Teracom Training Institute
Certified IP Telecom Network Specialist (CIPTS) Certification Package

Invest in yourself with Teracom's CIPTS Certification Package, four online courses giving you a solid foundation in datacom and networking, including Ethernet, IP and MPLS networking, understanding the fundamentals, technologies, jargon and buzzwords, and most importantly, the underlying ideas and how it all fits together… plus Telecommunications Certification Organization (TCO) Certified IP Telecom Network Specialist (CIPTS) Certification to prove it.

Benefit from decades of knowledge, insight and experience distilled into clear lessons, logically organized to build one concept on another. Get a major career-enhancing and productivity-enhancing knowledge upgrade – learning that you can't get on the job, reading magazines or talking to vendors… solid understanding that lasts a lifetime.

The CIPTS Certification Package includes four courses on IP telecom, provide a practical understanding of Ethernet LANs, VLANs, Optical Ethernet, IP and MPLS, and how these technologies work together to implement a converged network carrying phone calls, video and Internet traffic on a single network. We begin with the OSI Reference Model as a framework.

Each course has an exam consisting of ten multiple-choice questions. Passing the course exams proves your knowledge and results in your certification as a Certified IP Telecom Network Specialist. You'll get a full-color TCO Certificate suitable for framing, plus a personalized Letter of Introduction / Letter of Reference introducing you and explaining the knowledge your Certification represents.

Your investment is protected with a 30-day, 100% money-back guarantee.

Get started now!

Certified IP Telecom Network Specialist (CIPTS) Package Overview

The four courses in the CIPTS package are on the IP telecommunications network and its three main enabling technologies: Ethernet, IP and MPLS, and beginning with the OSI model and its layers to establish a framework.

Course 2212 The OSI Layers and Protocol Stacks establishes a framework for all of the subsequent discussions: the OSI 7-Layer Reference Model, which identifies and divides the functions to be performed into groups called layers. This framework is required to sort out the many functions that need to be performed, and to be able to discuss separate issues separately.

First, we'll define the term "protocol" and compare that to a standard. Then we'll define "layer" and how a layered architecture operates, and provide an overview of the name, purpose and function of each of the seven layers in the OSI model.

Then, we'll go back through the story more slowly, with one lesson for each of the layers, examining in greater detail the functions that have to be performed and giving examples of protocols and how and where they are used to implement particular layers.

The result is a protocol stack, one protocol on top of another on top of another to fulfill all of the required functions. To make this more understandable, this course ends with the famous FedEx Analogy illustrating the concepts using company-to-company communications, and an analogy of Babushka dolls to illustrate how the protocol headers are nested at the bits level.

On completion of this course, you will be able to define a protocol and differentiate that from a standard, explain why a layered architecture is required, list the seven layers of the OSI model, the name, purpose and functions of each one, and explain how a protocol stack operates and where the protocol headers are located. Detailed description of Course 2212 The OSI Layers and Protocol Stacks begins on page 5.

Next is Course 2211 LANs, VLANs, Wireless and Optical Ethernet – which could be titled "Layer 2".

We'll begin with the fundamental idea of a broadcast domain, first implemented with a bus cable. We'll understand LAN interfaces, and how each interface has a hard-coded MAC addresses, and how the address field in a MAC frame is used to indicate for whom a frame is intended, since all stations in a broadcast domain receive it.

We'll then understand how the bus is now inside a box called an Ethernet switch, LAN switch or Layer 2 switch, how the switch learns the MAC address of each station, and how the LAN switch forwards MAC frames to one or more stations.

Then we'll go over the important idea of VLANs, which are broadcast domains defined in software, and how VLANs can be used to segregate traffic by device type and by work area at the enterprise level, and segregate traffic by customer at the carrier level.

You'll learn about the many standards for implementing Ethernet, 802.3 from the original 10BASE-5 to 1000BASE-T on Categories of twisted-pair cables, 802.11 wireless LANs and Wi-Fi certification.

We'll finish with a compressive lesson on Optical Ethernet: Ethernet on fiber, which is the basis of today's telecom network. You'll learn how bits are represented on fiber, how fiber cables are installed underground, and how fiber splicing is used to connect bulk fiber to equipment. We'll review Optical Ethernet standards from 1 Gb/s to 100 Gb/s.

On completion of this course, you will be able to define a broadcast domain, explain Ethernet and the 802 standards, MAC addresses, LANs and VLANs, the jargon and buzzwords, the underlying ideas, and how it all works together to move data between two devices in the same broadcast domain over twisted pair, over the Ether, and through a glass fiber.

You'll know what Optical Ethernet is, and how it is the building block of telecom networks, including Metropolitan Area Networks (MANs), carrier MPLS networks, and Passive Optical Networks (PONs) for fiber to the home.

Detailed description of Course 2211 LANs, VLANs, Wireless and Optical Ethernet begins on page 9.

Next is Course 2213 IP Networks, Routers and Addresses – which could also be titled "Layer 3" – a comprehensive course on Layer 3 of the OSI Model, concentrating on IP addresses, routers and packets.

We begin with the two basic principles of packet networks: bandwidth on demand, also known as overbooking or statistical multiplexing; and packet-switching, also known as packet forwarding or routing.

We'll understand what routers do and where they are located, routing tables and the basic operation of a router and the standard strategy deploying an edge router between the LANs and the WAN at each location.

Then we'll cover IP version 4: address classes and how they are assigned to Regional Internet Registries then ISPs then end-users, dotted-decimal notation, static addresses, dynamic addresses and DHCP, public addresses, private addresses and NAT.

The course concludes with IPv6: the IPv6 packet and changes from IPv4, IPv6 address allocations and assignments and end up understanding how IPv6 subnets will be assigned to broadcast domains and 18 billion billion addresses per residence.

On completion of this course, you will be able to define bandwidth on demand and its advantages, what a router does, the basic structure of a routing table, where routers are located, define the IPv4 address structure and dotted-decimal notation, explain how both static and dynamic addresses are assigned using DHCP, what private addresses are and how they are interfaced to the public IP network, and the structure, allocation and assignment of IPv6 addresses.

Detailed description of Course 2213 IP Networks, Routers and Addresses begins on page 12.

The last course in this certification package is Course 2214 MPLS and Carrier Networks. This is a comprehensive course devoted to the structure, components and operation of carrier packet networks and services, how they are implemented, packaged and marketed, and how they are used by government, business and other carriers. The IP packets and routing of the previous course is one part of the story. Performance guarantees, and methods for quality of service, traffic management, aggregation and integration is another big part of the story, particularly once we leave the lab and venture into the real world and the business of telecommunications services.

We'll begin by establishing a basic model for a customer obtaining service from a provider, defining Customer Edge, Provider Edge, access and core. Then we'll explore the technical part of a service contract, called a Service Level Agreement (SLA) where the carrier promises a Class of Service (CoS) that specifies transmission characteristics like packet delivery rate and delay, provided the customer respects agreed limits, called a traffic profile.

Next, we'll understand virtual circuits, a powerful tool used for managing traffic on all large packet networks.

We'll go through the mechanics of Voice over IP to understand the critical transmission characteristic that must be guaranteed to be able to guarantee voice quality: delay, and variability in delay called jitter.

With the fundamentals in place, we'll go through the terminology and operation of MPLS, which is the virtual circuit technology used today by all carriers as a traffic management overlay on IP, replacing the now-obsolete predecessors X.25, Frame Relay and ATM.

We'll trace the download of a file from a customer's server over a carrier's MPLS core network to the customer's client using TCP/IP, identifying all of the equipment and protocols in operation, where they are located and how they interact.

Once we've covered all of the components of an MPLS network and its operation, we'll see how MPLS is used to implement differentiated services or Diff-Serv, i.e. different Classes of Service for different content (e.g. phone calls vs. web surfing), how MPLS is used to implement integration or "convergence" of services onto a single network service, and how MPLS is used to aggregate traffic for management.

The course is completed with a lesson on "MPLS service", and how that compares to Internet service.

On completion of this course, you will be able to draw a model for a service provider's network, define the terms Customer Edge and Provider Edge, explain what a traffic profile is and how that relates to a Service Level Agreement, the purpose, components, terminology and operation of MPLS, and how MPLS can be used to implement integration or convergence, aggregation and differentiated classes of service – what people mean when they say "MPLS service" and its pros and cons compared to Internet service.

Detailed description of Course 2214 MPLS and Carrier Networks begins on page 16.

Detailed Course Descriptions

Course 2212 The OSI Layers and Protocol Stacks

Protocols & Standards • Open Systems • OSI Model • Layers • Protocol Stacks • FedEx Analogy

14 interactive multipart lessons, multiple-choice exam and certificate. Updated 2020.

The OSI Layers and Protocol Stacks begins the discussion of IP-based telecom in the Certified Telecommunications Network Specialist (CTNS) certification package. It is the first course in the Certified IP Telecom Network Specialist (CIPTS) package.

This course establishes a framework for all of the subsequent discussions: the OSI 7-Layer Reference Model, which identifies and divides the functions to be performed into groups called *layers*. This framework is required to sort out the many functions that need to be performed, and to be able to discuss separate issues separately.

You'll learn what a layer is, the purpose of each layer, see examples of protocols used to implement each layer, and learn how a protocol stack really works with the famous "FedEx Analogy" presented as an embedded video by our top instructor, Eric Coll.

We'll cut through the jargon to demystify layers, and most importantly, the underlying ideas, and how it all works together… in plain English.

Course Outline

1. Introduction
Course introduction and overview.

2. Open Systems
Open systems vs. proprietary systems.

3. Protocols and Standards
The difference between a protocol and a standard.

4. ISO OSI 7-Layer Reference Model
Top-level overview and introduction to Layers

5. The Physical Layer
Fiber, Twisted Pair, Cable and Wireless

6. Data Link Layer
LANs and MAC Addresses

7. Network Layer
IP, MPLS, Packets and Routers

8. Transport Layer
Reliability, Connections, Ports and Sockets

9. Session Layer
SIP, POP and HTTP

10. Presentation Layer
ASCII, MIME, Compression, Encryption, Codecs

11. Application Layer
SMTP, HTML and English

12. Protocol Stacks
The FedEx Analogy

13. Protocol Headers
Babushka Dolls

14. Standards Organizations

Prerequisites

None. This is the best course to begin learning about IP and MPLS.

Course Objectives: What You Will Learn

This course can be taken by both those who need simply an overview and introduction to the idea of layers and the OSI model, and by those embarking on a certification and/or planning to take further courses.

If you're in the first group, the objective is not to become an instant expert, but rather to become familiar with the structure that is used to be able to discuss separate issues separately, what a layer is, the basic functions of each layer, what a protocol stack is and how it works, and where things you've heard of before like Ethernet, IP and TCP fit into the picture… to demystify the jargon and buzzwords, to eliminate frustration and increase your confidence and effectiveness.

If you're in the second group, and your objective is to put in place a structure for subsequent courses, following is a list of concrete objectives. On completion of this course, you will be able to explain:

- The concept of an open system and its advantages
- What a protocol is and what a standard is
- The OSI Model and its purpose
- What a Layer is
- The seven layers of the OSI model
- The name of each layer
- The functions each layer is responsible for
- Examples of actual protocols for each layer
- What a protocol stack is and how it operates
- Examples of standards organizations that publish protocols

Detailed Course Description

There are so many functions that need to be performed to be able to interwork different systems, a structure is required to be able to categorize and separate functions, so that it is possible to discuss separate issues separately and not mix things up. The method most commonly used to enable discussion of separate issues separately is the ISO OSI 7-layer Reference Model.

We'll start our discussion with some definitions, then an overview of the OSI model, introducing the ideas of layers, layered architectures and protocol stacks. Then we'll go through the layers individually and give examples of protocols like IP, TCP, LANs and DSL to see where they fit into the stack. We'll finish off understanding how a protocol stack actually works in operation, and conclude the course with a review of different active standards organizations.

Lesson 1. Course Introduction

The first lesson begins the course with a preview of the different functions that must be performed with a multimedia slideshow to illustrate the functions, then an overview of the course and lessons.

This lesson is available for free on teracomtraining.com and provides both a walkthrough of the course and a sample of the quality of the course graphics, text and presentation.

Lesson 2. Open Systems

In this lesson, we'll understand what is meant by an "open" system, and its advantages over proprietary systems and previous methods of interoperation.

Lesson 3. Protocols and Standards

Here, we'll sort out what is meant by the term "protocol", and how that relates to the concept of a standard. We will also start considering how many functions have to be performed to interoperate systems, and how these functions might be organized.

Lesson 4. The ISO OSI 7-Layer Reference Model

The ISO OSI 7-Layer Reference Model is the model most commonly used to define the structure of the "set of structured protocols" introduced in the previous lesson. We'll understand the reference model and how it operates, then introduce the layers in the OSI model, the name of each layer and the functions of each layer. In subsequent lessons, we'll go over the story again, more slowly, one layer at a time.

Lesson 5. The Physical Layer: Fiber, Twisted Pair, Cable and Wireless

Layer 1 is moving bits over Fiber, Twisted Pair, Cable and Wireless

Lesson 6. The Data Link Layer: LANs and MAC Addresses

Next is Layer 2, the Data Link Layer, responsible for managing aspects of communications between two stations on the same circuit. We'll cover frames, LANs and MAC addresses.

Lesson 7. The Network Layer: IP, MPLS, Packets and Routers

Here, we'll see that the definition of a network is connecting many data links together with network equipment, usually with redundant paths for availability and performance reasons. This implies the requirement to make route decisions. We'll see that the two basic kinds of networks are circuit-switched, i.e. the traditional telephone network, and packet-switched, networks using routers to forward packets from one link to another.

Lesson 8. The Transport Layer, Ports and Sockets

In this lesson, we'll cover Layer 4: the Transport Layer. We will see that there are two main functions: reliability of communications between the two end-point devices, and narrowing down the communications to particular software applications running on the devices. TCP and UDP are Layer 4 protocols in the OSI Model.

Lesson 9. The Session Layer: SIP, POP and HTTP

Layers 5, 6 and 7 are referred to as the “upper layers”. In this lesson, we will understand the functions associated with Layer 5: the session layer, responsible for initiating, maintaining and terminating sessions between software applications on different machines connected by a transport service. We will see that the usual implementation follows a client-server scenario, with the client logging on the server with a user name and password and having permissions after being authenticated. In other cases, the session establishment is less sophisticated, for example, no authentication and a session that lasts for the transfer of one web page; and in yet other cases is more sophisticated, involving the communication of the endpoints’ IP addresses to each other so they can subsequently communicate directly as is the case with SIP.

Lesson 10. The Presentation Layer: ASCII, MIME, Compression, Encryption, Codecs

Layer 6 is the Presentation Layer, a very important discussion, as this is the coding step, where messages are coded into 1s and 0s for eventual communication. ASCII, MIME, compression, encryption, and codecs all fit into this layer.

Lesson 11. The Application Layer: SMTP, HTML and English

In this lesson, we’ll examine the uppermost layer of the OSI model, Layer 7, the application layer. We will see that the application layer specifies the message to be transmitted to another system. It defines the format, vocabulary and syntax of messages. The same software that implements the application layer usually also implements a Human-Machine Interface… since in many instances, a human generates the content of the message.

Lesson 12. Protocol Stacks: The FedEx Analogy

In this lesson, we’ll employ an analogy of business-to-business communications using FedEx to illustrate how a protocol stack works, and better understand the OSI layers from a procedural point of view: how information travels down through the protocol stack on the left, through the network equipment in the center, and back up the protocol stack on the right. This lesson features video of our top instructor, Eric Coll, explaining the FedEx analogy to you via the camera on the left side of the screen, plus a graphical illustration on the right. Enjoy!

Lesson 13. Protocol Headers and Babushka Dolls

We’ll understand how a protocol stack works from a bits point of view: how one layer passes a block of 1s and 0s called a Protocol Data Unit to a lower layer, which performs its functions and adds control information in a header to create a bigger PDU, which is then passed down to the next lower layer. The result is like Russian Babushka dolls: a small doll inside a bigger one, inside a bigger one, inside a bigger one… and in our case, repeating seven times.

Lesson 14. Standards Organizations

The last lesson in this course is Standards Organizations, a brief overview of organizations that publish what they hope will become standard protocols for communications

Course 2211 LANs, VLANs, Wireless and Optical Ethernet

MAC Addresses • MAC Frames • Layer 2 Switches • VLANs • Ethernet on Copper • 1000BASE-T • Power over Ethernet • Cable Categories • Office Wiring Plan • Wireless Ethernet (Wi-Fi) • Optical Ethernet • Ethernet in the Core, MANs and PONs • Fiber Types • SFP Transceivers • Field Installation

7 interactive multipart lessons, multiple-choice exam and certificate. Updated 2020.

This course is all about Ethernet: the fundamentals, equipment and implementations including twisted-pair copper cables, wireless and fiber, in-building, in the network core, MANs and PONs.

You'll understand the jargon and buzzwords, the underlying ideas, and how it all works together to form the physical basis of today's IP telecom network.

We'll demystify Ethernet, MAC addresses, LANs and VLANs, Ethernet on copper, wireless Ethernet (Wi-Fi) and Optical Ethernet on fiber, explaining the jargon and buzzwords, the underlying ideas, and how it all works together… in plain English.

Course Outline

1. Course Introduction
2. Broadcast Domains, MAC Addresses and MAC Frames
3. LAN Switches a.k.a. Layer 2 Switches
4. VLANs
5. 802 Physical Standards: 802.3 Twisted Pair and 802.11 Wi-Fi
6. Twisted-Pair LAN Cables, Wiring Plan and Switch Hierarchy
7. Optical Ethernet and Fiber Links

Prerequisites

None. Course 2212 The OSI Layers and Protocol Stacks is useful to understand where LANs fit into the overall picture and how LANs and VLANs relate to routers and IP.

Course Objectives: What You Will Learn

The objective of taking this course is to become familiar with the standard technology used to implement Layer 2 in IP-based packet networks. After taking this course, you will be up to speed on MAC addresses and MAC frames, broadcast domains, LAN cables and LAN switches, VLANs, LAN Cables and Categories, Wireless LANs and Optical Ethernet.

In particular, on completion of this course, you will be able to explain:

- The idea of a broadcast domain.
- The idea of a MAC addresses to identify a LAN interface on a station in a broadcast domain.
- What MAC frames are, and what purpose they serve.
- What a LAN switch is, and what it does.
- How VLANs can be used to segregate devices into different broadcast domains.

- The IEEE 802 series of standards:
- The 802.3 standard and communicating MAC frames at 10 Mb/s on coaxial cables to Gigabit Ethernet on copper and fiber. What the code 1000BASE-T means.
- MAC frames over the Ether, a.k.a. Wi-Fi, the 2.4 and 5 GHz unlicensed bands, and the fundamentals of how the bits in MAC frames are communicated using radio carrier frequencies.
- Wiring Ethernet to the work area with Cat 5, Cat 5e and Cat 6 twisted-pair copper-wire cables. Wiring closets and Layer 2 aggregation switches.
- What Optical Ethernet is, and how it is the building block of telecom networks, including Metropolitan Area Networks (MANs), carrier MPLS networks, and Passive Optical Networks (PONs) for fiber to the home.
- The fundamentals of how the bits in MAC frames are communicated using light guided in glass tubes. How fiber cables are deployed and connected to equipment at each end. What designations like 100GBASE-ER4 mean.

Detailed Course Description

LANs are the standard method of implementing data links for communications between machines. This began as in-building communications using bus cables, and has evolved to switches and twisted pair cables inside the building, and Optical Ethernet equipment and fiber outside the building.

We'll begin the course with the original fundamental ideas of a bus topology, contention-based access control, broadcast domains, MAC addresses and MAC frames. Then we'll review the IEEE 802 standards and evolution of Ethernet from 10BASE-T to Gig-E, LAN cables, the TIA-568 cable categories, basic cabling design; what "bridging" means, how a LAN switch works, and finishing with VLANs and a preview of the next course: using routers to move frames between broadcast domains.

Lesson 1. Course Introduction

The first lesson begins the course with an overview of the course and lessons.

2. Broadcast Domains, MAC Addresses and MAC Frames

The fundamental idea of devices connected together in a broadcast domain, and how stations communicate using MAC addresses

3. LAN Switches a.k.a. Layer 2 Switches

How LAN switches are at the center of practical implementation of connecting stations, and how they forward frames between stations in a broadcast domain.

4. VLANs

Defining broadcast domains in software to segregate traffic. Used to separate customer traffic on carrier MANs, and used in-building as a basic network security measure.

5. 802 Physical Standards: 802.3 Twisted Pair and 802.11 Wi-Fi

Ethernet on copper wires, and standards like 1000BASE-T. Ethernet over the Ether, usually called Wi-Fi, and how MAC frames are communicated using radio carrier frequencies.

6. Twisted-Pair LAN Cables, Wiring Plan and Switch Hierarchy

Wiring Ethernet to the work area with Cat 5, Cat 5e and Cat 6 twisted-pair copper-wire cables, wiring closets and Layer 2 aggregation switches.

7. Optical Ethernet and Fiber Links

The fundamental idea of representing the 1s and 0s that make up a MAC frame using light carried in a glass tube, how fibers are actually installed and commissioned, and review the Optical Ethernet implementations in the 802.3 standard.

Course 2213 IP Networks, Routers and Addresses

IP Packets • Networks • Routers • Static, Dynamic, Public, Private Addresses • NAT • IPv6

11 interactive multipart lessons, multiple-choice exam and certificate. Updated 2020.

IP Networks, Routers and Addresses is a comprehensive course on Layer 3 of the OSI Model, concentrating on IP addresses, routers and packets.

You'll gain a solid understanding of the key principles of packet networks: bandwidth on demand, packet forwarding and packet filtering, how routers work, all of the different types of IP version 4 addresses: static and dynamic, public and private, network address translation plus IP version 6.

Based on Teracom's famous Course 101, tuned and refined over the course of 20 years of instructor-led training, we'll cut through the jargon to clearly explain IP and routers, packets and addresses, the underlying ideas, and how it all works together… in plain English.

Course Outline

1. Introduction
Course introduction and overview

2. Review: Channelized Time-Division Multiplexing (TDM)
Traditional TDM – and why it is inefficient

3. Statistical Time-Division Multiplexing: Bandwidth-on-Demand
Overbooking and opportunistic capacity

4. Private Network: Bandwidth on Demand + Routing
The simplest framework for understanding routers and bandwidth on demand

5. Routers
Routers and routing tables. Packet forwarding and packet filtering. Customer Edge.

6. IPv4 Addresses
Address classes and dotted-decimal notation.

7. DHCP
Dynamic addresses and static addresses – and how both are assigned using DHCP

8. Public and Private IPv4 Addresses
How to obtain public addresses, and why private addresses are used in many cases

9. Network Address Translation
How a NAT glues private IPv4 addressing used in-building to public addressing used on the Internet

10. IPv6 Overview
Introduction to IPv6, what's new, the improvements on IPv4 and the IPv6 packet format.

11. IPv6 Address Allocations and Assignment
Types of IPv6 addresses, registries and allocations to ISPs. How subnets are assigned to end-users.

Prerequisites

None. Course 2212 The OSI Layers and Protocol Stacks is useful to understand where IP and packets fit into the overall picture. Course 2211 LANs, VLANs, Wireless and Optical Ethernet complements this course, as IP packets are usually carried on Ethernet.

Course Objectives: What You Will Learn

The objective of this course is to develop a solid understanding of IP. After taking this course, you will be up to speed on the fundamental principles of packet networks: bandwidth on demand, also known as overbooking or oversubscription, and packet forwarding. You will know the IP packet format and how IP addresses are allocated, assigned and displayed. You will know the difference between static and dynamic addresses, public and private addresses and how Network Address Translation works. An additional objective is to become familiar with the basics of IPv6.

In particular, on completion of this course, you will be able to explain:

- The concept of statistical multiplexing, also known as oversubscription, overbooking and bandwidth on demand, why and how it can be implemented and its benefits.
- What a private network is
- What a router is and how it implements the network by connecting data links
- How routers move packets between broadcast domains, including VLANs
- How routers also act as a point of control for traffic, called packet filtering
- The basic structure and contents of a routing table
- The Customer Edge
- IPv4 address blocks: Class A, Class B and Class C, and dotted-decimal notation
- Static addresses and dynamic addresses, and how and why DHCP is used to assign both
- Public addresses and private addresses, how, why and where each is used
- Network Address Translation for interfacing domains where public addresses are used with those where private addresses are used
- The improvements and changes between IPv4 and IPv6, and
- The types of IPv6 addresses, how IPv6 addresses are allocated to ISPs then assigned to users, and how each residence gets 18 billion billion IPv6 addresses.

Detailed Course Description

Packet networks embody two main ideas: bandwidth on demand and packet switching. First, we'll recap channelized TDM and its limitations, then understand statistical TDM or bandwidth on demand. Next, we'll understand how routers implement the network with packet-switching, that is, relaying packets from one circuit to another, and how routers are a point of control for network security. We'll introduce the term Customer Edge (CE), and understand the basic structure and content of a routing table.

Then we'll cover the many aspects of IP addressing – needed to be able to do the packet switching: IPv4 address classes, dotted decimal notation, static vs. dynamic addresses, DHCP, public vs. private addresses, Network Address Translation, and finish with an overview of IPv6 overview and IPv6 address allocation and assignment.

Lesson 1. Course Introduction

The first lesson begins the course with an overview of the course and lessons.

This lesson is available for free on teracomtraining.com and provides both a walkthrough of the course and a sample of the quality of the course graphics, text and presentation.

Lesson 2. Review: Channelized Time-Division Multiplexing (TDM)

We'll review the idea of channelized Time-Division Multiplexing (TDM), what channels are, and how they can be used to aggregate traffic onto a high-speed circuit. Then we'll raise some questions: is that an efficient way to connect devices that produce traffic in bursts, which means devices that are normally doing nothing? And what about the problem of a single point of failure for all the aggregated traffic? Subsequent lessons explore the answers to those questions.

Lesson 3. Statistical Time-Division Multiplexing: Bandwidth-on-Demand

In this lesson, we'll understand how circuits that move bits constantly can be used efficiently when the user's traffic profile is: "idle most of the time, interspersed with bursts of data every once in a while." The answer is overbooking. This is also called statistical multiplexing and bandwidth-on-demand, and is a key part of a packet network: the internal circuits are heavily overbooked, to give users the highest speed at the lowest cost. It is necessary to know the users' historical demand statistics – also called their traffic profile – to know how much to overbook, hence the term statistical multiplexing.

Lesson 4. Private Network: Bandwidth on Demand + Routing

The purpose of this lesson is to expand the discussion of the previous lesson to include multiple circuits. The result is called a private network, and is the simplest framework for understanding routers, routing, network addresses and bandwidth-on-demand.

Lesson 5. Routers

In this lesson, we'll take a closer look at a router, more precisely identifying the functions a router performs to implement a packet network, and understand how a router routes by examining the basic structure and content of a routing table. We'll also understand how the router can act as a point of control, denying communications based on criteria including network address and port number, why this is implemented and its limitations. The term Customer Edge (CE) is defined in this lesson.

Lesson 6. IPv4 Addresses
Here, we'll understand IPv4 addresses, address classes and the dotted-decimal notation used to represent them.

Lesson 7. DHCP
In this lesson, we'll cover DHCP: the Dynamic Host Configuration Protocol, and understand the mechanism by which a machine is assigned an IP address. We'll also understand how the "dynamic" host configuration protocol can be used to assign static addresses to machines and the advantages of this method.

Lesson 8. Public and Private IPv4 Addresses
The purpose of this lesson is to define the terms "public" and "private" IP address, review how IP addresses are assigned and the costs for those addresses, then cover the ranges of IPv4 addresses that are used as private addresses, and understand how and why they are used.

Lesson 9. Network Address Translation
In this lesson, we'll explore how private IPv4 addresses used in-building and a public address required for Internet communications can be joined together with a software function called Network Address Translation.

Lesson 10. IPv6 Overview
Completing this course on IP, we'll first review the next generation of IP: IPv6, understand the improvements compared to IPv4 and review the format of the IPv6 packet and its header.

Lesson 11. IPv6 Address Allocations and Assignment
Finally, we examine the structure of the 128-bit IPv6 address, review the different kinds of IP addresses, the organizations that allocate them, and the current plans for how addresses will be assigned to end users… and how every residence gets 18 billion billion IPv6 addresses.

Course 2214 MPLS and Carrier Networks

Carrier Packet Networks • Technologies • MPLS • SLAs • CoS • Integration & Aggregation

11 interactive multipart lessons, multiple-choice exam and certificate. Updated 2020.

MPLS and Carrier Networks is a comprehensive training course designed to build a solid understanding of carrier packet networks and services, the terminology, technologies, configuration, operation and most importantly, the underlying ideas … in plain English.

We'll cut through the buzzwords and marketing to demystify carrier packet networks and services, explaining Service Level Agreements, traffic profiles, virtual circuits, QoS, Class of Service, MPLS, how MPLS relates to TCP/IP, how MPLS is used to implement Differentiated Services, integrated access, and traffic aggregation, and the difference between "MPLS service" and Internet service, without bogging down on details.

You will gain career- and productivity-enhancing knowledge of the structure, components and operation of carrier packet networks and services, how they are implemented, packaged and marketed by carriers and how they are used by government, business… and other carriers.

Course Outline

1. Introduction
   Course introduction and overview.
2. Carrier Packet Network Basics
   Customer Edge, Provider Edge, Access and Network Core
3. Service Level Agreements
   Contractual specification: Traffic Profile and Class of Service
4. Virtual Circuits
   Traffic Classes and pre-determined routes
5. QoS Requirement for Voice over IP
   How packetized voice works and what is needed
6. MPLS
   MPLS components, LER, LSP, LSR jargon, basic operation
7. TCP/IP over MPLS, and VPLS
   Tracing a file transfer through the equipment and protocols
   Implementing Virtual Private LAN Service with MPLS
8. Differentiated Classes of Service using MPLS
   Different transmission characteristics for different traffic
9. Integration and Convergence using MPLS
   Saving money with Integrated Access
10. Managing Traffic with MPLS Label Stacking
    Aggregating similar traffic to be managed as a single entity
11. MPLS Services vs. Internet Service
    Understanding the key difference: guarantees or not. The Future.

Prerequisites

Courses 2212 OSI Layers, 2211 LANs and 2213 IP are recommended. Those courses, along with this one, are included in the Certified Telecommunications Network Specialist (CTNS), the Certified IP Telecom Network Specialist (CIPTS) and Certified Telecommunications Analyst (CTA) certification packages.

Course Objectives

This course can be taken by both those who need simply an overview and introduction to carrier packet networks and MPLS, and by those who need to build a solid base and get up to speed on all or most of the listed topics.

The objective is to become familiar with the structure, components and operation of carrier packet networks and services, how they are packaged, marketed, contracted and used, and to demystify the jargon and buzzwords, particularly with regard to MPLS.

On completion of this course, you will be able to:

- Explain the components and basic structure of a carrier packet network including core, provider edge, access and customer edge,
- List three ways packet services are better than dedicated lines for wide-area networking,
- Define a Service Level Agreement, Class of Service and traffic profile,
- Define a traffic class and explain what a virtual circuit is, and what they are used for,
- Identify the steps involved in communicating voice in packets, and what transmission characteristics are critical to call quality,
- Explain the terminology specific to MPLS including Label Edge Router, Label-Switched Path, Forwarding Equivalence Class, Next-Hop Label Forwarding Entry, including defining the meaning and purpose of a label, and identifying where the label is placed in the headers,
- Trace the flow of a message transported by TCP in IP packets over an MPLS network,
- Identify a key benefit of MPLS from the user's point of view,
- Explain what Differentiated Services are, and how MPLS labels can be used to implement Diff-Serv, and an alternative,
- Explain how and why MPLS can be used to achieve service integration,
- Show how MPLS can be used to aggregate traffic,
- Explain what exactly someone means when they say "MPLS service" and explain why "IP service with a service level agreement" would be a more accurate term, and
- Identify two differences between MPLS service and Internet service, and the pros and cons of each.

Detailed Course Description

Lesson 1. Course Introduction

The first lesson provides an overview of the topics that will be covered, the course objectives and a description of each lesson. We'll briefly recap the concepts of packet switching and bandwidth on demand.

Lesson 2. Carrier Packet Network Basics

We'll begin by understanding the basic structure of a carrier packet network and connecting to it, including the Provider Edge (PE) and Customer Edge (CE)… and why Provider Edge equipment is sometimes placed at the customer premise. This lesson is completed with a roundup of the benefits of packet services over dedicated lines and circuit-switched connections.

Lesson 3. Service Level Agreements: Traffic Profile and Class of Service

How performance is specified, measured, guaranteed and controlled on an overbooked bandwidth-on-demand network – the Service Level Agreement where the network guarantees specified transmission characteristics, sometimes called a Class of Service, on condition that the customer stays within a defined traffic profile … and what happens to out-of-profile traffic.

Lesson 4. Virtual Circuits

An introduction to the critical ideas of virtual circuits and classes of traffic, used as a powerful traffic management tool in all large packet networks.

Lesson 5. QoS Requirement for Voice Over IP

Packet network services were originally designed for datacom. In this lesson, we'll understand how voice is packetized, carried over a packet network, then reconstructed at the far end – and the transmission characteristics necessary for voice quality.

Lesson 6. MPLS

With the fundamentals in place, we'll go through the terminology and operation of MPLS, which is the virtual circuit technology used today by all carriers as a traffic management overlay on IP, replacing the now-obsolete predecessors X.25, Frame Relay and ATM.

Lesson 7. TCP/IP over MPLS

We'll trace the download of a file from a customer's server over a carrier's MPLS core network to the customer's client using TCP/IP, identifying all of the equipment and protocols in operation, where they are located and how they interact.

At the end of that lesson, we'll see how the "M" in MPLS stands for Multiprotocol, and how it is used to implement Virtual Private LAN Service (VPLS) by carrying labelled MAC frames instead of the usual labelled IP packets.

Lesson 8. Differentiated Classes of Service using MPLS

Here, we'll examine how classifying traffic and mapping classes onto virtual circuits can be a Quality of Service (QoS) mechanism to implement multiple Classes of Service on a packet network. This is sometimes referred to as *differentiated services* or *Diff-Serv*, i.e. providing a different Class of Service for each application: VoIP, IPTV, email, web surfing and others.

Lesson 9. Integration and Convergence using MPLS
In this lesson, we'll see how virtual circuits and traffic classification can be used to combine all of the types of communications of a business or organization onto a single access circuit. This idea is sometimes called *convergence*, though *service integration* is a more accurate term. It results in a large cost savings compared to one access circuit for each type of communications. The same idea is used of course by carriers on their network core.

Lesson 10. Managing Aggregates of Traffic with Label Stacking
How MPLS is used to aggregate similar kinds of traffic with label stacking: carrying virtual circuits on virtual circuits, to be able to manage all of the instances of a kind of traffic (e.g. telephone calls) as a single entity in a Network Operations Center.

Lesson 11. MPLS Services vs. Internet Service
This lesson completes the course with a discussion of terminology used in sales and marketing of MPLS services, and how that translates to reality... what exactly a salesperson is referring to when they say "MPLS services", and compare and contrast that to Internet service.