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Module 1: Evolution of Transport Networks

Course Overview

Transport networks have been the backbone of all the possible telecommunication systems across the globe. Be it our traditional fixed line networks or internet services provider connections or even latest 5G mobile networks, none of these would have been possible without transport networks. Like any other system, Transport networks have also evolved over the years to fulfill the demands of end user applications. This course takes the participants through the journey of evolution of transport networks. It starts with basic categorization of wired and wireless media types. It provides the explanation of the features, specifications and applications of each type and highlights the key differences between them. This course also details the possible transport network topologies and multiplexing techniques.

Course Pre-requisites

The course is applicable to all technical and non-technical professionals of any organization operating in telecom technology domain.

Course Objectives

Upon completion of this training, the participants will be able to:

- Categorize the various transmission media types
- List the examples of wired and wireless media categories
- Explain the features and specifications of each type of transport media
- Differentiate the use cases, advantages, and disadvantages for different types of transport media
- Compare the most widely used transport media – Microwave versus Optical Fibre
- Describe the applications, advantages, and disadvantages of various transport network topologies
- Explain the basic multiplexing techniques to enhance the capacity and distance of transmission network

Course Duration

This duration of this e-learning course is of approximately 1 hour.

Course Outline

1. Transmission Media
    - Types of Transmission Media
        a. Wired or Guided media
            i. Twisted Pair (STP, UTP) cables
            ii. Co-axial cables
            iii. Fibre Optic cables
        b. Wireless or Unguided media
            i. Radio waves
            ii. Microwave
            iii. Satellite
            iv. Others- Infrared, Bluetooth, Wi-fi etc.
    - Comparison between Copper (metallic) and Optical Fibre medium
    - Microwave versus Optical Fibre
    - Transport Network Topologies
        a. Bus topology
        b. Star topology
        c. Ring topology
        d. Mesh topology
        e. Tree topology
        f. Hybrid topology
    - Connectivity Options of Network Topologies
        a. Point-to-point
        b. Point-to-multipoint
    - Multiplexing Techniques in Transport Network
        a. Frequency Division Multiplexing (FDM)
        b. Time Division Multiplexing (TDM)
        c. Wavelength Division Multiplexing (WDM)
        d. Dense Wavelength Division Multiplexing (DWDM)

Module 2: Identify Optical Fibre

Course Overview

Optical fibre communication has proven its credibility when it comes to the ever-evolving applications and use case scenarios over other transport media. This course takes the participants through the whole concept of identification of optical fibres for the intended application. It starts with comparing the various types of optical fibres based on modes of propagation and material. It then explains the concepts of fibre optics, specific use cases of different spectrum bands used in optical fibre communication. This course also lists the applications of optical fibres in fixed access and mobile networks.

Course Pre-requisites

The course is applicable to all technical and non-technical professionals of any organization operating in telecom technology domain.

Course Objectives

Upon completion of this training, the participants will be able to:

- List the types of optical fibres
- Differentiate the use cases, advantages, and disadvantages for single mode and multi-mode types of fibres
- Explain the principle of reflection, refraction, and Total Internal Reflection used in optical fibre communication
- Calculate the light collecting capabilities in terms of Numerical Aperture and V-number in both single mode as well as multi-mode fibres
- List the reasons for losses in optical fibres
- Explain the relevance and the applications of different spectrum bands allocated for optical fibre communication
- Comprehend the applications of optical fibres in fixed access and mobile networks

Course Duration

This duration of this e-learning course is of approximately 35 minutes.

Course Outline

- Types of Optical fibres – concepts and applications
  a. Single mode, multi-mode
  b. Step-index, Graded Index multi-mode fibres
  c. Polarization Maintaining fibre
- Principle of optical fibre communication
  a. Reflection, Refraction and Total Internal Reflection
  b. Light Collecting Capability
     i. Mode Field Diameter (MFD)
     ii. Critical Angle
     iii. Acceptance Cone
     iv. Numerical Aperture (NA)
  c. Number of modes supported by different types of fibre
- Optical Fibre Spectrum
  a. First, Second and Third windows
  b. O, E, S, C, L and U wavelength sub-bands
- Applications of Optical fibre in
  a. Fixed Access Network
  b. Cellular networks

Module 3: Fibre Optic Cable Design

Course Overview

Variety of application scenarios makes Optical fibre makes it a preferred choice amongst various types of transport media options. Hence Fibre Optic cable design plays an important role when it comes to aligning it with the intended use case. This course takes the participants through the construction of the optical fibre and the types of cable assembly for different types of optical fibre cables. It starts with explaining the cable types for location of the installation as well as the type of environment – be it indoor, outdoor or overhead, underground or in a submarine. It then expands further towards the categorization of fibre optic cables based on construction.

Course Pre-requisites

The course is applicable to all technical and non-technical professionals of any organization operating in telecom technology domain.

Course Objectives

Upon completion of this training, the participants will be able to:

- List the cable types depending upon location of installation and type of environment
- Differentiate the cable design principles of fibre optic cables for Indoor, outdoor or multi-purpose (I/O) environments
- List the features and specifications of different type of fibre optic cables based on construction type like Loose Tube Cable, Tight Buffered Cable and Ribbon Cables

Course Duration

This duration of this e-learning course is of approximately 25 minutes.

Course Outline

- Types of Optical fibres – based on location and type of environment
  a. Indoor cable types
     i. Simplex cables
     ii. Duplex cables
     iii. Multi-fibre cables
     iv. Breakout cables
     v. Heavy, Light, and Plenum-Duty cables
     vi. Riser cables
  b. Outdoor cable types
     i. Overhead cables
     ii. Direct Burial cables
     iii. Indirect Burial cables
     iv. Submarine cables
  c. Indoor/Outdoor Cables (Multi-purpose)
- Types of Fibre Optic Cables – based on construction
  a. Loose Tube Cable
  b. Tight Buffered Cable
  c. Ribbon Cables

Module 4: Fibre Optic Sources and Amplifiers

Course Overview

Fibre optic cable is just a dark fibre pipe without any signal passing through it. It is Optic sources that enable communication through it. Like any other transport medium, fibre optic cable also has limitation in terms of the distance it can allow communication between a transmitter and the receiver. To overcome this limitation, there are optical amplifiers which are used to extend the distance of communication over optical fibre. This course starts with explaining the functional principles of semiconductor diodes to act as transmitters over designated wavelengths. It then deep dives into comparing specifications, features and applications of different sources, regenerators and amplifiers.

Course Pre-requisites

The course is applicable to all technical and non-technical professionals of any organization operating in telecom technology domain.

Course Objectives

Upon completion of this training, the participants will be able to:

- Understand the principles of semiconductor technology behind fibre optic sources
- List the advantages and disadvantages of LEDs, Laser Diodes and Vertical Cavity Surface Emitting Lasers or VCSELs as optical sources
- Compare the specifications and applications of different fibre optic sources
- List the commonly used transceivers in the industry
- Explain the functioning of different types of Optical regenerators
- Differentiate the functioning and applications of various optical amplifiers such as Semiconductor Optical amplifiers or SOA, Erbium-Doped Fibre Amplifiers or EDFA and Raman amplifiers

Course Duration

This duration of this e-learning course is of approximately 40 minutes.

Course Outline

- Semiconductor technology behind photo diodes
- Types of Fibre optic sources, advantages and disadvantages
  a. Light Emitting Diodes or LEDs
  b. Laser diodes
  c. Vertical Cavity Surface Emitting Lasers or VCSELs
- Specifications and applications of different fibre optic sources
- Commonly used transceivers (SFP or XFP)
- Optical regenerator (1R, 2R, 3R)
- Optical Amplifiers – Functioning, supported wavelengths and applications
  a. Semiconductor Optical amplifiers or SOA
  b. Erbium-Doped Fibre Amplifiers or EDFA and
  c. Raman amplifiers

Module 5: Fibre Optic Couplers, Connectors and Patch Cords

Course Overview

There are many occasions when it is necessary to connect a fibre optic cable to another object. It may be the fibre optic cable needs to be connected to another cable or electronic interface device where the optical signal is converted into an electrical signal or light source. In order to achieve the minimum amount of lost light, it is essential to use the correct form of fibre optic connector. Optical devices that connect three or more fibre ends, split an input between two or more outputs or combine two or more inputs into a single output, are known as fibre optic couplers. The device allows the transmission of light waves through multiple paths. Fibre patch cables, also called fibre-optic patch cords, are typically cables containing one or two optical fibres, equipped with standardized fibre connectors at both ends. This course begins with an explanation of some common types of fibre optic connectors, couplers and patch cords. Plus, it will cover the advantages and disadvantages of different types of fibre optic connectors, couplers and patch cords.

Course Pre-requisites

The course is applicable to all technical and non-technical professionals of any organization operating in telecom technology domain.

Course Objectives

Upon completion of this training, the participants will be able to:

- Understand the applications of optical fibre couplers, connectors and patch cords
- List the commonly used fibre optic couplers, connectors, patch cords
- Compare the specifications and applications of different couplers, connectors and patch cords
- Explain the functioning of couplers, connectors and patch cords
- Differentiate the functioning and applications of various couplers such as Y and T-couplers, Tree and star couplers, Connectors such as ST, SC, FC, LC, MU, E2000, and MTRJ etc.
- List the advantages and disadvantages of different types of optical fibre components

Course Duration

This duration of this e-learning course is of approximately 50 minutes.

Course Outline

- Optical Fibre Couplers Information
- Passive and Active Couplers
- Types of Couplers
  a) Splitters (Y-Couplers and T-Couplers)
  b) Combiners
  c) X-Couplers
  d) Trees
  e) Stars
- Coupler Type
- Selecting Optical Fibre Connectors
- Major Components of Connectors
- Types of Optical Fibre Connectors
  a) Straight Tip (ST) Connector
  b) Subscriber Connector (SC)
  c) Lucent Connector (LC)
  d) Ferrule Connector (FC)
  e) MU Connector
  f) E 2000
  g) Subminiature Version A (SMA) Connectors
  h) Mechanical Transfer Registered Jack (MTRJ) Connector
  i) Volition Fibre-45 (VF-45) and Opti Jack Connector
  j) FDDI and ESCON Connectors
  k) MT Connector (MPO/MTP)
- Fibre Patch Cords
- Special Types of Fibre Patch Cord
  a) Armored Fibre Patch Cord
  b) Bend Insensitive Fibre Patch Cord
  c) Mode Conditioning Fibre Patch Cord
  d) Low Insertion Loss Fibre Patch Cord
  e) Uniboot Fibre Patch Cord

Module 6: Fibre Optic Loss, Dispersion, Optical Power Budget

Course Overview

In an optical fiber medium, light rays travel in jagged lines causing signal loss or dispersion. Higher-order mode loss results when light traveling in the fiber core is radiated across the fiber cladding. All these factors limit the transmission distance of the fiber. To make sure the fiber-optic connection has enough power for correct operation, you need to calculate the power budget of the link. This course begins with an explanation of the various losses in optical fibers that contribute to link loss. This is followed by a description of how to measure the total loss in an optical fiber, while all types of losses that must be considered.

Course Pre-requisites

The course is applicable to all technical and non-technical professionals of any organization operating in telecom technology domain.

Course Objectives

Upon completion of this training, the participants will be able to:

- List the various types of optical fibre losses
- Understand various types of losses such as attenuation, absorption, scattering losses
- Explain optical fibre dispersion
- List the normally occurring dispersion losses
- Understand each parameter used for link budget calculation

Course Duration

This duration of this e-learning course is of approximately 55 minutes.

Course Outline

- Losses in Optical Fibre
  a) Attenuation
  b) Absorption
  c) Scattering Losses
  d) Rayleigh Scattering
  e) Mie Scattering
- Optical Fibre Dispersion
- Types of Dispersion
  a) Modal Dispersion
  b) Chromatic Dispersion
  c) Polarization Mode Dispersion
- Calculation of Optical Power Budget
- Parameters of Link Budget Calculation

Module 7: Fibre Laying Installation Guidelines

Course Overview

Fibre Optics Technology is widespread around the world due to its advantageous features and customizable capabilities. It has been applied in many industries, which is why it is bound to design, manufacture and offer transmission performance at certain standard specifications. This course introduces participants to the methods of installing fibre optic cables inside and outside the plant. The course will also cover the benefits of labeling in optical distribution frames and fibre management systems in optical transmission networks.

Course Pre-requisites

The course is applicable to all technical and non-technical professionals of any organization operating in telecom technology domain.

Course Objectives

Upon completion of this training, the participants will be able to:

- Understand the characteristics, benefits and application of geographic information system (GIS) in optical fibre installation
- Explain and list the key steps of fibre route planning inside and outside the plan
- Understand the requirements while choosing fibre optic components and plan the actual installation.
- Mention the basic functions of Optical Distribution Frames
- Identify labelling in fibre management system

Course Duration

The duration of this e-learning course is of approximately 50 minutes.

Course Outline

- GIS System Definition, Concepts
- GIS Characteristics, Benefits and Applications
- Fibre Route Planning
- Fibre Optic Design Network
  a) Premises Installation Guidelines
  b) Outside the Plant Installation Guidelines
- Optical Distribution Frame or ODF Cable Termination Planning
- Labeling in a fibre Management System or FMS

Module 8: Safety Guidelines and Fibre Optic Installation Techniques

Course Overview

Fiber optic cables were designed to enhance voice and data communication in many different applications. The flexibility of the technology is extraordinary and advances in methods of communication have revealed even more uses for fiber optics. Compromise on any of the safety points will introduce invisible health dangers, can take extended periods of time to diagnose. This course introduces participants to the safety guidelines that an engineer must keep in mind when installing fiber optic cables in a plant. The course will also cover a variety of optical fiber installation techniques in underground, aerial and submarine networks.

Course Pre-requisites

The course is applicable to all technical and non-technical professionals of any organization operating in telecom technology domain.

Course Objectives

Upon completion of this training, the participants will be able to:

- Understand all the safety aspects that engineer must keep in mind when installing fibre optic cables
- List of health and safety tools and kits during the fibre cable installation
- Explain important safety practices that must be followed during the fibre optic installation
- List and explain different methods to install fiber optic cable
- Understand various types of fibre optic installation techniques and related recommended procedures
- Explain “Figure-8” technique in underground fibre cable installation
- List all traditional method of laying optical fibres such as Mini and Micro Trenching and Trenchless technique
- List complete series of tests that should be done while installing fibre optic cable

Course Duration

The duration of this e-learning course is of approximately 50 minutes.

Course Outline

- Safety Guidelines
- Health and Safety tools and kits
- Fibre Installation Techniques
- Underground Installation Techniques
  a) Figure-8
  b) Mini and Micro Trenching Technology
  c) Trenchless Technology
  d) Moling Impact
  e) Horizontal Directional Drilling (HDD)
- Merits and Demerits of Trenching and Trenchless Technology
- Duct Integrity Test
  a) Air Test
  b) Foam Sponge Test
  c) Shuttle Test
  d) Pressure Test
- Fibre Optic Cable Blowing
- Aerial Fibre Cable Installation

a) Moving reel method and
b) Stationary reel method

Module 9: Fibre Tools and Equipment for Testing, Splicing

Course Overview

Fibre Optic cable requires using various mechanical tools and equipment that must adhere to standard parameters and settings, to assists the fibre-optic devices in the successful transmission of information from source to receiver. These tools and equipment also help to reduce signal loss and strengthen weak signals. This course begins with an explanation of various tools like Optical Time Domain Reflectometer, Visual Fault Locator, Optical Spectrum Analyzer, Optical Power Meter, Mechanical Cleavers, Mechanical Splicers and Optical Fusion Splicers and how they contribute in carrying out seamless transmission of information.

Course Pre-requisites

This course is applicable to all technical and non-technical professionals involved in the telecommunication domain.

Course Objectives

Upon the completion of the training, the participants will be able to:

- Understand the working principle, parameters involved and applications of the Optical Time Domain Reflectometer
- Use of Visual Fault locator, its working principle, important parameters involved and its application as a continuity tester
- Understand the working principle of Optical Spectrum Analyzer and its use
- Explain the structure, constituents and working principle of Optical Power Meter
- Understand Mechanical Cleavers and their use
- Explain the procedure to use mechanical splicers to splice two bare fibers and secure them mechanically
- Describe Fusion Splicing procedure using Optical Fusion Splicers

Course Duration

The duration of this e-learning course is approximately 25 minutes.

Course Outline

- Fibre Testing Tools
  a) Optical Time Domain Reflectometer (OTDR)
  b) Operation of Visual Fault Locator
  c) Optical Spectrum Analyzer
  d) Optical Power Meter
- Fibre Splicing Tools
  a) Mechanical Cleavers
  b) Mechanical Splicers
  c) Optical Fusion Splicer

Module 10: Fibre Maintenance and Troubleshooting

Course Overview

It is extremely important that optical fiber cables are regularly inspected for defects and performance. There are simple procedures to test, troubleshoot and maintain a fibre-optic system. This course begins with the detailed explanation about fibre maintenance-preventive and corrective maintenance. In the subsequent section, the prime causes leading to service interruptions in optical fibre are detailed. Further, the course concludes with discussion on various techniques to find faults in the optical fibre.

Course Pre-requisites

This course is applicable to all technical and non-technical professionals of any organization operating in telecom technology domain.

Course Objectives

Upon the completion of training, the participants will be able to:

- Define Preventive maintenance and tasks carried out for detecting faults.
- Define Corrective maintenance and activities involved in the same.
- Describe the possible causes of service interruptions in optical fibre communication.
- Describe the use of OTDR (Optical Time Domain Reflectometer) and Visual Fault Locator to find fault in Optical Fibre cable.

Course Duration

This duration of this e-learning course is of approximately 10 minutes.

Course Outline

- Preventive Maintenance
- Corrective Maintenance
- Causes of Service Interruptions
- Common Methods of Fault Finding
  a) Optical Time Domain Reflection (OTDR)
  b) Visual Fault Locator (VFL)