
Fundamentals of VoIP & IP Telecom Networks

A three-day vendor-independent training course covering all aspects of Voice over IP and the modern converged broadband IP telecommunications network it runs on.

Specifically designed for non-engineering professionals, this course will fill in the gaps and get you up to speed on the fundamentals and the technologies involved with Voice over IP and the network it runs on:

- Today's broadband converged IP telecommunications network
- Fundamentals of telecom
- Fundamentals of the Internet, cloud computing and data centers
- What all of the VoIP jargon and buzzwords mean
- How VoIP works end-to-end; all of the components involved
- What SIP is
- How an organization saves money moving to softswitches and SIP trunking
- The OSI Layers
- Ethernet, IP and MPLS
- Who supplies what, and how it all fits together, and more.

Get a solid knowledge base to build on... structured, complete knowledge starting with fundamentals, that you can't get on the job, reading articles or from vendors.

Eliminate buzzword frustration, and gain the knowledge to be confident!

This is career-enhancing knowledge that lasts a lifetime, and training that will be repaid many times over in increased accuracy and productivity.

With case studies and exercises, you will learn how a VoIP call is set up and carried end-to-end, how softswitches and SIP trunking works and much more.

Bonus! TCO Certified VoIP Analyst (CVA) Certification included!
Unlimited repeats, no time limits

**Register online at teracomtraining.com
or call us toll-free: 1-877-412-2700**

Fundamentals of VoIP & IP Telecom Networks is a three-day vendor-independent training course covering all aspects of Voice over IP and the broadband, converged IP network it runs on.

Key Course Features

- Today's broadband converged IP telecommunications network
- Fundamentals of telecom and networks
- Fundamentals of the Internet, cloud computing and data centers
- What all of the VoIP jargon and buzzwords mean
- How VoIP works end-to-end; all of the components involved
- What SIP is
- How an organization saves money moving to softswitches and SIP trunking
- The OSI Layers
- Ethernet, IP and MPLS
- Who supplies what, and how it all fits together
- Case studies and class exercises to cement your knowledge
- 300-page color printed course workbook with detailed notes
- Bonus TCO Certified VoIP Analyst (CVA) online courses and certification

Course Outline

Part 1: Fundamentals

1. Introduction to Broadband Converged IP Telecommunications
2. Telecom Fundamentals
3. Network Fundamentals
4. The Internet, Cloud Computing, Data Centers and SD-WANs
5. Digital Voice

Part 2: VoIP and SIP

6. VoIP Systems, Components, Standards, Jargon and Buzzwords
7. VoIP for Individuals
8. VoIP for Organizations
9. Packetized Voice and Sound Quality
10. SIP and Call Managers / Softswitches
11. SIP Trunking & Carrier Connections

Part 3: Networking

12. The OSI Layers and Protocol Stacks
13. Ethernet, LANs and VLANs
14. IP Networks, Routers and Addresses
15. MPLS and Carrier Networks

Learning Exercises

- Trace a Skype to Cellphone VoIP Call End-to-End, identifying each link from Wi-Fi to Internet to PSTN to cellphone, links made of fiber, buildings and antennas over which the digitized voice is carried... and how.
- Listen to Sound Clips with Packet Loss, Delay and Jitter
- Examine Actual MAC and IP Addresses in Use
- In-Class Group Collaborative Quizzes

Detailed Course Outline

Part 1: Fundamentals

1. Introduction to Broadband Converged IP Telecommunications

We begin with a comprehensive big-picture introduction to today's telecom network: the concepts of convergence and broadband, the different parts of the network, the three key technologies: Ethernet, IP and MPLS, what they are and what each does. You'll learn how a service is implemented end-to-end, and identify today's standard residential, business and wholesale services.

- A. History of Telecommunications
- B. Convergence
- C. Broadband
- D. Today's Telecom Network
- E. Network Core
- F. Ethernet, IP and MPLS
- G. Network Access
- H. Telecommunication Service Implementation
 - I. Carrier Interconnect
 - J. Residential, Business and Wholesale Services

2. Telecom Fundamentals

Next, we'll ensure you have a solid foundation in the fundamental ideas of telecom: the elements of a circuit; terminals, clients, servers and peers; how bits are represented on fiber with pulses; and how bits are represented with modems on wireless, cable TV and DSL. Then we'll understand how capacity is shared to carry many users' traffic on common facilities: Frequency Division Multiplexing, Time Division Multiplexing, overbooking and Bandwidth on Demand.

- A. Communication Circuit Model
- B. Terminals, Clients, Servers and Peers
- C. Representing Bits on Digital Circuits: Pulses
- D. Representing Bits in Frequency Channels: Modems
- E. Serial and Parallel
- F. Sharing: Frequency-Division Multiplexing
- G. Sharing: Channelized Time-Division Multiplexing (TDM)
- H. Efficient Sharing: Statistical Time Division Multiplexing
- I. Overbooking and Bandwidth on Demand

3. Network Fundamentals

In this chapter, we'll cover the essential concepts and technologies of IP networks. We'll review basic circuit configurations, and introduce how IP packets are communicated in MAC frames, how routers relay packets from one circuit to another, and how MPLS is used for traffic management. These topics are revisited in later chapters.

- A. Unbalanced Data Links: CATV, PON, Wi-Fi, CAN-BUS
- B. Balanced Data Links: LANs and Ethernet
- C. Frames and MAC Addresses
- D. Networks
- E. Packets and IP Addresses
- F. IP Packets in MAC Frames
- G. IP Packets
- H. TCP, UDP and Port Numbers
- I. MPLS Labels

4. The Internet, Cloud Computing Data Centers and SD-WANs

The Internet, which started out as a way to send text email messages, is now worldwide converged broadband communications. In this chapter, we'll understand what exactly an Internet Service Provider does, and how they get packets delivered world-wide. We'll review web clients, browsers and apps, web servers, then understand the huge business of web services, cloud computing and data centers.

- A. A Network to Survive Nuclear War
- B. The Inter-Net Protocol
- C. Internet Service Providers (ISPs)
- D. Domain Name System (DNS)
- E. Web Clients: Browsers and Apps
- F. Web Servers: HTTP, HTTPS, HTML
- G. Web Services
- H. Cloud Computing and AWS
- I. Data Centers
- J. Internet IP VPNs
- K. SD-WANs
- L. Country-Spoofing VPN Service
- M. Anonymizer VPN Service & The Dark Web

5. Digital Voice

The converged network carries all media: voice, video, text and images, in packets. An essential first step is digitizing the media, representing it using 1s and 0s, to be carried in said packets. We'll understand how voice is digitized and reconstructed, and the G.711 64 kb/s standard, and other codecs.

- A. Analog and Digital: What Do We Really Mean?
- B. Continuous Signals, Discrete Signals
- C. Voice Digitization (Analog → Digital Conversion)
- D. Voice Reconstruction (Digital → Analog Conversion)
- E. Digital Voice: 64kb/s G.711 Standard
- F. Codecs and Voice Compression

Part 2: VoIP and SIP

6. Fundamentals of VoIP

Next, we dive into the fundamentals of Voice over IP: the basics of communicating voice in IP packets, demystifying the jargon and buzzwords and explaining in plain English the components of a VoIP telephone system like soft switches and gateways, what each does, along with protocols like SIP.

- A. The Big Picture
- B. VoIP System Components
 - 1. Terminals
 - 2. Voice in IP Packets
 - 3. Softswitches / SIP Servers / Call Managers
 - 4. Media Servers and Unified Messaging
 - 5. Gateways
 - 6. LANs and WANs
- C. Key VoIP Standards
- D. Where This is Headed: Broadband IP Dial Tone

7. VoIP for Individuals

"Voice over IP" can happen in many different ways. We'll review the many flavors of VoIP, comparing and contrasting the various implementations, starting with Internet telephony, computer to computer VoIP over the Internet and Internet – PSTN VoIP. We'll cement your knowledge by tracing a VoIP phone call from a laptop in the classroom over Wi-Fi to the Internet, then to a mobile network operator and to a cellphone in the classroom, identifying all the circuits, components, buildings and companies involved in the end-to-end connection.

- A. Internet Telephony: Computer-Computer VoIP over Internet
- B. Internet Telephony Clients
- C. VSPs: Internet to Phone e.g. Skype to Phone
- D. Class Exercise: Trace a Phone Call from Laptop to Cellphone
- E. VSP: Internet VoIP with Adapter and PSTN Phone Number e.g. Vonage
- F. VoIP Becomes the New POTS

Class Exercise: Trace a VoIP Call End-to-End Internet to Cellphone

We'll establish a phone call from a VoIP client on a computer in the classroom via Wi-Fi and the Internet to a cellphone in the classroom, and identify where the voice packets travel, from one circuit, device, and company to the next, end-to-end between the two sets of microphones and speakers to reinforce your understanding of the telecom business and how everything is connected.

8. VoIP for Organizations

Next, we'll look at all the ways VoIP is implemented for organizations, including SIP Trunking to replace expensive PBX trunks. We will compare and contrast choices for a VoIP system: getting it from the phone company; buying a call manager / softswitch; renting a Hosted PBX; and cloud solutions. You'll gain the knowledge to confidently differentiate VoIP architectures and discuss pros and cons of options.

- A. VoIP-Enabled PBX and Migration Options
- B. Premise Softswitch / Call Manager: PBX Replacement
- C. Hosted PBX and Cloud Services: Softswitch as a Service (SaaS)
- D. SIP Trunking
- E. IP Centrex
- F. Phone Powering and PoE
- G. LAN Configuration for VoIP

9. Packetized Voice and Sound Quality

In this chapter, you'll learn what exactly packetized voice is, how it happens, and the various standards in use. You'll learn about the factors affecting sound quality, and how packets actually get "lost" in a network. We'll listen to sound clips of impairments, and provide you with a practical checklist of tips and recommendations for ensuring success.

- A. Voice Packetization
- B. Measuring Voice Quality
- C. Factors Affecting Voice Quality
- D. Codecs: G.711, G.729, HD Voice
- E. Network Delay and Jitter
- F. RTP
- G. VoIP Protocol Stack: RTP, UDP, IP, MAC
- H. How Packets Get "Lost"
- I. Packet Loss and Sound Samples – In-Class Demo
- J. Testing and Troubleshooting
- K. First Step: The IP Network
- L. Second Step: The VoIP

Class Activity: Sound Clips with Impairments

Listening to sound clips, you'll hear the effect of different levels of uncorrected delay, jitter and packet loss, and understand how the quality of the reproduced speech at the far end is affected.

10. SIP and Call Flow in the IP World

SIP is the open, standard protocol for setting up Voice over IP telephone calls. All VoIP systems that purport to be "compatible" or "standards-based" must implement the Session Initiation Protocol. SIP defines the procedure and messages to set up a phone call – or any other kind of communication. In this chapter, you'll learn what exactly setting up a VoIP telephone call entails, understand what SIP is, how it works, demystify jargon like proxy server, registration and location server, understand how SIP fits in with softswitches and call managers, and trace the establishment of an IP phone call step by step. At the end of this, you'll understand how VoIP phone calls are set up – maybe worth attending the course all by itself!

- A. What SIP is and What it Can Do
- B. Relationship to Other Protocols
- C. SIP URIs: "Telephone Numbers"
- D. Registration and Location
- E. Outbound Proxy
- F. Finding the Far End
- G. The SIP Trapezoid
- H. SIP Message Example
- I. How SIP Relates to Softswitches and Call Managers
- J. Relating Phone Numbers to SIP URIs

11. SIP Trunking and Carrier Connections

We round out the Voice over IP part of the course with connections to carriers, beginning with Class of Service (CoS) performance guarantees and ending with transmission choices: SIP trunking, MPLS VPN and SD-WAN. We'll cover SIP trunking to replace PBX trunks for business phone systems; connecting with gateways and Megaco; and understand how cellular, cable, internet and incumbent carriers connect for PSTN VoIP phone calls.

- A. Connecting with Gateways
- B. Carrier Class of Service (CoS)
- C. SIP Trunking Service
- D. VoIP at Carriers: Session Border Controllers
- E. PSTN VoIP Interconnection at the Toll Center
- F. PSTN Tandem Access Trunk Interconnection at the Toll Center
- G. Comparing Transmission Choices: SIP Trunking, MPLS VPN and SD-WAN

Part 3: Networking

12. The OSI Layers and Protocol Stacks

The last day is devoted to understanding the modern converged IP-based telecom network. To get started, we'll organize the discussion using the OSI 7-Layer Reference Model, explaining what a layer is, and what the layers are, and giving examples of protocols like TCP and IP and how they work together in a protocol stack.

- A. Protocols and Standards
- B. ISO OSI Reference Model
- C. OSI 7-Layer Model
- D. Physical Layer: Ethernet, Fiber, DSL, cable, wireless
- E. Data Link Layer: 802 MAC
- F. Network Layer: IP and MPLS
- G. Transport Layer: TCP and UDP
- H. Session Layer: POP, SIP, HTTP
- I. Presentation Layer: ASCII, Encryption, Codecs
- J. Application Layer: SMTP, HTML, English ...
- K. Protocol Stack in Operation: Babushka Dolls
- L. Standards Organizations

13. Ethernet, LANs and VLANs on Copper, Fiber and Wireless

Ethernet and its MAC frames are the building blocks of new telecom networks, both in-building and between buildings. A VoIP phone plugs into a copper Ethernet LAN cable, or uses an Ethernet Wireless LAN to connect to the network. The network itself is built with point-to-point circuits conforming to the Optical Ethernet standard connecting Ethernet ports in different locations with fiber. In this module, you will learn the basic principles of Ethernet and LANs, the crucial concepts of MAC addresses, MAC frames and broadcast domains, how devices connect via LAN switches, and how VLANs separate groups of users.

- A. MAC Addresses, MAC Frames and Broadcast Domains
- B. Ethernet and 802 standards
- C. LAN Switches, a.k.a. Layer 2 Switches
- D. VLANs
- E. Optical Ethernet
- F. Wireless Ethernet (Wi-Fi)

14. IP Networks, Routers and Addresses

This chapter is devoted to IP, used to implement Layer 3. We begin with IP addressing: IPv4 address classes, subnets, DHCP, static and dynamic addresses, public addresses, private addresses and NAT. We use the simplest IP network to explore how routers implement the network by relaying packets from link to link, and also act as a point of control to deny communications based on IP address and/or port number. We'll complete the chapter with IPv6 addressing.

- A. IPv4 Address Classes
- B. Subnets: Prefix and Subnet Mask
- C. DHCP, Static and Dynamic Addresses
- D. Assigning Subnets to Broadcast Domains
- E. IP Network: Routers and Routing Tables
- F. Routers and Customer Edge (CE)
- G. Public and Private IPv4 Addresses
- H. Network Address Translation (NAT)
- I. IPv6
- J. IPv6 Address Allocation and Address Types

Class Exercise: IP and MAC Addresses

Using the Windows interface, we'll determine the current MAC and IP Addresses of a classroom computer, and the private and public IP addresses of the Edge Router and NAT it's connected to.

This will help visualize what IP addresses are, and covers two of the questions on the Final Exam.

15. Carrier Networks and MPLS VPNs vs. SD-WAN

IP packets are used to carry everything, including phone calls and the Super Bowl. But IP in itself does not include any way to prioritize or manage traffic to guarantee call quality or picture quality. In the core of a carrier's network, MPLS is used to implement those functions. In this chapter, we'll complete your knowledge with the basics of carrier networks and the important concept of a Service Level Agreement. Then you'll gain a practical understanding of how MPLS works and how it is used by carriers to implement MPLS VPNs, different Classes of Service, service integration and traffic aggregation; and contrast that to a cheaper solution: Internet VPNs and SD-WAN.

- A. Carrier Packet Network Basics
- B. Service Level Agreements and Class of Service (CoS)
- C. Provider Equipment at the Customer Premise
- D. Virtual Circuit Technologies
- E. MPLS
- F. MPLS VPNs for Business Customers
- G. MPLS for Service Integration
- H. MPLS and Diff-Serv to Support Classes of Service
- I. MPLS for Traffic Aggregation

Our Goal

Our goal is to bust the buzzwords, demystify jargon, understand technologies and mainstream solutions and - most importantly - the ideas underlying all of this, and how it all works together... knowledge you can't get on the job, talking to vendors or reading trade magazines.

How You Will Benefit

You'll gain a long-lasting, solid base of unbiased career-enhancing knowledge you can build on, an investment sure to be repaid many times over, increasing your confidence and productivity and eliminating jargon- and buzzword-related frustration.

Plus, you will receive a high-quality 300-page workbook – a valuable reference packed with detailed notes, diagrams and practical explanations, as well as a course completion certificate attesting to your IP telecom knowledge skills.

You can get TCO Certified VoIP Analyst (CVA) Certification by writing the optional CVA exams after the class.

Don't Miss This Opportunity!

If you've read this far, you know by now that this is the training you've been looking for to fill the gaps and get on top of VoIP and IP Telecom. Coverage of all major topics, high-quality course materials, TCO CVA certification and certificate suitable for framing, bonus poster and value pricing... don't miss this opportunity. Invest in yourself and your career and [register](#) for this course now.

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