferJet, Etherloop, ARINC 818, G.HN/G.9960, CAN bus, MIPI, Infrared, Frame Relay, FO, X.25

2.7 Importance of IP addressing

The Internet Assigned Numbers Authority (IANA) is in charge of determining how IP numbers are distributed. An official Internet Engineering Task Force (IETF) document is a Request for Comments (RFC). Specifications and organizational notes for subjects connected to the internet and computer networking may be found in this document. The acronym IP refers to the Internet protocol in its entire form.

A logical address is essentially what an IP address is. It is not possible to touch or see it. The primary function of an IP address is to identify a particular networking device throughout the vast expanse of the internet. An Internet Protocol (IP) address is a numerical label assigned to each device on a network that is used to facilitate communication between those devices. Without the correct IP address, there is no way to communicate with the devices connected to the internet since they are all identified by a unique number known as the IP address.

IP addressing comes in two different flavors. The two versions of IP addressing is IPv4 & IPv6. IPv4 was the first version to be implemented for production use, initially on SATNET in 1982 and then on the ARPANET in January 1983. Then, in 1998, IPv6 was released to the public.

2.8 IPv4 & IPv6 Overview

IP v4 Overview

The logical address of IPv4 consists of a total of 32 bits. The given entity consists of four octets. Each octet consists of 8 bytes. There are five classes of IPv4. The classes are denoted as A, B, C, D, E, and F. Classful IP addresses fall into specific ranges identified by their subnet mask. These ranges include /8, /16, and /24, often called classful IP addresses. In the absence of the /8, /16, and /24 IP address classes, it is called Classless IP.

Example of IPv4 addressing:

192.168.0.1/24 is class C & classfull,

192.168.0.1/25 is class C but it's classless IP

Table 2.12 : Classful IPv4 address

IPv4 - CLASSFUL (Maintain Network & Host bit)								
CL	N Bits	H Bits	Network bit & Host bit (Classful)				Range	IP Range
A	8	24	N	H	H	H	0 - 126	0.0.0.0 - 126.255.255.255
B	16	16	N	N	H	H	128 - 191	128.0.0.0 - 191.255.255.255
C	24	8	N	N	N	H	192 - 223	192.0.0.0 - 223.255.255.255
D	For Multicast		1 st	2 nd	3 rd	4 th	224 - 239	224.0.0.0 - 239.255.255.255
E	For Research		Octet	Octet	octet	Octet	240 - 255	240.0.0.0 - 255.255.255.255
Special IP	Loopback - 127.0.0.1 APIPA - 169.254.0.1 - 169.254.255.254							

IPv4 address has 4 octet. It has some specific calculations.

Now in this table showing how each octet work and manage:

Table 2.13 : IPv4 Octet calculation

Each Octet										
/	Mask	Binary	2 ⁷ = 128	2 ⁶ = 64	2 ⁵ = 32	2 ⁴ = 16	2 ³ = 8	2 ² = 4	2 ¹ = 2	2 ⁰ = 1
0	255	11111111	128	64	32	16	8	4	2	1
2	254	11111110	128	64	32	16	8	4	2	0
4	252	11111100	128	64	32	16	8	4	0	0
8	248	11111000	128	64	32	16	8	0	0	0
16	240	11110000	128	64	32	16	0	0	0	0
32	224	11100000	128	64	32	0	0	0	0	0
64	192	11000000	128	64	0	0	0	0	0	0
128	128	10000000	128	0	0	0	0	0	0	0
256	0	00000000	0	0	0	0	0	0	0	0

There are some specific ranges of IP address can use for private purpose. Also there are some reserve IP addresses ranges for research purpose only. Those IP can not use for personal usage.

Now in this table showing, the ranges of private IPv4:

Table 2.14 : IPv4 range for private usage

IPv4 - Private IP range - RFC 1918		
Class	IP Range	IP Block
A	10.0.0.0 - 10.255.255.255	10.0.0.0/8
B	172.16.0.0 - 172.31.255.255	169.254.0.0/16 & 172.16.0.0/12
C	192.168.0.0 - 192.168.255.255	192.168.0.0/16

Now an example of IPv4 Calculation:

Example - 192.168.0.1/24

Table 2.15 : IPv4 example calculation

IP v4 - Calculation			
1 st Octet - (8bits)	2 nd Octet - (8bits)	3 rd octet - (8bits)	4 th Octet - (8bits)
192	168	0	1
11000000	10100100	00000000	00000001
IP - 192 . 168 . 0 . 1		Binary - 11000000 . 10100100 . 00000000 . 00000001	
192 . 168 . 0 . 1/24		192 . 168 . 0 . 1 - Network ID /24 - Network Bit	

So, this 192.168.0.1/24 IP Calculation is:

IP Class & Type: C & Private

CIDR Notation: /24

Wildcard Mask: 0.0.0.255

Subnet Mask: 255.255.255.0

Network Address: 192.168.0.0

Broadcast Address: 192.168.0.255

Usable Host IP Range: 192.168.0.1 - 192.168.0.254

Total Number of Hosts & Usable Hosts: 256 & 254

Binary Subnet Mask: 11111111.11111111.11111111.00000000

IP v6 Overview

IPv6 is the latest version of the Internet Protocol. IPv6 is 128 bit. It has 8 group. Each group is 16 bit. Which are Hexa-Decimal conversion. Now in this table showing Hexa-Decimal conversion of IPv6.

Table 2.16 : IPv6 Conversion

IP v6 - Conversion		
Decimal	Binary	Hexa-Decimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

2.9 IPv4 Sub-netting

Now this table showing all the chart of subnetting:

Table 2.17 : IPv4 Subnet calculation

CLASS			SUBNET				HOST					
C	B	A	/	NetMask	Block Size	Class A	Class B	Class C	Class A	Class B	Class C	
			/8	255.0.0.0	256	1			16777214			
			/9	255.128.0.0	128	2			8388606			
			/10	255.192.0.0	64	4			4194302			
			/11	255.224.0.0	32	8			2097150			
			/12	255.240.0.0	16	16			1048574			
			/13	255.248.0.0	8	32			524286			
			/14	255.252.0.0	4	64			262142			
			/15	255.254.0.0	2	128			131070			
			/16	255.255.0.0	256	256	1		65534	65534		
			/17	255.255.128.0	128	512	2		32766	32766		
			/18	255.255.192.0	64	1024	4		16382	16382		
			/19	255.255.224.0	32	2048	8		8190	8190		
			/20	255.255.240.0	16	4096	16		4094	4094		
			/21	255.255.248.0	8	8192	32		2046	2046		
			/22	255.255.252.0	4	16384	64		1022	1022		
/23	255.255.254.0	2	32768	128		510	510					
			/24	255.255.255.0	256	65536	256	1	254	254	254	
			/25	255.255.255.128	128	131072	512	2	126	126	126	
			/26	255.255.255.192	64	262144	1024	4	62	62	62	
			/27	255.255.255.224	32	524288	2048	8	30	30	30	
			/28	255.255.255.240	16	1048576	4096	16	14	14	14	
			/29	255.255.255.248	8	2097152	8192	32	6	6	6	
			/30	255.255.255.252	4	4194304	16384	64	2	2	2	

Now This circular diagram showing the distribution of IPv4 subnetting:

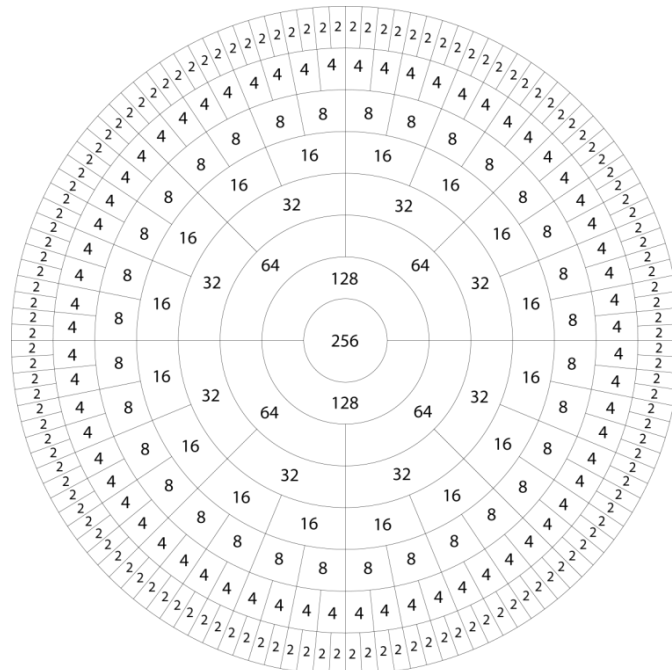


Figure 2.18 : IPv4 Distribution Diagram

2.10 IPv6 Sub-netting

This table showing IPv6 example: **2001:0000:3238:DFE1:0071:0000:0000:FEFB**

Table 2.19 : IPv6 Calculation

Rules	Description
R1: Discard leading Zeroes.	-Block no 5, 0071 , the leading two 0s can erase. -Then 2001 : 0000 : 3238 : DFE1 : 71 : 0000 : 0000 : FEFB
R2: If two or more blocks have sequence zeroes, then erase them all and replace them with double colon (::)	-2001 : 0000 : 3238 : DFE1 : 63 : 0000 : 0000 : FEFB - 6th & 7th blocks contain consecutive 0s , omit them all and replace with double colon sign :: -Then 2001 : 0000 : 3238 : DFE1 : 71 :: FEFB
R3: Sequential blocks of zero can replace only once by (::) colon. So, if there's more blocks of zeroes in the IPv6, they can be replace with a single zero	-2001 : 0000 : 3238 : DFE1 : 71 :: FEFB - After Consecutive blocks to 0s :: there are still blocks of 0s in the 2nd block of the address. -It can be shrunk down to a single 0 2001 : 0 : 3238 : DFE1 : 71 :: FEFB

2.11 Topologies

A network topology refers to the physical and logical configuration of nodes and links inside a network. Nodes commonly comprise a diverse array of equipment, including switches, routers, OLT, ONU, and software that contain the functionalities of switches and routers. Graphs are frequently employed as a means of depicting network topologies. Now here showing the type of networking topologies:



Figure 2.20 : Point to Point Topology

Point-to-Point Topology: The point-to-point topology is a straightforward network configuration. This type of topology establishes a direct link between two nodes. Then, it enables exclusive utilization of the connection's whole bandwidth for communication between these nodes for the end users. In contemporary times, there is a prevailing trend towards utilizing logical topological linkages facilitated by satellite links and microwaves.

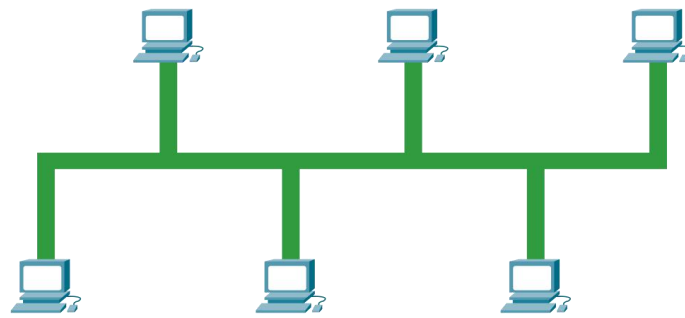


Figure 2.21 : BUS Topology

BUS Topology: The bus network topology is characterized by the arrangement of nodes in a sequential manner over a singular cable. As mentioned above, the configuration is currently prevalent in cable broadband distribution networks. It means all the nodes are interconnected through a single cable equipped with terminators on both ends. In this setup, a single primary cable serves as the central infrastructure for the whole network.

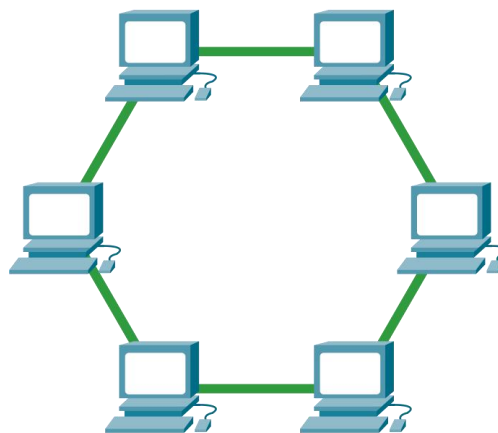


Figure 2.22 : RING Topology

Ring Topology: The ring network topology connects nodes in a closed loop. Some rings transmit data bidirectionally, whereas others do not. This bidirectional ring topology are more zestful compare to bus network topology. Because they allow traffic in both directions and allow nodes to be accessed from various paths. Ring networks are typically used in metro networks that use SONET.

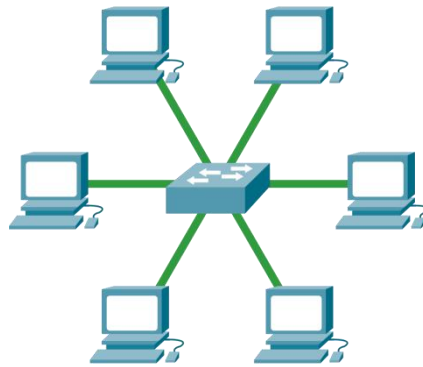


Figure 2.23 : STAR Topology

Star Topology: The star network topology involves the connection of all nodes to a central hub through a communication channel. To establish a point-to-point connection with the central hub, each node in the star network topology must have an individual connection. The hub, which serves as a server, is responsible for controlling and managing the entirety of the network. The physical configuration of local area networks (LANs) that utilize Ethernet switches and most wired networks in residential and commercial settings often adhere to a star topology.

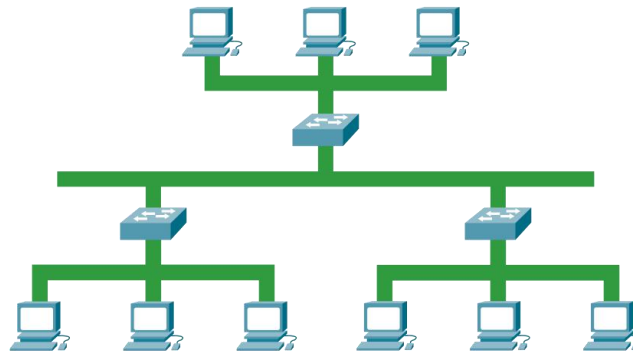


Figure 2.24 : TREE Topology

Tree Topology: The tree network topology is characterized by a hierarchical structure, with a single root node and all other nodes interconnected in a branching pattern. The topology has a star structure, wherein all nodes are directly connected to a central hub. A prevalent configuration for more extensive Ethernet switch networks, such as those used in data center networks, involves using a tree structure.

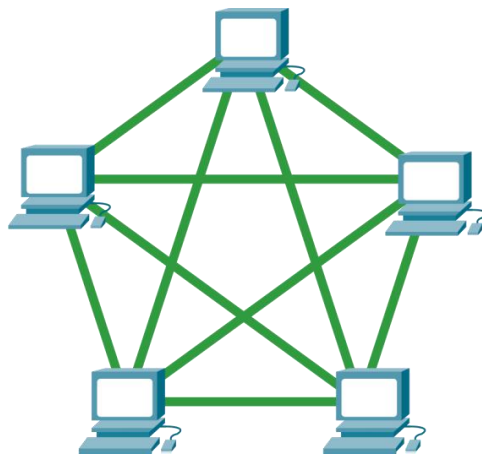


Figure 2.25 : MESH Topology

Mesh Topology: The mesh network topology establishes interconnections between nodes, enabling numerous pathways connecting at least specific sites within the network. A network is classified as fully meshed when every node is directly interconnected with all other nodes.

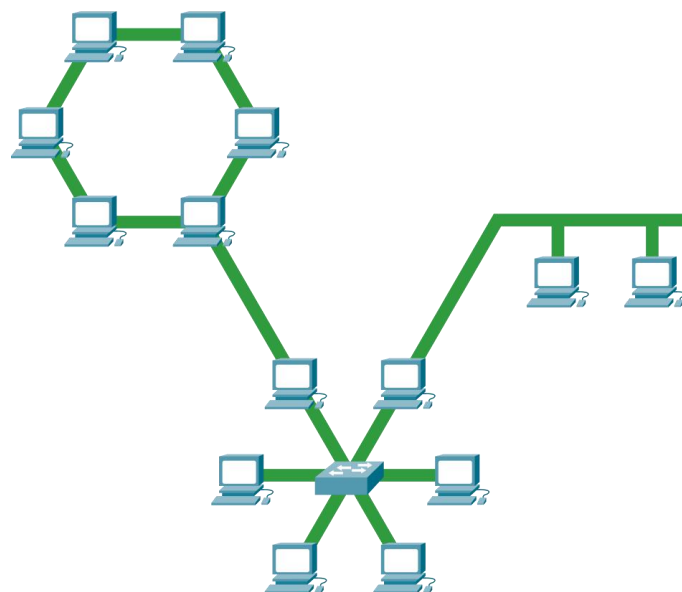


Figure 2.26 : HYBRID Topology

Hybrid Topology: The hybrid network topology refers to amalgamating two or more distinct topologies. Hybrid topologies often offer significant versatility, as they can handle many configurations.

Chapter 3

Brief Overview Modern FTTx Networking

3.1 What is FTTx

FTTx stands for Fiber to the x. FTTx is a comprehensive term employed to delineate diverse broadband network topologies, contingent upon the location of their termination points. The symbol 'x' within the term FTTx denotes a specific entity. The location in question has the potential to serve as a residential dwelling, a storage unit, or any other type of premises intended for use by the final consumer. Consequently, FTTx encompasses several implementations, including Fiber to the Home (FTTH), Fiber to the Building (FTTB), Fiber to the Premises (FTTP), and Fiber to the Curb (FTTC).

FTTx technology is employed to facilitate the advancement of next-generation access by substantially enhancing broadband capabilities, thereby substantially improving the speed and quality of the service provided. The utilization of Fiber to the x network architecture is commonly observed in Last-mile connectivity. The network extends from the end-user premises to the edge of the carrier network. The technology can provide enhanced connectivity to residential and commercial establishments globally, resulting in improved speed and quality of service.

Fiber to the X (FTTx) is being increasingly adopted as a replacement for legacy copper-based networks. Because of its lots of advantages and its speed and capacity with QoS. Additional benefits encompass increased transmission rates and reduced energy use. The Fiber to the X (FTTX) network infrastructure aims to bring fiber optic connectivity closer to the end-user.

The proliferation of cloud computing, smart cities, and 5G technology has increased demand for enhanced bandwidth and network performance. Fiber to the X (FTTX) provides a high-capacity fiber optic network with minimal delay, making it suitable for meeting various demands. Furthermore, it also facilitates the attainment of enhanced capacity and sustained connectivity. Additionally, it facilitates the

transmission of signals over long distances, possesses a compact and lightweight design, and exhibits resistance to electromagnetic interference.

3.2 EPON & GPON Technology

In 1987, British Telecommunications first introduced Passive Optical Network. The following table shows:

Table 3.1 : EPON & GPON Specifications

EPON	GPON
<ul style="list-style-type: none"> ● Ethernet Passive Optical Network ● IEEE Standard 802.ah ● Upload 1.25Gbps ● Download 1.25Gbps ● Splitting Ratio 1:64 ● 1 port can handle 64 end devices 	<ul style="list-style-type: none"> ● Gigabit Passive Optical Network ● ITU Standard TG.984 ● Upload 1.25Gbps ● Download 2.5Gbps ● Splitting Ratio 1:128 ● 1 port can handle 128 end devices

According to PON technology developers reference, EPON & GPON power Standard maintained for best practice. The following table shows:

Table 3.2 : EPON & GPON Power Standard

Factor	EPON	GPON		
ONU Rx	-6 to -27 dBm	-6 to -28 dBm		
ONU RX Wavelength	1490 nm	1490 nm		
PON Module Rx	32 dBm	33 dBm		
PON Module Tx	PX20++ is 6~7 dBm PX20+++ is 7~8 dBm	C+ is 5~7 dBm C++ is 6~10 dBm		
ONU Tx	0 ~ 3 dBm	0 ~ 4 dBm		
Splitting Ratio	EPON 1:64		GPON 1:128	
	1:2 > 1:32	1:2 > 1:4 > 1:8	1:2 > 1:64	1:2 > 1:4 > 1:16
	1:4 > 1:16	1:2 > 1:2 > 1:16	1:4 > 1:32	1:4 > 1:4 > 1:8
	1:8 > 1:8	1:4 > 1:4 > 1:4	1:8 > 1:16	1:2 > 1:8 > 1:8

3.3 FTTx Devices:

OLT

Optical Line Terminal. Basically a multi layer switch. OLT is a switch with some limited L3 features to distribute and connect end users. Basically 2 types of OLT. One is EPON OLT and other one is GPON OLT.



Image 3.3 : ECOM 8 port GPON OLT (CDATA OEM)



Image 3.4 : BDCOM 8port GPON OLT



Image 3.5 : Dasan 8port GPON OLT

Switch (L2)

A network switch lets network devices communicate by transferring data packets. Software-based switches handle virtual networks or hardware networks. A network switch operates on Layer 2 of the OSI model, the data-link layer.



Image 3.6 : BDCOM Switch

ONU/ONT

Optical Network Unit, For EPON technology it called ONU and ONT for GPON technology. Basically it's convert the light signal into electrical signal and electrical signal to light signal. xPON ONU/ONT supports both EPON & GPON.



Image 3.7 : ECOM xPON ONU (CDATA OEM)

Media Converter (MC)

Media Converter was the previous technology of ONU/ONT. MC consumed more electricity and maintain is very difficult. Only 1 user can connect with a MC.



Image 3.8 : Media Converter SET

Home Gateway Unit (HGU)

Home Gateway Unit. It is a multifunctional device. It has built in PON port for input optical fiber. It has telephone port and CATV port/ Also this device can run as a home router. HGU supports triple play service. Also A HGU is combined of ONU & Home Router. That's why HGU is very useful than other routers and ONU.

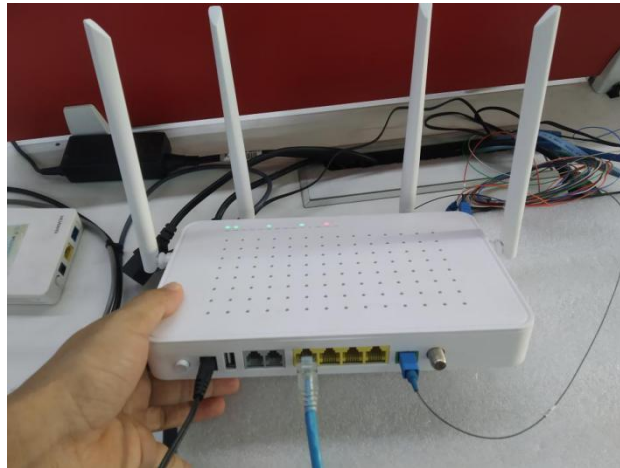


Image 3.9: BDCOM 4 port HGU

Router

Router is a L3 device. It working PDU is packet. A router basically route data from source to specific destination. Also with a router a network engineer can control and manage limited BW for a efficient service to end users. Router is the main component in any network. In a router admin can make policy, control users and ensure safety from hacking threats with routers L3 features.



Image 3.10 : MikroTik CCR1036-12G-4S

3.4 FTTx Accessories:

PON Module

PON module is such a device which converts Electrical signal into Light signal & Light signal to Electrical signal. PON module use on Passive Optical Network connectivity. For GPON OLT we use GPON PON module. For EPON OLT we use EPON PON module. EPON and GPON PON module can't support on same device.



Image 3.11 : PON Module (EPON)

SFP Module

SFP or Small form-factor Pluggable module is such a device which converts Electrical signal into Light signal & Light signal to Electrical signal. It's mainly use to transmit and receive large scale of data.



Image 3.12 : SFP Module (10G)

Patch Cord

It is a also called short cable. To connect a device with another device within a shortest range we use Patch cord like SC-SC, FC-FC etc.



Image 3.13 : Patch cord (SC-SC)

Serial Cable & Converter

Serial cable mainly use to Console connection for configure any device with admin permissions. Console can't communicate with PC directly. It requires a converter.



Image 3.14 : CONSOLE cable with Converter

Splitter

Basically splitter is a prism. It split lasers one into many and Many laser combine into one laser. Like 1:4, 1:8, 1:16 etc. In FTTx network system we use split 2 times. 2 times split ensure quality services.



Image 3.15 : Splitter (PLC and Cassette type)

TJ Box

It use for Optical Fiber Terminal Joint Box to protect an optical fiber joint from rain, dust, light etc threats. TJ box ensure optical fibers quality and joints from dB losses.



Image 3.16 : TJ Box

FOD box

Fiber-Optic Distribution Box is the interface between the feeder and drop cables in a FTTH or FTTx communication network system. This unit combines the functions of fiber splicing, splitting, distribution, storage, and cable connection into a single integrated system.



Image 3.17 : Fiber-optic Distribution Box

3.5 FTTx Tools:

Splicer Machine

To joint a optical fiber we use splicer machine. Splicers are machines used to join two optical fibers by welding, also known as fusing. Splicing is the term used to describe this process. After being prepped, sliced, and positioned in alignment fixtures on the splicer, the ends of the optical fiber are spliced. After that, splice it into the joint.



Image 3.18 : Splicer Machine

OPM

To measure optical laser power we use OPM meter to ensure efficient service. It use to test optical fiber in the units of dBm.



Image 3.19 : Optical Power Meter

OTDR

The Optical Time Domain Reflectometer is a device for assessing fiber cable integrity and for the construction, certification, maintenance, and troubleshooting.



Image 3.20 : OTDR meter

Crimper

To connect RJ45 connector on UTP cable we use crimper tools



Image 3.21 : Crimper Tool

Chapter 4

Brief Overview of GPON technology

4.1 GPON Technology

PON technology is designed to allow an efficient broadband internet connection for multiple end users by using a single optical fiber from Internet Service Provider. It was first introduced by British Telecommunications in 1987. GPON technology was first introduced and showed by the US operator Cox Communications in 1997.

4.2 Exclusive features of GPON

Most exclusive feature of GPON is Triple Play Service. Triple play service enables Voice, Data and Video service at a time. Voice service provide telephony services. Data services provide internet activities and Video service provide cable TV services.

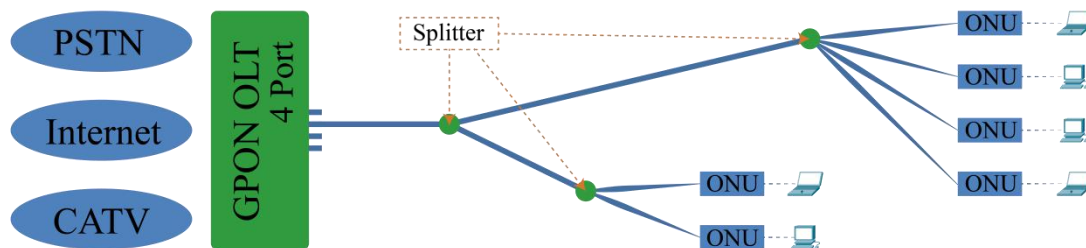


Figure 4.1 : GPON OLT to endpoint communication

4.3 GPON working Principle for upstream & downstream

GPON working principle for Downstream. When OLT communicate with ONU, it communicate with 1490nm wavelength (λ) for Voice and Data service. Also it used 1550nm wavelength (λ) for CATV service.

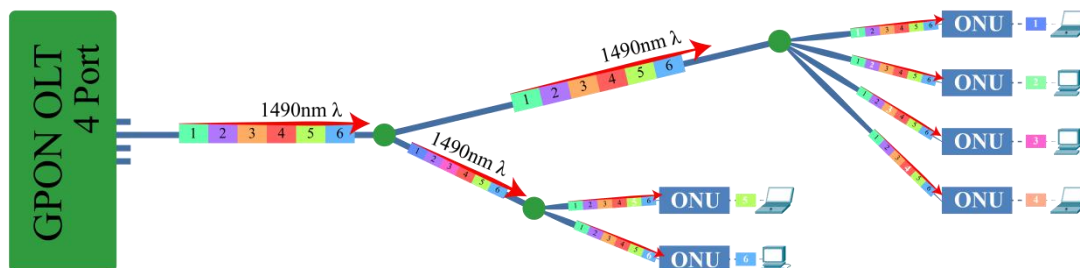


Figure 4.2 : GPON OLT to ONU communication

GPON working principle for Upstream. When ONU communicate with OLT, it communicate with 1310nm wavelength (λ) for Voice and Data service. But for CATV service it don't need ONU to OLT communication on 1550nm wavelength (λ).

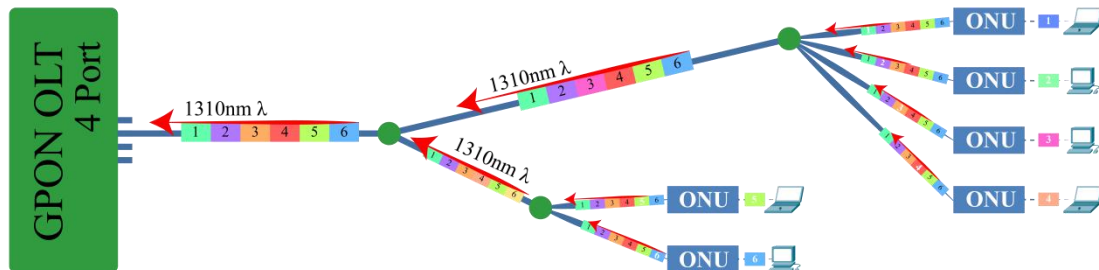


Figure 4.3 : GPON ONU to OLT communication

4.4 GPON Profiling mechanism

GPON mainly worked on profile based configuration. For ensure best quality service GPON profiling need to configure as it's technical standard made by it's developers. Here some technical term comes for GPON technology.

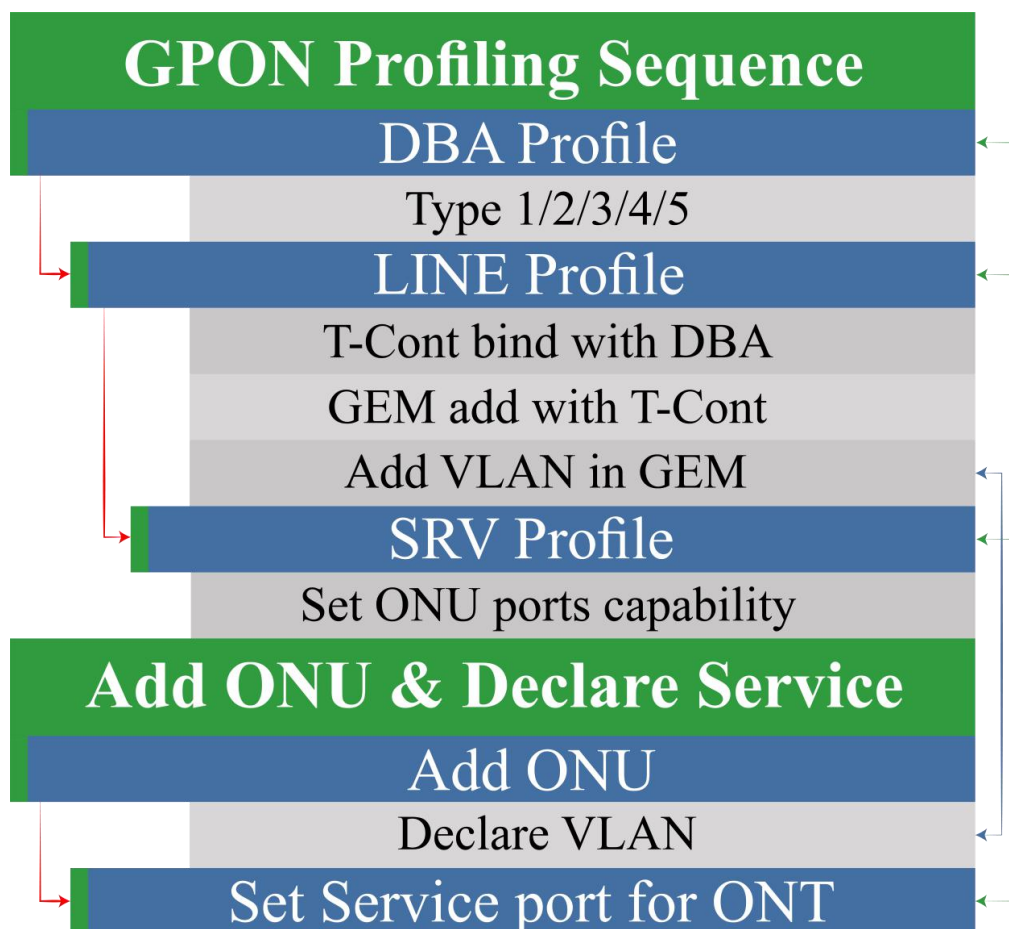


Figure 4.4 : GPON profiling

DBA Profile - Dynamic Bandwidth Allocation (DBA) profile used for upstream BW management. Mainly ISP manage BW by Routers. But in this case GPON has 1.25GB Upload speed and 2.5GB download speed. Because of upload speed is less than download speed it need to manage. So that, there is no conflict. For configure DBA profile, Bandwidth speed must declare by type function. 128 DBA profile can be create into a GPON OLT.

```
GPON(config)# dba-profile profile-id
<0-128> - Profile ID. <U><0-128>

GPON(config)# dba-profile profile-id 1

GPON(config-dba-profile-1)# type4 max 1024000

GPON(config-dba-profile-1)#

GPON(config-dba-profile-1)# █
```

Image 4.5 : DBA Profile

Type Function - There are 5 type of Type function. Type1 Fixed bandwidth, Type2 Assured bandwidth, Type3 Assured bandwidth + Maximum bandwidth, Type4 Maximum bandwidth, Type5 Fixed + Assured + Maximum bandwidth.

```
GPON(config)# dba-profile profile-id 1

GPON(config-dba-profile-1)# type
type1 - Fixed bandwidth
type2 - Assured bandwidth
type3 - Assured bandwidth, Maximum bandwidth
type4 - Maximum bandwidth
type5 - Fixed bandwidth, Assured bandwidth, Maximum
bandwidth

GPON(config-dba-profile-1)# type4 max 1024000

GPON(config-dba-profile-1)# █
```

Image 4.6 : Type Function

LINE Profile - The ONT line profile used to bind between T-CONT and DBA profiles, the QoS mode of service flows, and the mapping relationship between GEM Port and ONT side services. It is mainly used to configure DBA, T-CONT, and GEM Port related information.

```

GPON(config)# ont-lineprofile gpon profile-id 1
GPON(config-ont-lineprofile-1)# tcont 1 dba-profile-id 1
GPON(config-ont-lineprofile-1)# gem add 1 tcont 1
GPON(config-ont-lineprofile-1)# gem mapping 1 1 vlan 103

```

Image 4.7 : LINE Profile

T - CONT - An ONU object that represents a set of logical connections is known as a Transmission container, or T-CONT for short. For the purpose of allocating upstream bandwidth on the GPON, it appears as a single unit. Service traffic is routed to various GEM ports and subsequently various T-CONT, and this routing is determined by the profiling process and the mapping method.

```

GPON(config)# ont-lineprofile gpon profile-id 1
GPON(config-ont-lineprofile-1)# tcont
T-CONT-LIST          - T-CONT ID list. <L><0-7>(e.g.:0-2, 3)
GPON(config-ont-lineprofile-1)# tcont 1 dba-profile-id 1

```

Image 4.8 : T-CONT in LINE profile

GEM - The GPON Encapsulation Method (GEM) is a data transport system used for the transmission convergence layer of GPON. The mechanism described here offers a connection-oriented connectivity system with variable-length framing for transporting data services through passive optical network (PON) technology. The GEM protocol has been developed to be agnostic to the service node interface present at the Optical Line Terminal (OLT) as well as the many kinds of User Network Interface (UNI) interfaces found at the Optical Network Units (ONUs).

```

GPON(config-ont-lineprofile-1)# gem add
<1-30>          - GEM ID. <U><1-30>
GPON(config-ont-lineprofile-1)# gem add 1 tcont 1
GPON(config-ont-lineprofile-1)#

```

Image 4.9 : GEM in LINE profile

SRV Profile - SRV or Service profile use to configure ONU/ONT ports capability.

```
GPON(config)# ont-srvprofile gpon profile-id 1
GPON(config-ont-srvprofile-1)# ont-port catv adaptive eth adaptive pots adaptive iphost adaptive
GPON(config-ont-srvprofile-1)# ring check enable
GPON(config-ont-srvprofile-1)# port vlan eth 1-4 transparent
Configure ONT port(s) VLAN, total: 4, success: 4
GPON(config-ont-srvprofile-1)#
```

Image 4.10 : SRV (service) Profile

Service-port - Service port is a mechanism where declare that how a packet will go through which LINE profile and Which SERVICE Profile.

```
GPON(config)#
GPON(config)# service-port autoconfig vlan 103 gpon 0/0 port 1 gempport 1 multi-service user-vlan 1 tag-action translate
config service-port autoconfig complete, total 1, failed 0.
GPON(config)# service-port autoindex vlan 103 gpon 0/0 port 1 ont 1 gempport 1 multi-service user-vlan 103 tag-action transparent
config service-port total 1, failed 0.
GPON(config)#
```

Image 4.11 : Service port Configure

4.5 Advantages of GPON

GPON has a lots of feature & advantage. GPON also some of the previous PON technologies limitations and challenges. Some of Advantages are described here:

Transmission Distance

Gigabit Passive Optical Network (GPON) can transmit high-volume data across long distances compared to previous cable connection technology. The distance is 10–20 km. Copper cabling is usually limited to 100 meters.

High Speed

GPON has faster speeds than conventional cabling solutions. Their bandwidth is high-performance, ranging from 5Gbps to 25Gbps. Five is generally down and peaks at 25. Larger enterprises can get 40 Gbps. Compare these cables to copper wires—these speeds are too high. These rates can be communicated across great distances, making them better than copper lines.

Less Space

Copper wires use significantly more area than GPON fiber lines. It is a little portion of copper wires. In a building, linking it takes less room. Extended signal reach technology has decreased the requirement for bulky signal-boosting equipment. Business networks need a few server rooms and equipment. The network requires less area due to the few boosting equipment and thin cables. One optical fiber may divide 32 signals for 128 end ports.

Cost Effective

The cost has decreased using GPON technology. GPON wires cost less than copper LAN cables. Smaller server rooms need less installation money than copper lines. Eliminating wire closets and other gadgets save money over time. The cost of GPON is 40-50% cheaper. Setup and operation are faster and cheaper. Splitters reduce fiber use by splitting a single fiber into multiple transmissions. Unlike copper cables, maintenance is rare. Maintenance is lower since equipment failure is infrequent. Such factors make it cost-effective.

Diversity

GPON may provide several services. These network services include data, telephony, Wi-Fi, and security cameras. All of these services are necessary for business. One cable system may offer all these services, saving money on individual cabling systems for each purpose. GPON's performance diversity beats others. GPON management and troubleshooting are simple.

Nature Friendly

IT systems constantly aim to protect the environment—environmentally friendly GPON. Electricity and air conditioning are used less with GPON. Because it doesn't need certain operating temperatures. Running requires fewer parts. The cabling system is one of the finest advancements of recent times due to its efficiency and high-tech setup.

Chapter 5

Troubleshoot & Remotely Client Support

5.1 Default Configuration of New GPON OLT

This is default Plug n Play Configuration for ECOM GPON 8 Port OLT.

```
GPON(config)#
GPON(config)# dba-profile profile-id 1
GPON(config-dba-profile-1)# type4 max 1024000
GPON(config-dba-profile-1)# commit
GPON(config-dba-profile-1)# exit
GPON(config)# ont-lineprofile gpon profile-id 1
GPON(config-ont-lineprofile-1)# tcont 1 dba-profile-id 1
GPON(config-ont-lineprofile-1)# gem add 1 tcont 1
GPON(config-ont-lineprofile-1)# gem mapping 1 1 vlan 1
GPON(config-ont-lineprofile-1)# commit
GPON(config-ont-lineprofile-1)# exit
GPON(config)# ont-srvprofile gpon profile-id 1
GPON(config-ont-srvprofile-1)# ont-port catv adaptive eth adaptive pots adaptive iphost adaptive
GPON(config-ont-srvprofile-1)# ring check enable
GPON(config-ont-srvprofile-1)# port vlan eth 1-4 transparent
Configure ONT port(s) VLAN, total: 4, success: 4
GPON(config-ont-srvprofile-1)# commit
GPON(config-ont-srvprofile-1)# exit
GPON(config)# loopback-detection enable
GPON(config)# interface vlanif 1
GPON(config-interface-vlanif-1)# ip address 192.168.2.100 255.255.255.0
GPON(config-interface-vlanif-1)# exit
GPON(config)# ip route 0.0.0.0/0 192.168.2.1
GPON(config)# interface gpon 0/0
GPON(config-interface-gpon-0/0)# loopback-detection 1-8 enable
GPON(config-interface-gpon-0/0)# exit
GPON(config)# service-port autoconfig vlan 1 gpon 0/0 port 1 gempport 1 multi-service user-vlan 1 tag-action transparent
config service-port autoconfig complete, total 1, failed 0.
GPON(config)# service-port autoconfig vlan 1 gpon 0/0 port 2 gempport 1 multi-service user-vlan 1 tag-action transparent
config service-port autoconfig complete, total 1, failed 0.
GPON(config)# service-port autoconfig vlan 1 gpon 0/0 port 3 gempport 1 multi-service user-vlan 1 tag-action transparent
config service-port autoconfig complete, total 1, failed 0.
GPON(config)# service-port autoconfig vlan 1 gpon 0/0 port 4 gempport 1 multi-service user-vlan 1 tag-action transparent
config service-port autoconfig complete, total 1, failed 0.
GPON(config)# service-port autoconfig vlan 1 gpon 0/0 port 5 gempport 1 multi-service user-vlan 1 tag-action transparent
config service-port autoconfig complete, total 1, failed 0.
GPON(config)# service-port autoconfig vlan 1 gpon 0/0 port 6 gempport 1 multi-service user-vlan 1 tag-action transparent
config service-port autoconfig complete, total 1, failed 0.
GPON(config)# service-port autoconfig vlan 1 gpon 0/0 port 7 gempport 1 multi-service user-vlan 1 tag-action transparent
config service-port autoconfig complete, total 1, failed 0.
GPON(config)# service-port autoconfig vlan 1 gpon 0/0 port 8 gempport 1 multi-service user-vlan 1 tag-action transparent
config service-port autoconfig complete, total 1, failed 0.
GPON(config)# save Building Configuration...
```

Image 5.1 : Default Configuration of GPON OLT

5.2 OLT/ONU Hang and Not working

Checking ONU, Port, and device state to make sure if all state ok or not

```
GPON(config)# show ont info 0/0 1 all
```

```
-----
F/S P  ONT SN          Control  Run   Config  Match
      ID          flag     state   state  state
-----
0/0 1  1  D0116AF6D481  Active  Online success match
-----
Total: 1, online: 1, deactive: 0, failed: 0
```

(A) Checking ONU state

```
GPON(config-interface-gpon-0/0)# show port ddm-info 1 with-ONU-optical
```

```
-----
Temperature(C)      : 40.3
Supply Voltage(V)   : 3.17
TX Bias current(mA) : 8
TX power(dBm)       : 7.52
RX power(dBm)       : -40.00
-----
Vendor              : ANSAOEN
Product name        : AS60PG43207CPSS7
Version             : 000
Serial number       : PG01220412000820
Vendor specific     : 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
-----
ONT      Rx optical(dBm)
-----
1        -40.00
-----
```

(B) Checking Port state

```
GPON(config)# show mac-address port gpon 0/0/1 ont 1
```

```
-----
Total: 1
-----
MAC          VLAN  Sport  Port      Onu
-----
BB:69:F4:84:04:EE  1    0      pon0/0/1  1
-----
```

(C) Checking Port all MAC

```
GPON(config)# show power state
```

```
-----
Slot-ID  WorkStatus
-----
1        notworking
2        working
-----
```

```
GPON(config)# show fan
```

```
-----
Fan speed mode: auto
Fan speed level: 1
-----
FAN[1] status: Normal (6300RPM)
FAN[2] status: Normal (6000RPM)
FAN[3] status: Normal (6480RPM)
-----
```

```
GPON(config)# show temperature
```

```
The temperature of the board: 39.5(C)
```

```
GPON(config)# show cpu
```

```
-----
Utilization      : 15%
Load Average(1m) : 10.75
Load Average(5m) : 10.35
Load Average(15m): 8.20
-----
```

```
GPON(config)# show memory
```

```
-----
Total memory : 1011MB
Free memory  : 708MB
Utilization  : 30%
-----
```

```
GPON(config)# █
```

(D) Checking device state

Image 5.2 : Checking all ONU aspects

5.3 PON Port/ PON Module Not Working Properly

Checking PON state and PON Module Tx power

```
GPON(config)# interface gpon 0/0
```

```
GPON(config-interface-gpon-0/0)# show port ddm-info 1
```

```
-----
Temperature(C)      : 40.0
Supply Voltage(V)   : 3.18
TX Bias current(mA) : 8
TX power(dBm)       : 7.52
RX power(dBm)       : -40.00
-----
Vendor              : ANSAOEN
Product name        : AS60PG43207CPSS7
Version             : 000
Serial number       : PG01220412000820
Vendor specific     : 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
-----
Optical Module Threshold Parameter
-----
Rx power warning threshold(dBm) : [-,-]
Rx power alarm threshold(dBm)   : [-,-]
Tx power warning threshold(dBm)  : [-,-]
-----
GPON(config-interface-gpon-0/0)# shutdown 1
GPON(config-interface-gpon-0/0)# no shutdown 1
GPON(config-interface-gpon-0/0)# reset statistics port 1
GPON(config-interface-gpon-0/0)# █
```

Image 5.3 : Checking PON state

5.4 Configure PON based Services

VLAN assigned on each PON. To ensure PON based service

```

GPON(config)# vlan 400-408
Create vlan successfully:
400-408

GPON(config)# interface gpon 0/0

GPON(config-interface-gpon-0/0)# vlan native-vlan 1 401
GPON(config-interface-gpon-0/0)# vlan native-vlan 2 402
GPON(config-interface-gpon-0/0)# vlan native-vlan 3 403
GPON(config-interface-gpon-0/0)# vlan native-vlan 4 404
GPON(config-interface-gpon-0/0)# vlan native-vlan 5 405
GPON(config-interface-gpon-0/0)# vlan native-vlan 6 406
GPON(config-interface-gpon-0/0)# vlan native-vlan 7 407
GPON(config-interface-gpon-0/0)# vlan native-vlan 8 408

GPON(config-interface-gpon-0/0)# exit

GPON(config)# service-port autoconfig vlan 401 gpon 0/0 port 1 gempport 1 multi-service user-vlan 1 tag-action translate
config service-port autoconfig complete, total 1, failed 0.

GPON(config)# service-port autoconfig vlan 402 gpon 0/0 port 2 gempport 1 multi-service user-vlan 1 tag-action translate
config service-port autoconfig complete, total 1, failed 0.

GPON(config)# service-port autoconfig vlan 403 gpon 0/0 port 3 gempport 1 multi-service user-vlan 1 tag-action translate
config service-port autoconfig complete, total 1, failed 0.

GPON(config)# service-port autoconfig vlan 404 gpon 0/0 port 4 gempport 1 multi-service user-vlan 1 tag-action translate
config service-port autoconfig complete, total 1, failed 0.

GPON(config)# service-port autoconfig vlan 405 gpon 0/0 port 5 gempport 1 multi-service user-vlan 1 tag-action translate
config service-port autoconfig complete, total 1, failed 0.

GPON(config)# service-port autoconfig vlan 406 gpon 0/0 port 6 gempport 1 multi-service user-vlan 1 tag-action translate
config service-port autoconfig complete, total 1, failed 0.

GPON(config)# service-port autoconfig vlan 407 gpon 0/0 port 7 gempport 1 multi-service user-vlan 1 tag-action translate
config service-port autoconfig complete, total 1, failed 0.

GPON(config)# service-port autoconfig vlan 408 gpon 0/0 port 8 gempport 1 multi-service user-vlan 1 tag-action translate
config service-port autoconfig complete, total 1, failed 0.

GPON(config)# save Building Configuration...

```

Image 5.4 : Configure PON Based Services

5.5 Check & Find ONU/ONT Status

To check ONU functionality properly working or not, check status properly

```

GPON(config)# interface gpon 0/0
GPON(config-interface-gpon-0/0)# show ont info all
-----
F/S P  ONT  SN          Control  Run   Config  Match  Last
ID      ID          flag    state  state  state  state  down-cause
-----
0/0 1 1  D0116AF6D481 Active   Online success match  dying-gasp
0/0 1 2  D0116AF6D4AD Active   Online success match  reboot
0/0 1 3  D0116AF6D4D9 Active   Online success match  re-register
0/0 1 4  D0116AF6D517 Active   Online success match  --
0/0 1 5  D0116AF6D505 Active   Online success match  reboot
0/0 1 6  D0116AF6D4F5 Active   Online success match  --
0/0 1 7  D0116AF6D5D0 Active   Online success match  re-register
0/0 1 8  D0116AF6D519 Active   Online success match  --
0/0 1 9  D0116AF6D4B9 Active   Online success match  --
0/0 1 10 D0116AF6D513 Active   Online success match  --
0/0 1 11 D0116AE70D44 Active   Online success match  --
0/0 1 12 D0116AF6D503 Active   Online success match  --
0/0 1 13 D0116AF6D4FD Active   Online success match  --
0/0 1 14 D0116AF6D4F1 Active   Online success match  --
-----
Total: 14, online: 14, deactive: 0, failed: 0
GPON(config-interface-gpon-0/0)#

GPON(config-interface-gpon-0/0)# show ont optical-info 1 all
-----
F/S P  ONT  Voltage  Tx optical  Rx optical  Laser bias  Temperature
ID      (V)      power(dBm) power(dBm)  current(mA) (C)
-----
0/0 1 1  0.00     0.00       -30.00      0.00        0.00      0.00
0/0 1 2  0.00     0.00       -30.00      0.00        0.00      0.00
0/0 1 3  0.00     0.00       -30.00      0.00        0.00      0.00
0/0 1 4  3.32     2.18       -4.83       16.80       28.13     24.74
0/0 1 5  3.32     1.78       -4.90       14.55       15.25     24.40
0/0 1 6  0.00     0.00       -30.00      0.00        0.00      0.00
0/0 1 7  3.34     2.91       -4.44       19.20       25.75     24.40
0/0 1 8  3.36     1.87       -5.08       15.25       15.45     27.45
0/0 1 9  3.32     2.09       -5.12       15.45     15.05     26.43
0/0 1 10 3.34     2.19       -4.65       11.85     11.85     26.43
0/0 1 11 3.28     2.20       -3.96       14.35     14.35     27.45
0/0 1 12 3.34     2.09       -5.34       14.35     14.35     27.45
0/0 1 13 0.00     0.00       -30.00      0.00        0.00      0.00
0/0 1 14 3.30     2.17       -4.80       16.10     16.10     24.06
-----
GPON(config-interface-gpon-0/0)#

```

(A) Checking ONU status

(B) Checking ONU Rx power

```

GPON(config)# show mac-address port gpon 0/0/1
-----
Total: 1
-----
MAC              VLAN  Sport  Port      Onu
-----
B8:69:F4:84:04:EE 401   0      pon0/0/1  1
-----
GPON(config)#

```

(C) Checking End Device MAC with ONU

Image 5.5 : Checking End Device MAC with ONU

5.6 Check Which ONU Defected & Not Working properly

Checking defected ONU offline and it's reason

```
GPON(config)# show ont info all
```

F/S	P	ONT ID	SN	Control flag	Run state	Config state	Match state	Last down-cause
0/0	1	1	D0116AF6D481	Active	Online	success	match	dying-gasp
0/0	1	2	D0116AF6D4AD	Active	Online	success	match	reboot
0/0	1	3	D0116AF6D4D9	Active	Online	success	match	re-register
0/0	1	4	D0116AF6D517	Active	Online	success	match	--
0/0	1	5	D0116AF6D505	Active	Online	success	match	reboot
0/0	1	6	D0116AF6D4F5	Active	Online	success	match	--
0/0	1	7	D0116AF6D50D	Active	Online	success	match	re-register
0/0	1	8	D0116AF6D519	Active	Online	success	match	--
0/0	1	9	D0116AF6D4B9	Active	Online	success	match	--
0/0	1	10	D0116AF6D513	Active	Online	success	match	--
0/0	1	11	D0116AE70D44	Active	Online	success	match	--
0/0	1	12	D0116AF6D503	Active	Online	success	match	--
0/0	1	13	D0116AF6D4FD	Active	Online	success	match	--
0/0	1	14	D0116AF6D4F1	Active	Offline	initial	initial	dying-gasp

Total: 14, online: 13, deactive: 0, failed: 0

Image 5.6 : Checking the reason of defected ONU

5.7 ONU Not passing Traffic

If a ONU has downstream MAC then It passing traffic. If not then it's not passing.

```
GPON(config)# show mac-address port gpon 0/0/1 ont 1
```

MAC	VLAN	Sport	Port	Onu
B8:69:F4:84:04:EE	401	0	pon0/0/1	1

```
GPON(config)# show mac-address port gpon 0/0/1 ont 2
```

MAC	VLAN	Sport	Port	Onu

Image 5.7 : Checking ONU passing traffic

5.8 Clear ONU MAC

For GPON 128 ONU MAC registration Limitation, need to clear offline or all MAC.

```
GPON(config)# interface gpon 0/0
GPON(config-interface-gpon-0/0)# ont delete 1 offline-list all
Total offline ONT(s):1 delete.
GPON(config-interface-gpon-0/0)# ont delete 1 all
This command will delete all the ONTs in port. Are you sure to
Number of ONTs that can be delete: 13, success: 13
GPON(config-interface-gpon-0/0)#
```

Image 5.8 : Clearing all (offline/online) MAC

5.9 Bind MAC With a Specific PON Port

Manual authorize ONU may be connect but, If not bind then ONU won't pass service.

```
GPON(config)# interface gpon 0/0
GPON(config-interface-gpon-0/0)# show ont autofind all
-----
Number          : 1
Frame/Slot      : 0/0
Port            : 1
Logic ID        : 0
Ont SN          : 443031316AF6D4FD (D011-6AF6D4FD)
Password        : 1234567890
LoId            : user
LoId Password   : password
OMCC Ver        : 0xA0
Vendor ID       : ECOM
Ont Version     : F670.1B
Ont Software Version : V1.2.6
Equipment ID    : E511G-XP-F670
Last autofind time : Mon Jan 3 00:19:31 2000
-----
Number          : 2
Frame/Slot      : 0/0
Port            : 1
Logic ID        : 1
Ont SN          : 443031316AF6D505 (D011-6AF6D505)
Password        : 1234567890
LoId            : user
GPON(config-interface-gpon-0/0)# ont add 1 1 sn-auth 443031316AF6D505 ont-lineprofile-id 0 ont-srvprofile-id 0
GPON(config-interface-gpon-0/0)# show ont info 1 all
-----
F/S P  ONT SN      Control  Run   Config  Match  Last   Desc
      ID          flag    state  state  state  state  down-cause
-----
0/0 1  1  D0116AF6D505  Active  Online success match  --
-----
Total: 1, online: 1, deactive: 0, failed: 0
GPON(config-interface-gpon-0/0)#
```

Image 5.9 : Binding ONU MAC manually

5.10 Check All The Connected Devices

Check ONU Downstream MAC. By checking MAC table from the opposite side of ONU we can check which type or kind of device using. That's end users device address.

```
GPON(config)# show ont info 0/0 1 all
-----
F/S P  ONT SN      Control  Run   Config  Match
      ID          flag    state  state  state  state
-----
0/0 1  1  D0116AF6D50D  Active  Online success match
0/0 1  2  D0116AF6D4AD  Active  Online success match
0/0 1  3  D0116AF6D519  Active  Online success match
0/0 1  4  D0116AF6D4B9  Active  Online success match
0/0 1  5  D0116AF6D4FD  Active  Online success match
0/0 1  6  D0116AE70D44  Active  Online success match
0/0 1  7  D0116AF6D503  Active  Online success match
0/0 1  8  D0116AF6D517  Active  Online success match
0/0 1  9  D0116AF6D4D9  Active  Online success match
0/0 1 10  D0116AF6D4F5  Active  Online success match
0/0 1 11  D0116AF6D505  Active  Online success match
0/0 1 12  D0116AF6D481  Active  Online success match
0/0 1 13  D0116AF6D513  Active  Online success match
-----
Total: 13, online: 13, deactive: 0, failed: 0

GPON(config)# show mac-address port gpon 0/0/1
-----
Total: 1
-----
MAC          VLAN  Sport  Port      Onu
-----
B8:69:F4:84:04:EE  1    11    pon0/0/1  12
-----
```

Image 5.10 : Checking end users device addresses

5.11 Firmware Upgradation for OLT

Browse 192.168.1.100. Go to TREE>System Upgrade>OLT>Upload then Upgrade.

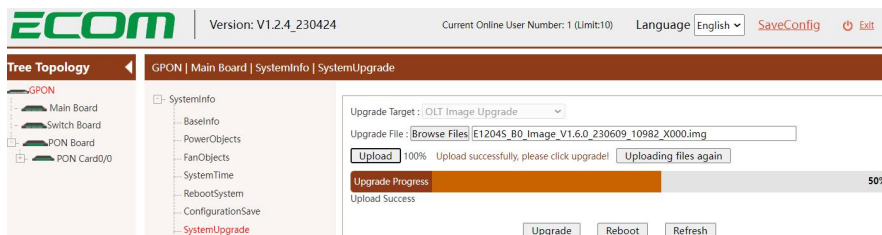


Image 5.11 : Firmware (OLT) Upgrade on WEB

5.12 Firmware Upgradation for ONU

Browse 192.168.1.100. Go to TREE>System Upgrade>ONU>Upload then Upgrade.

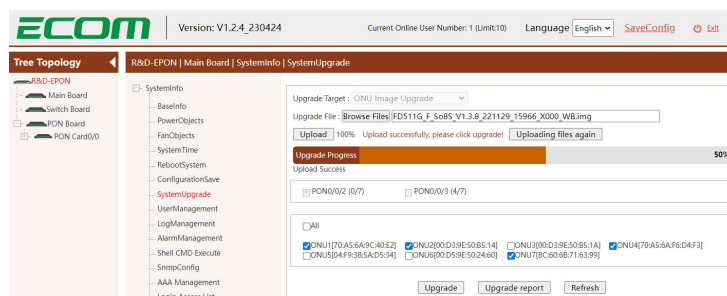


Image 5.12 : Firmware (ONU) Upgrade on WEB

5.13 VLAN Create, Delete & Assign

VLAN Configuring on GPON OLT

```
GPON(config)# vlan 400-408
Create vlan successfully:
400-408
```

```
GPON(config)# no vlan 400-408
Delete vlan successfully:
400-408
```

```
GPON(config)# vlan 409,411-415
Create vlan successfully:
409,411-415
```

```
GPON(config)# no vlan 409,411-415
Delete vlan successfully:
409,411-415
```

(A) VLAN Create

(B) VLAN Delete

```
GPON(config)# no vlan 400-408
Delete vlan successfully:
400-408
```

```
GPON(config)# interface gpon 0/0
```

```
GPON(config-interface-gpon-0/0)# vlan trunk 1-4 401-404
pon0/0/1: trunk vlan allowed , failed: 0, success: 4
pon0/0/2: trunk vlan allowed , failed: 0, success: 4
pon0/0/3: trunk vlan allowed , failed: 0, success: 4
pon0/0/4: trunk vlan allowed , failed: 0, success: 4
```

```
GPON(config)# no vlan 409,411-415
Delete vlan successfully:
409,411-415
```

```
GPON(config-interface-gpon-0/0)#
```

```
GPON(config-interface-gpon-0/0)# exit
```

(C) VLAN Assign on UPLINK

(D) VLAN Assign on PON

Image 5.13 : VLAN Create, Delete & Assign

5.14 Port Wise VLAN For Certain Service

Port wise VLAN assign. So that specific VLAN service will pass on a PON.

```
GPON(config)# interface gpon 0/0

GPON(config-interface-gpon-0/0)# vlan trunk 1-4 401-404
pon0/0/1: trunk vlan allowed , failed: 0, success: 4
pon0/0/2: trunk vlan allowed , failed: 0, success: 4
pon0/0/3: trunk vlan allowed , failed: 0, success: 4
pon0/0/4: trunk vlan allowed , failed: 0, success: 4
```

Image 5.14 : Port wise VLAN assign

5.15 ONU Wise VLAN For Certain Service

ONU wise VLAN assign. We can set different VLAN for ONU in a particular PON.

```
GPON(config)# interface gpon 0/0

GPON(config-interface-gpon-0/0)# ont port native-vlan 1 1 eth 1 vlan 401
GPON(config-interface-gpon-0/0)# ont port native-vlan 1 2 eth 1 vlan 402
GPON(config-interface-gpon-0/0)# ont port native-vlan 1 3 eth 1 vlan 403
GPON(config-interface-gpon-0/0)# ont port native-vlan 1 4 eth 1 vlan 404
GPON(config-interface-gpon-0/0)# exit
```

Image 5.15 : ONU wise VLAN assign

5.16 Configure Native VLAN Service

Assign Native VLAN on PON. So that service will auto pass on a certain VLAN.

```
GPON(config)# vlan 400-408
Create vlan successfully:
400-408

GPON(config)# interface gpon 0/0

GPON(config-interface-gpon-0/0)# vlan native-vlan 1 401
GPON(config-interface-gpon-0/0)# vlan native-vlan 2 402
GPON(config-interface-gpon-0/0)# vlan native-vlan 3 403
GPON(config-interface-gpon-0/0)# vlan native-vlan 4 404
GPON(config-interface-gpon-0/0)# vlan native-vlan 5 405
GPON(config-interface-gpon-0/0)# vlan native-vlan 6 406
GPON(config-interface-gpon-0/0)# vlan native-vlan 7 407
GPON(config-interface-gpon-0/0)# vlan native-vlan 8 408
GPON(config-interface-gpon-0/0)# exit
```

Image 5.16 : Native VLAN on PON

5.17 Management IP Setup for Remote Access

Management IP setup to access, monitor and configure OLT remotely. With a management IP we can access OLT within local network also outside network with.

```
GPON(config)# interface vlanif 1
GPON(config-interface-vlanif-1)# ip address 192.168.2.100 255.255.255.0
GPON(config-interface-vlanif-1)# exit
GPON(config)# ip route 0.0.0.0/0 192.168.2.1
```

Image 5.17 : Setup management IP

5.18 Loop-back Protection Enable for OLT & ONU

Enable Loop Back configuration to get info if loop happen. Loopback is a major problem for any network infrastructure & device management. It's a high risk issue.

```
GPON(config)# loopback-detection enable
GPON(config)# interface epon 0/0
GPON(config-interface-epon-0/0)# ont ring check 3 all enable
Number of ONTs that can be set: 7, success: 7
GPON(config-interface-epon-0/0)# loopback-detection 1-4 enable
GPON(config-interface-epon-0/0)# exit
```

Image 5.18 : Enable Loopback protection

5.19 Loop-back Detection and Prevention

Monitoring if loopback raised on any port of the GPON OLT. This is how we can monitor if loopback raise and identify which specific port defected by loopback issue.

```
GPON(config)# show loopback-detection
-----
System loopback-detection is running
Detection interval time is 30 seconds

Port      Enable Per-vlan Control      auto-recovery(time) Loopback-status Link-status
-----
ge0/0/1   dis    dis    en/block    en (120s)    undetected    up
ge0/0/2   dis    dis    en/block    en (120s)    undetected    down
ge0/0/3   dis    dis    en/block    en (120s)    undetected    down
ge0/0/4   dis    dis    en/block    en (120s)    undetected    down
xge0/0/1  dis    dis    en/block    en (120s)    undetected    down
xge0/0/2  dis    dis    en/block    en (120s)    undetected    down
pon0/0/1  en     dis    en/block    en (120s)    undetected    down
pon0/0/2  en     dis    en/block    en (120s)    undetected    down
pon0/0/3  en     dis    en/block    en (120s)    undetected    up
pon0/0/4  en     dis    en/block    en (120s)    undetected    down
-----
```

Image 5.19 : Loopback monitoring

5.20 Back Laser Warning Activation

Back laser also a major issue for FTTx network.

```
GPON(config)# interface gpon 0/0

GPON(config-interface-gpon-0/0)# anti-rogueont auto-detect all enable
Number of Ports that can be set: 8, success: 8

GPON(config-interface-gpon-0/0)# anti-rogueont auto-detect all disable
Number of Ports that can be set: 8, success: 8

GPON(config-interface-gpon-0/0)# exit
```

Image 5.20 : Back laser checking

5.21 Cooling Fan Speed Controlling

Configure cooling fan to keep the device temperate normal.

```
GPON(config)# show fan
-----
Fan speed mode: auto
Fan speed level: 1
-----
FAN[1] status: Normal      (6300RPM)
FAN[2] status: Normal      (6300RPM)
FAN[3] status: Normal      (6480RPM)
-----

GPON(config)# fan speed mode manual level1
GPON(config)# fan speed mode auto
```

Image 5.21 : Cooling FAN configure

5.22 OLT CPU Temperature Threshold

Setup CPU temperature. If it crosses then OLT will warn.

```
GPON# config

GPON(config)# temperature threshold high-temperature 80
```

Image 5.22 : Checking CPU temperature

5.23 Log report Service on for Future Troubleshoot

Enable every details of LOG to easy troubleshoot in future.

```
GPON(config)#

GPON(config)# event output all enable

GPON(config)#
```

Image 5.23 : Enable LOG report

5.24 Check Laser Power for OLT & OLU

Checking SFP module power, if it's functioning ok or not.

```
GPON(config)# interface gpon 0/0
GPON(config-interface-gpon-0/0)# show port ddm-info 1
-----
Temperature(C)           : 42.6
Supply Voltage(V)        : 3.17
TX Bias current(mA)       : 8
TX power(dBm)            : 7.52
RX power(dBm)            : -40.00
-----
Vendor                   : ANSAOEN
Product name             : AS60PG43207CPSS7
Version                  : 000
Serial number            : PG01220412000820
Vendor specific          : 00 00 00 00 00 00 00 00 00
                          00 00 00 00 00 00 00 00 00
-----
Optical Module Threshold Parameter

GPON(config-interface-gpon-0/0)# show ont optical-info 1 all
-----
F/S P  ONT  Voltage  Tx optical  Rx optical  Laser bias  Temperature
ID      (V)      power(dBm) power(dBm)  current(mA) (C)
-----
0/0 1  1      0.00      0.00      -30.00      0.00      0.00
0/0 1  2      3.32      2.11      -4.89       17.85     36.60
0/0 1  3      3.36      2.07      -4.41       22.85     37.61
0/0 1  4      0.00      0.00      -30.00      0.00      0.00
0/0 1  5      3.36      2.19      -4.68       18.90     38.63
0/0 1  6      3.30      2.17       2.90       14.15     37.95
0/0 1  7      0.00      0.00      -30.00      0.00      0.00
0/0 1  8      0.00      0.00      -30.00      0.00      0.00
0/0 1  9      3.36      1.95      -5.19       17.20     36.26
0/0 1 10      0.00      0.00      -30.00      0.00      0.00
0/0 1 11      0.00      0.00      -30.00      0.00      0.00
0/0 1 12      3.30      1.89      -4.57       18.35     36.94
0/0 1 13      0.00      0.00      -30.00      0.00      0.00
-----
```

(A) SFP module power checking

(B) Checking ONU laser power

Image 5.24 : Checking ONU laser power

5.25 Check Log & Find Issues

Checking LOG what alarm has raised. It will help to troubleshoot easily.

```
GPON(config)# show log
GPON(config)# show log
USER.INFO 2000-01-03 02:09:44 VTYSH[823]: [root@console] cmd: exit
USER.INFO 2000-01-03 02:07:54 VTYSH[823]: [root@console] cmd: interface gpon 0/0
USER.INFO 2000-01-03 02:06:39 VTYSH[823]: [root@console] cmd: temperature threshold high-temperature 80
USER.INFO 2000-01-03 02:06:37 VTYSH[823]: [root@console] cmd: config
USER.INFO 2000-01-03 02:06:34 VTYSH[823]: [root@console] cmd: exit
USER.INFO 2000-01-03 02:06:26 VTYSH[823]: [root@console] cmd: temperature threshold high-temperature 80
USER.INFO 2000-01-03 02:06:19 VTYSH[823]: [root@console] cmd: temperature threshold high-temperature 80
USER.INFO 2000-01-03 02:01:52 VTYSH[823]: [root@console] cmd: exit
USER.INFO 2000-01-03 02:01:46 VTYSH[823]: [root@console] cmd: vlan trunk 1-2 401-404
USER.INFO 2000-01-03 02:01:41 VTYSH[823]: [root@console] cmd: vlan mode 1-2 trunk
USER.INFO 2000-01-03 02:01:08 VTYSH[823]: [root@console] cmd: interface xge 0/0
USER.INFO 2000-01-03 02:01:05 VTYSH[823]: [root@console] cmd: exit
USER.INFO 2000-01-03 02:00:56 VTYSH[823]: [root@console] cmd: vlan trunk 1-2 401-404
USER.INFO 2000-01-03 02:00:48 VTYSH[823]: [root@console] cmd: interface xge 0/0
USER.INFO 2000-01-03 02:00:36 VTYSH[823]: [root@console] cmd: exit
USER.INFO 2000-01-03 02:00:21 VTYSH[823]: [root@console] cmd: vlan trunk 1-4 401-404
USER.INFO 2000-01-03 01:59:54 VTYSH[823]: [root@console] cmd: interface gpon 0/0
USER.INFO 2000-01-03 01:59:23 VTYSH[823]: [root@console] cmd: vlan 400-410
USER.INFO 2000-01-03 01:59:06 VTYSH[823]: [root@console] cmd: sysname GPON
USER.INFO 2000-01-03 01:59:01 VTYSH[823]: [root@console] cmd: config
USER.INFO 2000-01-03 01:59:00 VTYSH[823]: [root@console] cmd: enable
USER.INFO 2000-01-03 01:58:59 VTYSH[823]: [root@console:0] login via Console successfully
USER.INFO 2000-01-03 01:57:39 SWMPD[888]: Received TERM or STOP signal... shutting down...
USER.INFO 2000-01-03 01:57:39 SWMPD[888]: Received TERM or STOP signal... shutting down...
USER.INFO 2000-01-03 01:56:07 VTYSH[823]: [root@console] cmd: reboot
USER.INFO 2000-01-03 01:56:04 VTYSH[823]: [root@console] cmd: erase saved-config
USER.INFO 2000-01-03 01:56:00 VTYSH[823]: [root@console] cmd: no vlan 400-408
USER.INFO 2000-01-03 01:55:47 VTYSH[823]: [root@console] cmd: config
USER.INFO 2000-01-03 01:55:44 VTYSH[823]: [root@console] cmd: exit
USER.INFO 2000-01-03 01:54:80 VTYSH[823]: [root@console] cmd: exit
USER.INFO 2000-01-03 01:54:00 VTYSH[823]: [root@console] cmd: ont port native-vlan 1 4 eth 1 vlan 404
USER.INFO 2000-01-03 01:53:53 VTYSH[823]: [root@console] cmd: ont port native-vlan 1 3 eth 1 vlan 403
USER.INFO 2000-01-03 01:53:47 VTYSH[823]: [root@console] cmd: ont port native-vlan 1 2 eth 1 vlan 402
USER.INFO 2000-01-03 01:53:30 VTYSH[823]: [root@console] cmd: ont port native-vlan 1 1 eth 1 vlan 401
USER.INFO 2000-01-03 01:53:34 VTYSH[823]: [root@console] cmd: interface gpon 0/0
USER.INFO 2000-01-03 01:53:30 VTYSH[823]: [root@console] cmd: exit
USER.INFO 2000-01-03 01:53:26 VTYSH[823]: [root@console] cmd: ont port native-vlan 1 1 eth 1 vlan 405
USER.INFO 2000-01-03 01:53:21 VTYSH[823]: [root@console] cmd: ont port native-vlan 1 1 eth 1 vlan 401
USER.INFO 2000-01-03 01:53:17 VTYSH[823]: [root@console] cmd: interface gpon 0/0
USER.INFO 2000-01-03 01:53:10 VTYSH[823]: [root@console] cmd: exit
USER.INFO 2000-01-03 01:53:08 VTYSH[823]: [root@console] cmd: ont port native-vlan 1 1 eth 1 vlan 401
USER.INFO 2000-01-03 01:52:46 VTYSH[823]: [root@console] cmd: interface gpon 0/0
USER.INFO 2000-01-03 01:51:11 VTYSH[823]: [root@console] cmd: exit
USER.INFO 2000-01-03 01:51:07 VTYSH[823]: [root@console] cmd: anti-roguent auto-detect all disable
USER.INFO 2000-01-03 01:51:03 VTYSH[823]: [root@console] cmd: anti-roguent auto-detect all enable
USER.INFO 2000-01-03 01:50:53 VTYSH[823]: [root@console] cmd: interface gpon 0/0
USER.INFO 2000-01-03 01:50:37 VTYSH[823]: [root@console] cmd: exit
USER.INFO 2000-01-03 01:50:33 VTYSH[823]: [root@console] cmd: anti-roguent auto-detect all disable

GPON(config)# 2000-01-03 02:15:38 PON 0/0/1 ONU
2000-01-03 02:15:38 PON 0/0/1 ONU 2 Onu offline
2000-01-03 02:15:38 PON 0/0/1 ONU 3 Onu offline
2000-01-03 02:15:38 PON 0/0/1 ONU 4 Onu offline
2000-01-03 02:15:38 PON 0/0/1 ONU 5 Onu offline
2000-01-03 02:15:38 PON 0/0/1 ONU 6 Onu offline
2000-01-03 02:15:38 PON 0/0/1 ONU 7 Onu offline
2000-01-03 02:15:38 PON 0/0/1 ONU 8 Onu offline
2000-01-03 02:15:38 PON 0/0/1 ONU 9 Onu offline
2000-01-03 02:15:38 PON 0/0/1 ONU 10 Onu offline
2000-01-03 02:15:38 PON 0/0/1 ONU 11 Onu offline
2000-01-03 02:15:38 PON 0/0/1 ONU 12 Onu offline
2000-01-03 02:15:38 PON 0/0/1 ONU 13 Onu offline
```

(A) Checking event report

(B) Checking LOG report

Image 5.25 : Checking event report

Chapter 6

Remotely Monitor With NMS

6.1 What is NMS

NMS is a Network Monitoring System. Often termed a Network Management System. A Network Monitoring System is a subset of network management that monitors computer networks for problems and flaws to maintain performance. NMS collects information from all connected devices. Then the collected data will analyze & categorize to identify network issues. Those network issues can be:

- Device failures
- Interface errors
- Check LOG
- Check alarm
- Packet loss
- Troubleshoot & Resolve
- Configure OLT
- ONU Manage
- Firmware upgrade & corruption resolve
- Load balance

6.2 Install NMS

Step1:

Download and then install and run the **StartNms.exe** file.

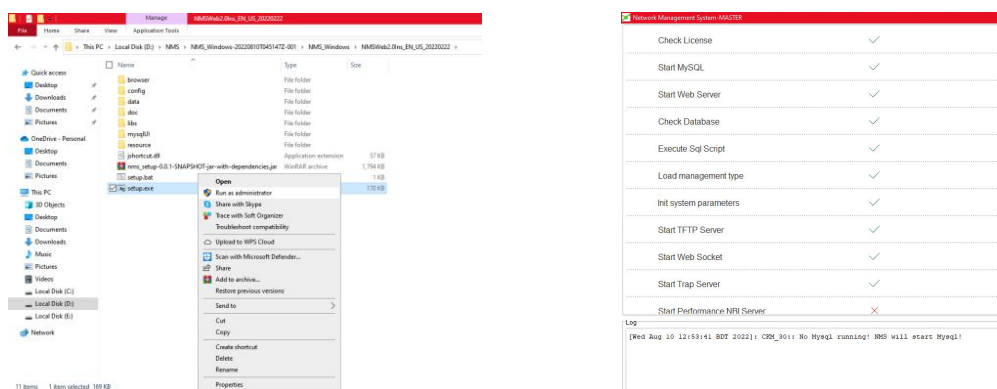


Image 6.1 : Install NMS

Step2: Then go to browser & type **localhost:8888**. Log in with **root & 1234**

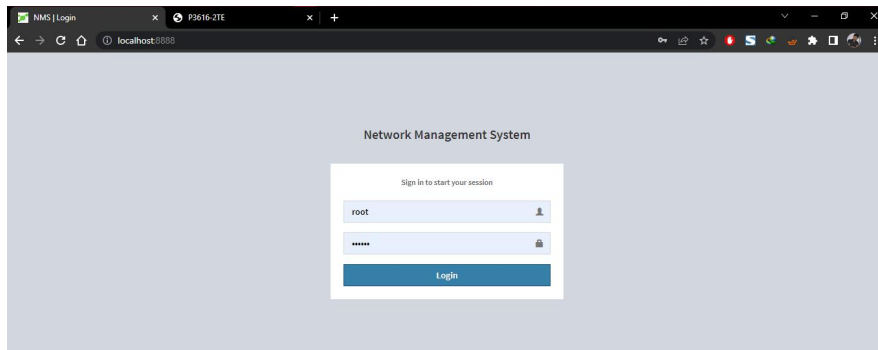


Image 6.2 : Browse localhost:8888

6.3 Configure NMS

Now, we will configure NMS with Device: P3616-2TE into PC then monitor it.

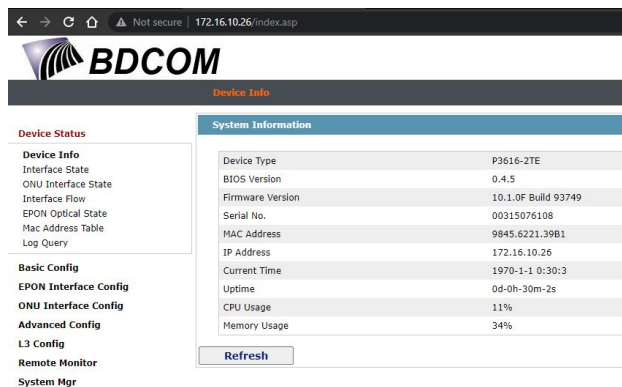


Image 6.3 : Configure NMS into OLT

Step1: Then user interface will show. Where user will monitor all connected devices.

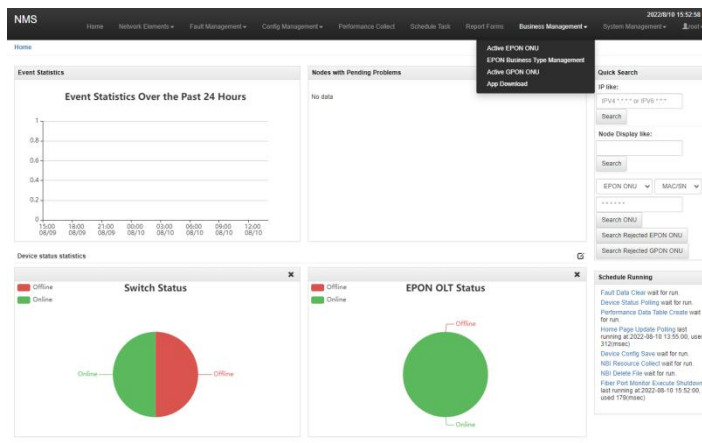


Image 6.4 : NMS dashboard

Step2: Before configure NMS, We need to con figure OLT Which we want to monitor. Now, Access the OLT and run the command as shown in the picture:

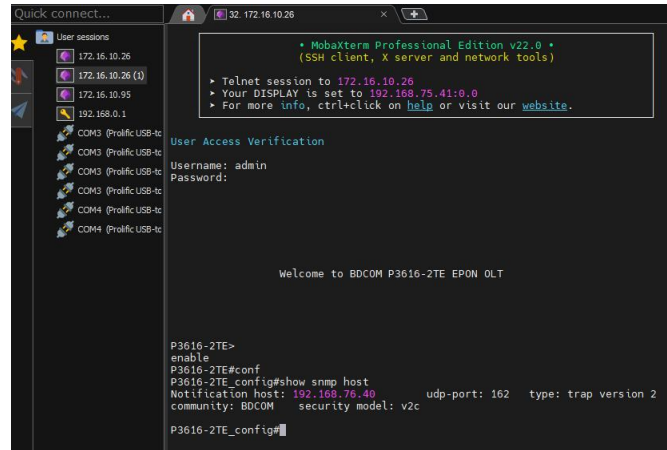


Image 6.5 : Configuring OLT in CLI

Step3: Add new device go to **Network Elements > Discovery Element**

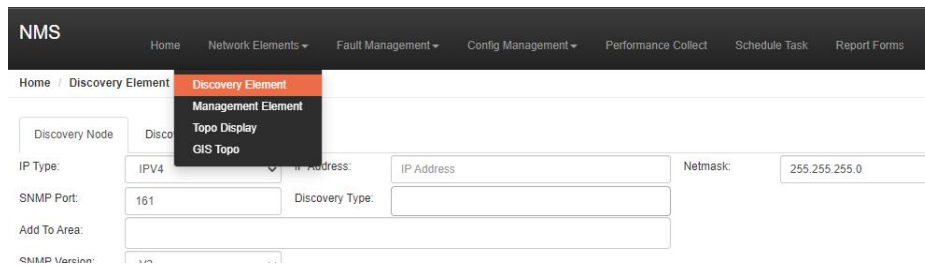


Image 6.6 : Add device into NMS

Step5: Input - **IP type: IPV4, SNMP Port: 161, IP: 172.16.10.26, NetMask: 255.255.255.0 Discovery Type: EPON Community: BDCOM.**

Then press **Add > Discovery**

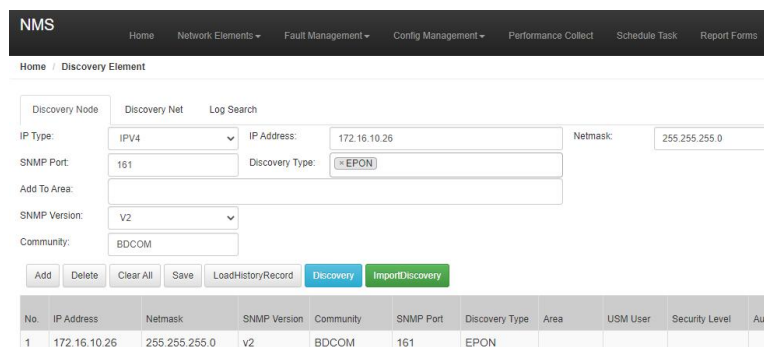


Image 6.7 : Adding info of the OLT into NMS

Step4: If all the input data right, NMS will find the device and start collect data

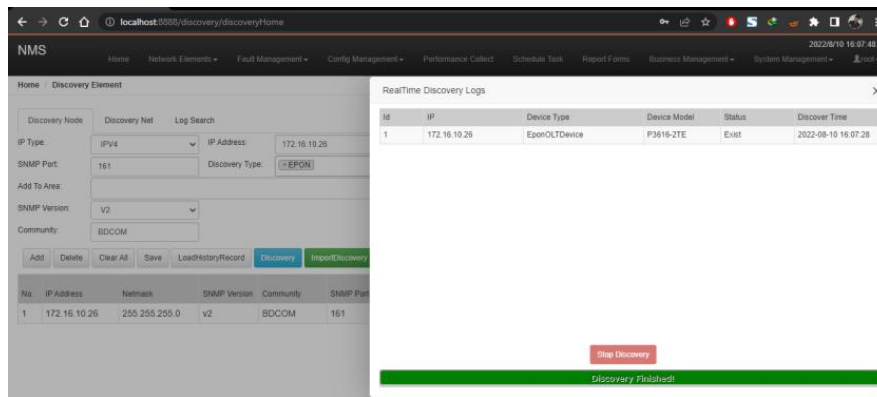


Image 6.8 : Showing the OLT if online

6.4 Monitor Devices in NMS

For monitoring added devices status & configure followed these steps

Step1: Access the added device go to **Network Elements > Management Element**

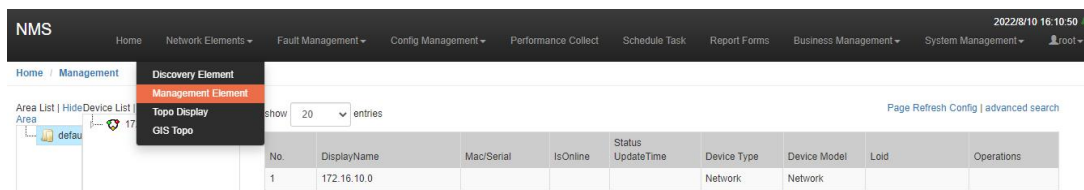


Image 6.9 : Access OLT by using NMS

Step2: Here we can access the particular device and configure it

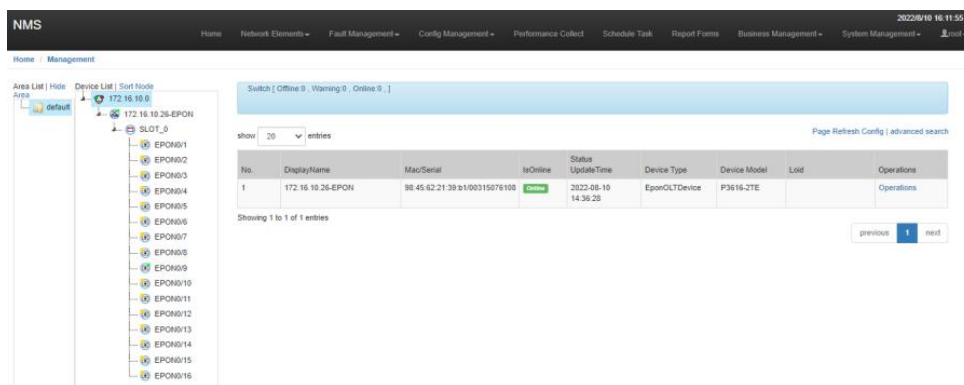


Image 6.10 : Inside the OLT by NMS

Step3: Showing all connected ONU's in the OLT's PON port. To configure go to **Operations > Config** then set values as desire. Then ONU will set the value.

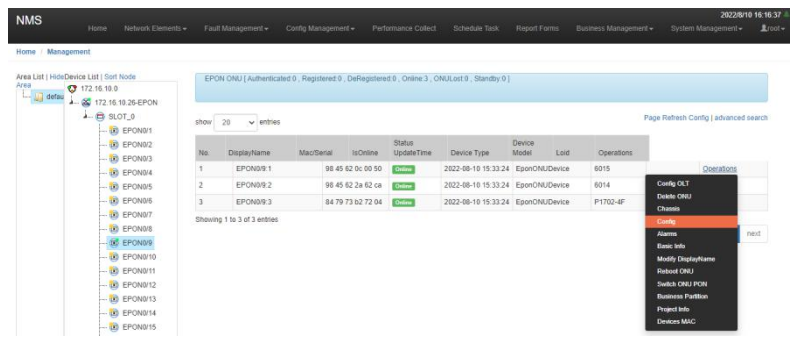


Image 6.11 : All configuration of OLT inside NMS

Step4: Here all the available function showing for the ONU Configure.

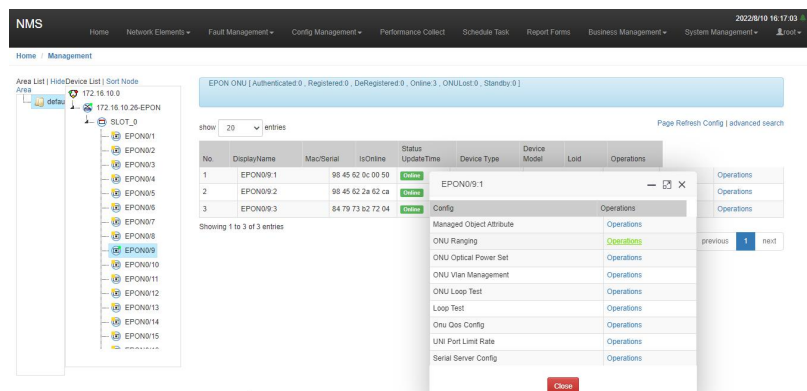


Image 6.12 : Available function of OLT into NMS

Note: If Device goes down / Link down or any issue raise. Like as PON module up-down, ONU not passing packet or any errors happen. Then Automatically alarm/notification will generate. Also, network engineer can configure as this alarm/notification can get through mobile SMS, E-Mail. This NMS system will make easier to manage devices remotely

Chapter 7

Conclusion

7.1 What I've Learned

On day one of this internship period, I was petrified. I was puzzled about the complexity of networking, its calculations, technological advantages & disadvantages, deployment theory, practical field challenges, etc. After this internship, I'm confident enough to deploy any FTTx network structure configurations. I'm confident enough to work with any vendor OLT and MikroTik routers.

During this internship period, I attended FTTx workshops, seminars, and MTCNA vendor exams. I've experience working on ECOM, BDCOM, VSOL, CDATA, DBC, RicherLink, SyroTek, Dasan OLT, and MikroTik CCR2116-12G-4S+ router setup.

I've learned to splice optical fiber, measure optical laser, firmware upgrade or downgrade, and check hardware for warranty claims. I can set up OS on any model of MikroTik router and switches. I was also introduced to various persons dominating and leading the current networking field with their skills and experience. I learned a lot from them..

7.2 Overall Experience

Overall experiences on this internship, it was an excellent journey for me. The transformation from a student to a 9 to 5 working person was excruciating. Through this journey, I've seen bad days and good days too. I have received compliments from satisfied clients and been scolded if I couldn't solve issues.

There is a wise saying, "I never lose. Either I won or learned." So I may not win every time, but I have learned a lot and still learning. The networking sector is a vast area. Every day it changes rapidly. So I need to study consistency for future success in the networking job field. There is no substitute for success without education, training, course, and learning from experts.

7.3 Carrier Scope in Future

There's great scope in telecommunication sector. World is changing rapidly. Everything transforming into automation or managed by network communication. So a lots of networking engineers required in job market right now. Also networking skill can leads to a new carrier like as security expert, system admin etc. Some of the example of current market for a network engineers

- NOC Support Engineer
- Network Engineer
- IT Executive
- IT Specialist
- IT Support Engineer
- System Engineer
- System Admin
- ISP businessman
- Network Analyst
- Cyber Security officer

Because of everything moving into automation there's various new type of job opportunity unlocked. Which are cyber security related jobs, DevOps, IoT related jobs, Network design, Networking monitoring etc.

References

1. Introduce with IQRA Technologies Ltd: “<https://iqratech.com.bd/about-us>” [Access Time 12 August 2023 10:02 AM]
2. IQRA Technologies Ltd Products “<https://iqratech.com.bd/shop>” [Access Time 12 August 2023 11:05 AM]
3. OSI Model: “https://en.wikipedia.org/wiki/OSI_model” [Access Time 13 August 2023 04:20 PM]
4. IPv4 Subnetting: “https://www.tutorialspoint.com/ipv4/ipv4_subnetting.htm” & “<https://subnetipv4.com>”. [Access Time 13 August 2023 04:20 PM]
5. TCP/IP Model: “<https://www.geeksforgeeks.org/tcp-ip-model/>” [Access Time 13 August 2023 05:00 PM]
6. GPON Technology: “<https://en.wikipedia.org/wiki/GPON>” [Access Time 15 August 2023 12:16 AM]
7. NMS: “https://en.wikipedia.org/wiki/Network_monitoring” [Access Time 17 August 2023 09:16 AM]

Internship Completion Letter



Date: 16 January 2022

“TO WHOM IT MAY CONCERN”

This is to certify that **Toufiqur Rahman** is an Undergraduate student of Daffodil International University from **Department of Electronics and Telecommunication Engineering (ETE)**.

He has successfully completed **03(Three) months (From 15th October 2021 to 15th January 2022)** long Internship at this Company.

His internship activity includes understanding the operational and maintenance activate of the Telecommunication network of this company.

During the period of his internship program with us, he has been exposed to different process was found punctual and hard working. We wish him every success in his life.

A handwritten signature in black ink, appearing to read 'Quazi Rahman', is written over a horizontal line.

Engr. Quazi Mahmudur Rahman

Director & Chief Executive Officer (CEO)

IQRA TECHNOLOGIES LTD.

Contact: +8801318313838

Email: mahmud@iqratech.com.bd

Web: www.iqratech.com.bd



236, New Elephant Road, Sheltech Sieera, 4th Floor, Suite # 405, Dhaka-1207.
Phone : +88 01318 313 837-38, E-mail: iqratechbd@gmail.com, Web: www.iqratech.com