

TELECOM BOOT CAMP

A full week covering the whole telecom and networking picture from fundamentals to future trends.... in plain English.

Come to BOOT CAMP to get up to speed on the whole telecom and networking picture from A to Z, beginning with fundamentals, the Internet, cloud computing, web services and data centers, digital media; broadband on wireless, fiber and copper, telecom carriers and equipment, the OSI layers, Ethernet and LANs, IP, MPLS, Voice over IP, SIP and SIP trunking, Security, and finishing with 5G and IoT applications like Smart Cities and highway platoons.

Totally updated for the 2020s with broadband Internet and the converged IP telecom network in the front seat, the topics in this week-long course are the full knowledge set necessary for anyone serious in telecom today.

Thousands of people from organizations including Cisco, Intel and Microsoft, CIA, NSA, IRS, FAA and FBI, all branches of US Armed Forces, AT&T, Verizon, Bell Canada, Wells Fargo, Bank of America, TD Bank, Oneida Tableware, the San Francisco Giants and hundreds of others who needed to be more effective in understanding and dealing with telecom and networking technology have benefited from this course.

We bust the buzzwords, explain the jargon, and more importantly, the ideas and concepts behind the jargon: key concept-level knowledge that you can't get on the job, from magazines or vendors.

This core training - and our superb instructors - consistently receive rave reviews on evaluations. Covering the topics in a systematic way, we build structured knowledge that lasts a lifetime. Many attendees tell us that this is training they wish they'd had years ago!

<p>Course Objectives</p> <ul style="list-style-type: none"> • Establish a solid base in the fundamentals of today's telecom, datacom and networking. • Fill in the gaps. Understand jargon and buzzwords. • Understand mainstream technologies and solutions. • Put a structure in place that project-specific knowledge can be built on in the future. • Understand how it all fits together. • Develop career-enhancing knowledge skills. 	<p>Course Content</p> <p>The Fundamentals</p> <ul style="list-style-type: none"> • Today's broadband converged IP telecom network • Telecom, network and digital fundamentals • Web Services, Cloud Computing, Data Centers • Residential, Business and Wholesale Services <p>Telecom Technologies</p> <ul style="list-style-type: none"> • 4G, 5G, Wi-Fi, Satellite, Broadband Fixed Wireless • Fiber fundamentals, WDM, Optical Ethernet, PONs • DSL, POTS, Cable Modems, T1, LANs on copper <p>Equipment, Carriers and Interconnect</p> <ul style="list-style-type: none"> • Routers and switches, CO Switches, PBXs, Gateways • Internet Exchanges, Switched Access, POPs, CLECs <p>Networking</p> <ul style="list-style-type: none"> • OSI Layers, Ethernet, LANs and VLANs • Routers, IP addresses, DHCP, public-private NAT • MPLS and Carrier VPNs, SLAs, Class of Service <p>Voice over IP and SIP</p> <ul style="list-style-type: none"> • Components & operation of VoIP phone systems • Internet VoIP, Business VoIP, SIP & SIP trunking <p>Security</p> <ul style="list-style-type: none"> • Phishing and extortion, firewalls and ports, encryption • Certificates, SSL, authentication, viruses and trojans • MPLS and Carrier VPNs, SLAs, Class of Service <p>5G and IoT</p> <ul style="list-style-type: none"> • 5G on 700, 800 MHz, 2.5 GHz, 3.5 GHz, mmWave • IoT examples. Cool applications like platooning.
<p>Prerequisites</p> <p>None</p>	
<p>Who should attend</p> <ul style="list-style-type: none"> • This course is for those needing to fill in the gaps, understand buzzwords, jargon and technologies like SIP, LTE, 5G, Ethernet, MPLS and TCP/IP, and more importantly, the ideas behind these technologies and how it all fits together. • Ideal for non-engineering professionals in need of a solid knowledge base to be more effective in dealing with technology projects and technical personnel. 	
<p>Tuition Fees</p> <p>Save \$695! BOOT CAMP is value priced at only US\$2495 for the full week.</p> <p>Compare to \$4999 for lower quality elsewhere.</p>	

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

BOOT CAMP Overview

Specifically designed for non-engineers, Teracom's renowned telecommunications training is organized into two courses back-to-back to make a full week called BOOT CAMP:

- Course 101: Broadband, Telecom, Datacom and Networking for Non-Engineers, then
- Course 130: Voice over IP, SIP, Security, 5G and IoT.

Some people, needing a comprehensive base in telecom, attend only the core training Course 101 the first three days, and get the CTNS Certification.

Others, who already have a base, attend Course 130 the last two days for VoIP, the Security module, 5G and IoT with examples like Smart Cities, and get the CVA Certification.

Most people attend all five days, designated as Course 111 BOOT CAMP, to get the most comprehensive and highest quality telecommunications training available, at a discounted price, with three TCO Certifications included: CTNS, CVA and the prestigious CTA.

Monday – Wednesday: Course 101

The first three days of BOOT CAMP is *Course 101: Broadband, Telecom, Datacom and Networking for Non-Engineers*, our "core training" for non-engineering professionals, to getting you up to speed on telecom, datacom and networking, from fundamentals and jargon to the latest technologies.

Totally updated for the 2020s with broadband Internet and the converged IP telecom network in the front seat, these topics are the core knowledge set necessary for anyone serious in telecom today.

Part 1: The Fundamentals

- Today's broadband converged IP telecom network
- Telecom fundamentals: pulses, modems, multiplexing
- Network fundamentals: IP packets and MAC frames
- The Internet, ISPs and Net neutrality
- Web Services, Cloud Computing, Data Centers
- Residential, Business and Wholesale Services
- Digital Media: digital voice, video, images, data, text

Part 2: Telecom Technologies

- Wireless: Cellular, 4G, 5G, Mobile Internet & PSTN
- Wi-Fi, Satellite, 3.5 GHz Broadband Home Internet
- Fiber: fundamentals, WDM, Optical Ethernet, PONs
- Copper: POTS, DSL, Cable Modems, T1, LAN cables

Part 3: Equipment, Carriers and Interconnect

- Core Routers and Layer 2 Switches
- CO Switches & PBXs vs. Softswitches, Gateways
- Internet Exchanges
- Toll Centers, POPs, Switched Access and CLECs

Part 4: Networking

- OSI Layers and Protocol Stacks
- Ethernet LANs, LAN switches and VLANs
- Routers, IP addresses, DHCP, public-private NAT
- IPv6 address types and allocation
- Carrier networks, SLAs, Class of Service
- MPLS for CoS, VPNs, integration and aggregation
- Practical solutions and project methodology

Thursday – Friday: Course 130

The last two days of BOOT CAMP week is Course 130 *Voice over IP, SIP, Security, 5G and IoT*, vendor-independent training for non-engineers covering VoIP and SIP, a comprehensive survey of all things security, and finishing with 5G, the Internet of Things (IoT), and examples of cool applications like platooning and Smart Cities.

This course builds on telecom and IP fundamentals covered in our acclaimed three-day core training Course 101 Broadband Telecom, Datacom and Networking for Non-Engineers.

Part 1: Voice over IP and SIP

- The components & operation of VoIP phone systems
- Internet VoIP telephone service
- Business VoIP systems: call managers, SIP servers, hosted PBX, cloud services, Centrex.
- What SIP is and how it works
- Voice quality: delay, jitter, packet loss
- SIP Trunking and Carrier Connections

Part 2: Security

- Security risk areas & attacker objectives
- Phishing, credential reuse and extortion
- Network security, ports and firewalls
- Public and private key encryption, digital signatures
- Digital certificates & SSL, authentication, passwords
- Wi-Fi security, Internet VPNs, VoIP security
- Viruses and trojans; zero-day exploits

Part 3: 5G and IoT

- New Radio: more bits/second and new spectrum
- 700 MHz, 800 MHz, 2.5 GHz, 3.5 GHz and mmWave
- 5G use cases; 5G handset chip: Snapdragon X55
- Things Communicating over the Internet
- Communications and computing for every Thing
- Cool applications: platooning, ultra-broadband, ultra-low power, smart cities

Free Bonuses! Online Courses and TCO Certifications

Three TCO Certifications and their Online Courses are included with BOOT CAMP: Certified Telecommunications Network Specialist (CTNS) with seven online courses, Certified VoIP Analyst (CVA) with six online courses, Certified Telecommunications Analyst (CTA) Certification Package with sixteen courses.

You get unlimited repeats and there are no time limits. A good second pass through the topics, and refresh your knowledge anytime in the future. Write the optional course exams to verify your knowledge and earn TCO Certifications.

Your Course Materials: An Invaluable Reference

No-one expects anyone to learn all of this in one shot! For self-study and day-to-day reference after the course, BOOT CAMP comes with high-quality printed color course books that have been called the best on-the-job reference tool around. Written in plain English, these easy-to-use references includes copies of all graphics PLUS extensive detailed text notes.

Topics are organized in logical groups to give you easy reference to the practical experience, theoretical background, and unbiased information on industry technologies, products and trends you will need. With numerous chapters covering all major topics, you'll obtain an invaluable resource impossible to find anywhere else in one book.

Nine Reasons to Come to BOOT CAMP

Teracom's courses have been taught to wide acclaim across North America since 1992 and are designed for the non-engineering professional needing to fill in the gaps, build a solid base of knowledge... and see how it all fits together. Totally up to date for the 2020s!

1. Cut through the jargon and vendor hype to gain a structured understanding of telecommunications and networking, allowing you to make informed choices and meaningful comparisons -- knowledge you can't get on the job, reading trade magazines or talking to vendors, and an investment that will be repaid many times over.
2. Eliminate uncertainty and frustration from not knowing terms and technologies with a clear understanding of fundamentals, components, systems, standards, jargon and buzzwords. Be more confident, more accurate and more productive.
3. Get up to speed on the latest developments and trends. This course is totally up to date with SIP trunking, VoIP, 5G, Optical Ethernet, MPLS, Data Centers, Cloud Computing and more.
4. Get a broad overview of security risks, measures and best practices: network security, computer security, OS security, application security, information security, communication security.
5. Find out what 5G wireless is going to be and how it will be used.
6. Understand IoT and explore the ways that everything will be online in the future: from shipping containers to streetlights, self-driving transport trucks, VR and brain implants.
7. Learn more with instructor-led training, where you can interact and ask questions – the best kind of training you can get – and instructors consistently rated “excellent” on student evaluations.
8. Get Certifications: CTNS, CVA and CTA Certification Packages with BOOT CAMP.
9. Get two high-quality color course books with copies of graphics plus detailed text notes, bringing together all of this information, impossible to find in one place anywhere else, a valuable reference for years.

Who Should Attend

- Professionals needing to fill knowledge gaps, understand buzzwords, jargon, and technologies like LTE, 5G, Ethernet, TCP/IP and MPLS, VoIP and SIP, and more importantly, the ideas behind these technologies... and how it all fits together.
- Non-engineers in need of a solid knowledge base to be more effective in dealing with technology projects and technical personnel.
- Decision-makers and project managers who need to understand what the "techies" are saying.
- Managers and planners. Telecom and network system administrators. Finance, tax and accounting personnel. Software and support system developers.
- Anyone who wants to eliminate buzzword frustration to be more confident and more productive.
- Anyone who wants a comprehensive overview of security risks, measures and best practices.
- Anyone interested in 5G and IoT applications and trends.
- Anyone willing to invest five days in career-enhancing training, the best you can get, with real instructor in a classroom, where you can interact and ask questions, with TCO Certifications and two reference books.

Gain Vendor-Independent Knowledge You Can Build On

The knowledge you gain taking this renowned training course is vendor-independent foundational knowledge in telecommunications, networks, IP, packets, fiber, wireless, VoIP and SIP, fundamentals, technologies, standard practices, and how it all fits together.

You will be able to build on this proven knowledge base to quickly get up to speed for a particular project - then have the versatility to work on subsequent projects. Not only will it eliminate buzzword frustration, the cost of this training will be repaid in accuracy and productivity many times over.

Teracom's proven instructor-led training courses have been developed and refined over many years providing training for organizations including AT&T, Verizon, Bell Canada, Intel, Microsoft, Cisco, Qualcomm, the CIA, NSA, IRS, FAA, US Army, Navy, Marines and Air Force and hundreds of others... and are totally updated for the 2020s.

[Register today](#) to get this career-enhancing addition to your knowledge skills!

Here's What Seminar Attendees Like You Are Saying

Hundreds of people like you have benefited from Teracom's telecommunications training. Many tell us this was their best course ever; filled gaps in their knowledge and tied everything together... knowledge they've been needing for years. Others on course their first week on the job remarked "what a wonderful way to get started in the business."

Here's a sampling of comments from Teracom alumni:

"Feedback from my team was TERRIFIC. It gave our entire technical Call Center a common foundation, and you seem to have crafted that perfect balance between technical depth, real-world applications, and lively delivery. I couldn't be happier with the results. The things my team learned from this training were applied in real-world situations almost immediately."

- Rusty Walther, Vice President, Client Services, AboveNet Communications

"Excellent! I learned a lot - everyday terms, definitions, and acronyms. Seminar notebook very helpful. The instructor was the best I ever had - lots of knowledge and experience and stories were GREAT."

- Serena Laursen, Microsoft

"Thank you for conducting a very successful course last week. It was both informative and interesting and you were able to find the perfect balance of sharing deep knowledge, provide relatable examples and lighten it up with great humor. The feedback that we have received has been extremely positive."

- Charlotte Kaheru, International Finance Corporation, World Bank

"The seminar delivered exactly what was advertised, at a very high quality.

Truth in advertising!" - Gary Lundberg, Copper Mountain Networks

Whether you work for an organization that produces telecom, datacom or networking products or services; or you buy these products and services - or just have to get up to speed on what all the rest of them are talking about when they say "SIP trunking", "Ethernet", "MAC frame", 5G, MPLS, VPN, Data Center, Cloud Computing...

"Best course we have ever had onsite at 3Com"

"Perfect content; well organized, well-paced, building block approach, resulted in a very nice cathedral" - Jim George, Qualcomm

"Course was excellent! One of the best I have taken. Extremely well organized and presented. Seminar workbook is outstanding - a very valuable reference" - Kieran Delaney, Maritime Life

"I liked most the use of analogies to explain complex concepts. It delivered exactly what the brochure promoted. Gave me a thorough understanding so I feel more confident."

- Judith Myers, AT&T

"Excellent! Tied the individual pieces of knowledge together into a picture... was interactive and built up the knowledge layers properly." - Jim Geiss, Century Link

"Filled in a lot of gaps in my knowledge of networking... able to deliver the knowledge effectively and entertainingly. Excellent seminar"- Kirk Kroeker, IEEE Computer Society

"Layman's terms with humor was very relaxing - helped me concentrate... understanding is now CLEAR ... the manual will be very helpful" - Linda Côté, Bell Canada

"Best instructor I have had on a course - excellent explainer in layman terms, not techie terms"

- Susan Coleman, Bell Sygma

"Best course materials ever; the full text descriptions are invaluable. Course filled in so many gaps for me. Bravo!" - Ross Brooks, Vertek

"Outstanding! The best I've encountered, and I've attended many seminars."

- Bob Gibbons, WMX Technologies

How You Will Benefit

Course 101 Monday – Wednesday

Demystify Buzzwords and Jargon

One of the biggest challenges in telecommunications is dealing with all of the acronyms, abbreviations, jargon and buzzwords.

The list goes on and on: Broadband, Ethernet, TCP/IP, SIP trunking, OSI, Layer 2, VoIP, Hosted PBX, DSL, OE, PRI, ILEC, POP, MAN, Wi-Fi, LAN, WAN ...

It can be very frustrating sitting in meetings with these terms flying around and not understanding most of them... particularly when someone asks your opinion. Plus, there is a second-order problem: even if you were to figure out all of the current jargon and buzzwords, there will surely be more next month!

The solution? Understand the fundamentals. Take the cover off the box and see what it does and how it works. Doing this, you'll find out there are only four or five fundamental ideas in telecom, with ongoing incremental improvement in each area.

Understand the Fundamentals

Once you understand the fundamentals, not only will the buzzwords and jargon be demystified, you'll have a solid knowledge base. In the future, if you're not familiar with the exact product someone is discussing, you'll still know what they are talking about.

We'll begin with a big-picture view, identifying the different parts of the network, understanding how circuits are implemented by carriers, how carriers interconnect, and the residential, business and wholesale services.

We'll make sure everyone is starting at the same level, with telecom essentials like how bits are represented using pulses on fiber and LAN cables, how bits are represented using modems on wireless and coax systems, and the different kinds of multiplexing.

Without bogging down on details, you'll learn the mechanics of the broadband converged telecom network: IP packets carried in MAC frames, and how phone calls, television, images and text are digitized and carried in the IP packets.

Understand the Technologies: Wireless, Fiber and Copper

With the fundamentals in place, we'll understand the technologies for communicating over radio, fiber and copper wires, and the mainstream technologies in each area.

In the wireless chapter, we'll start with spectrum, then you'll learn the components and operation of a mobile cellular network, 4G LTE and 5G, mobile internet, fixed wireless broadband internet, Wi-Fi and satellites.

In the fiber chapter, we'll understand the basic principles of fiber and fiber cables, wavelengths, Optical Ethernet and PONs. For copper, you'll learn how DSL and Cable modems work, along with LAN cable categories and more.

You'll learn the kinds of equipment used, what each does, and how it all interconnects for phone calls and Internet traffic.

Taking this course to understand the fundamental ideas and mainstream technologies puts you back in control, with the confidence to contribute effectively.

Understand the Telecom Network

In the not-too-distant future, the Internet and the Public Telephone Network will become the same thing, and all communications including phone calls, television and internet traffic will be in IP packets. A basic understanding of IP addresses and packets and what routers do is a cornerstone of modern telecommunications knowledge.

Taking this course, you'll fill the gaps in your knowledge of IP and packet networks, and fully understand the ideas of packets, IP addresses and routers. We'll demystify DHCP, static and dynamic addresses, private and public addresses and Network Address Translation. You'll also learn how everyone gets 18 billion billion IPv6 addresses.

We'll complete your knowledge with MPLS, understanding how MPLS is used as an IP packet traffic management system, to implement Class of Service quality guarantees, and to implement business communication services called MPLS VPNs.

Learn About Cloud Computing and Data Centers

Cloud computing and data centers are a mammoth business and one of the biggest growth areas in the telecom area today.

To understand data centers, we'll start by reviewing what the Internet actually is, and the role of ISPs. Then we'll understand the web: client-server computing over the Internet, what a web server is, how it serves web pages to clients, and how back-end processing is needed to do transactions and database operations like finding your bank balance and creating a web page to send to you to display it.

Then you'll learn how the computing power necessary to support thousands or millions of users doing this is implemented in Data Centers with Cloud Computing infrastructure to allow scalability and fault-tolerance... and how this service is sold as "Web Services" by the likes of Amazon's AWS and Microsoft Azure.

With the Web Services business sector revenue at \$50 billion per year and climbing, familiarity with Data Centers and Cloud Computing is career-enhancing knowledge.

Course 130 Thursday - Friday

Demystify How Voice Moves in Packets

The best way to end buzzword and knowledge-gap frustration is to understand the fundamentals and build a solid vendor-independent knowledge base.

We'll start with a big-picture view, identifying the components of VoIP systems and what each does: VoIP phones, SIP, soft switches and gateways.

You'll learn all the steps involved in putting sound coming out of someone's mouth into IP packets, transporting the packets across the IP network, and reproducing the sound in someone's brain at the far end.

Then we'll put the theory into practice with a practical demonstration of Voice over IP over Wi-Fi in the classroom, to the Internet, to a cellphone in the classroom.

We'll trace the voice packets end to end through all of the devices, circuits and carriers involved, laptop to cellphone. Some people rate this part of the course the best!

Understanding how the packets move end-to-end gives you confidence and a solid knowledge base to build on; in the future, even if you're not familiar with the exact VoIP or SIP product someone is discussing, you'll still know what they are talking about.

Learn About Voice Quality

Whether it is Skype or Skype for Business over the Internet, or a Cisco Call Manager and SIP trunking, call quality is of primary importance, particularly for the callers!

You'll gain useful knowledge of what affects VoIP quality and how problems can be corrected. You'll learn how voice quality is measured and factors that affect it including codec, delay, jitter and lost packets. We'll demystify how packets actually get delayed or "lost", and listen to the sound effects.

Sort Out VoIP Phone Systems

After covering Internet VoIP for individuals, we'll compare and contrast all of the different configurations for business VoIP telephone systems.

We'll examine all of the different choices including premise softswitch, call manager, IP PBX vs. PBX replacement, hosted PBX, cloud services, SIP trunking, IP Centrex.

You'll also learn about Power over Ethernet for business phones and the recommended LAN configuration for VoIP.

SIP Trunking and Carrier Connections

You'll learn what SIP trunking is, and how it replaces expensive PRI and PBX trunks with a lower-cost service that moves VoIP over an IP network between business locations, plus includes a gateway service for PSTN phone calls, saving money in two ways.

You'll learn how Session Border Controllers are used as the edge equipment to connect different VoIP networks, and all the functions the SBC does including SIP security.

Get a Broad Survey of Security Risk Areas and Measures

Telecommunications allows information transfer; but can also be a venue for malicious attacks. We'll update your knowledge and fill the gaps with a wide survey of all things security, risks and measures, beginning with phishing and extortion emails, network security, firewalls and ports, encryption, authentication, certificates, Wi-Fi security, VPNs, viruses, trojans and exploits.

Get Up to Speed on 5G

You'll get up to speed on the current state of 5G, and learn about its immediate benefit: 40% more efficient than LTE.

We'll understand the design goals for 5G and review the New Radio spectrum allocations: 700 MHz, 800 MHz, 2.5 GHz and 3.5 GHz and millimeter-wave bands, and discuss the pros and cons and typical applications of each.

We'll finish with the Qualcomm Snapdragon X55 chip that is the enabler for the first wave of 5G smartphones... and commands a royalty of 3.25% of the retail price of a phone.

Get Inspired with Application Examples: 5G, IoT and Convergence

We finish with the Internet of Things, what the Things could be, how and what the Things might communicate; and examples of VoIP, convergence, IoT and 5G: public safety interagency communications, Star-Trek-type personal communicators for hospitals, converged applications running on business VoIP phones, contact centers, platooning to make road trains of automobiles, ultra low-power monitoring and tracking, virtual reality and augmented reality and Smart Cities.

BOOT CAMP Detailed Outline

BOOT CAMP is our three-day core training plus two days on VoIP, SIP, Security, 5G and IoT, representing the full knowledge set in telecom today. Our philosophy is: start at the beginning. Understand the fundamental ideas. Understand mainstream technologies that implement these ideas. Learn the acronyms, abbreviations and jargon. Get an unbiased big-picture view that will give you the knowledge you need to ask the right questions, make meaningful comparisons and informed decisions.

Course 101 Monday - Wednesday

Part 1: Fundamentals

The first part of BOOT CAMP is six chapters that cover the fundamentals of telecom, filling gaps, explaining concepts and establishing a solid knowledge base. First is a high-level pass with a big-picture view and introducing all of the course topics. Then we progress in a logical order: how telecom circuits are provisioned by carriers, telecom fundamentals, followed by IP packet network fundamentals. Then you'll learn about the Internet as a business: ISPs, web services like AWS, cloud computing and data centers. We'll review today's services in the residential, business and wholesale categories. The fundamentals are completed with digital media: how voice is digitized, digital video, digital images, digital quantities and digital text.

1. Introduction to Telecommunications

We begin with a comprehensive big-picture introduction to broadband telecom: the concepts of convergence and broadband, today's telecom network, the parts of the network, the three key technologies: Ethernet, IP and MPLS, what they are and what each does. You'll learn how a circuit 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. Circuits
- 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: FDM on Radio, CATV and Fiber
- G. Sharing: Channelized TDM
- H. Efficient Sharing: Statistical TDM and Bandwidth on Demand

3. Network Fundamentals

In this chapter, we'll ensure you also have a solid foundation in the fundamentals and jargon of the network. Today's converged telecom network is based on what used to be called "data communications": packets in frames. Without bogging down on details, we'll review basic circuit configurations, understand how routers relay packets from one circuit to another, and how the packets are actually transmitted from one device to another in frames. You'll fill gaps and get up to speed on IP packets, MAC frames and MPLS labels, what each is for and how they work together.

- A. Unbalanced Configurations: CATV, PON, WiFi, CAN-BUS
- B. Balanced: 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. MPLS Labels

4. The Internet, Cloud Computing and Data Centers

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. Net Neutrality

5. Telecom Services

No foundation in telecom would be complete without understanding where the money is: services with recurring billing. We'll organize services into Residential, Business and Wholesale, and identify today's standard choices and offerings in each area. We'll cover Broadband Internet for residences, plus Internet VoIP with PSTN phone number, and streaming video; in the business category VPNs, SIP trunking, PRI and Centrex; and wholesale services dark fiber, wavelengths, Carrier Ethernet and IP transit.

- A. Residential
 - 1. Broadband Internet
 - 2. POTS & PSTN Phone Calls
 - 3. VoIP Internet Telephone Service
 - 4. "Basic Cable" and Video on Demand
- B. Business
 - 1. Internet with Security, DNS
 - 2. "MPLS Services" and MPLS VPNs
 - 3. Internet VPNs
 - 4. Centrex
 - 5. SIP Trunking, PRI & PBX Trunking

- D. Wholesale
 1. Bulk: Dark Fiber, Wavelengths, Carrier Ethernet
 2. Software-Defined Network (SDN)
 3. Internet Transit
 4. Content Delivery Networks (CDN)

6. Digital Media: Voice, Video, Images, Quantities, Text

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. The same principles apply to images and video in formats like jpg and mp4 video. We'll review binary and hexadecimal, and finish with unicode for text and emojis.

- 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. Digital Video: H.264 / MP4, HD, 4K
- G. Digital Images: JPG, GIF, PNG
- H. Digital Images in Emails: MIME
- I. Digital Quantities: Binary and Hex
- J. Digital Text: ASCII and Unicode

Part 2: Telecom Technologies

In the second part, we explore the three main technologies for transmitting information from one place to another, grouped into wireless, fiber and copper. We'll cover wireless spectrum, mobile network components and operation, 4G LTE, 5G, fixed wireless broadband home internet, Wi-Fi and satellites. Then you'll learn optical basics, and how networks are built with point-to-point fibers running Optical Ethernet, wave-division multiplexing, fiber in the core, metro and to the premise. We'll finish with copper-wire technologies: DSL and POTS on twisted pair, Hybrid Fiber-Coax cable TV systems, T1 and the categories of LAN cables.

7. Wireless

In this chapter, you will learn all about wireless transmission. We'll identify the components and basic principles of operation of a mobile network. You'll understand the requirements for coverage, capacity and mobility, and why cellular radio systems are used. You'll learn how mobile to PSTN phone calls are connected, how mobile Internet works, roaming and virtual operators. You'll learn about 4G LTE and 5G for mobile, and fixed wireless broadband internet. We'll cover WiFi and the latest 802.11ax standard, and finish with satellite communications.

- A. Radio Fundamentals
- B. Spectrum
- C. Mobile Network Components and Operation
 1. Towers
 2. Transceivers
 3. Backhaul
 4. Mobile Switches & MTSOs
- D. Cellular and Handoffs
- E. PSTN Phone Calls using the Phone App ("Voice Minutes")
- F. Mobile Internet ("Data Plan")
- G. Broadband Delivery: Cellular + WiFi
- H. Mobile Operators, MVNOs and Roaming
- I. Spectrum-Sharing: FDMA, TDMA, CDMA, OFDM
- J. 4G LTE

- K. 5G New Radio (NR)
- L. 3.5 GHz Fixed Wireless Broadband Home Internet
- M. WiFi: Wireless LANs & 802.11 Standards
- N. LEO and GEO Satellite

8. Fiber Optics

The core of the converged network is routers connected point-to-point to other routers with fiber. Telephone companies that used to pull copper access wires to every home in a suburb are investing to pull an access fiber to every home. In this chapter, we'll cover the basics of fiber, the makeup of fiber cables, wavelengths and WDM. You'll understand how Optical Ethernet is used to actually implement the fiber connections, and how OE is used in the core, in metro areas, and fiber to the premise via Passive Optical Networks (PONs).

- A. Optical Basics
- B. Fiber and Cable Construction
- C. Distance-Limiting Factor: Dispersion
- D. Optical Wavelengths and Bands
- E. Wave-Division Multiplexing: CWDM and DWDM
- F. Optical Ethernet
- G. Network Core: Regional Rings and POPs
- H. Metropolitan Area Network
- I. Fiber to the Premise
 - 1. Passive Optical Network (PON)
 - 2. Active Optical Network
 - 3. MAN Stations and Stubs

9. Copper

Before wireless and fiber, two copper wires were used as the physical access circuit for telephone and cable TV service in suburbs and cities. Today, these wires are used to deliver broadband. In this chapter, we'll understand how DSL broadband service runs on twisted pairs put in place for analog POTS telephone service; how cable modems move broadband on coaxial cable; and how both are delivered as fiber to the neighborhood then copper to the premise. To finish up, we'll review digital on copper wires: LAN cables and T1s.

- A. Twisted Pair Loops
 - 1. The Public Switched Telephone Network (PSTN)
 - 2. Analog Circuits
 - 3. The Voiceband
 - 4. Plain Ordinary Telephone Service (POTS)
 - 5. DTMF
 - 6. DSL and VDSL2
 - 7. Fiber to the Node + DSL to the Premise
- B. Hybrid Fiber-Coax
 - 1. CATV: Fiber to the Node + Coax to the Premise
 - 2. Cable Modems
 - 3. DOCSIS
- C. T1 and E1
- D. LAN Cables and Categories

Part 3: Equipment, Carriers and Interconnect

In the third part, we explore the equipment that is connected by the fiber, copper and wireless of Part 2 to form networks, and the place and purpose of each. Then we understand where and how connections physically take place for PSTN phone calls, for Internet traffic and CLEC services.

10. Telecom Equipment

In this chapter, we review the different types of telecom equipment, beginning with the essentials of the broadband telecom network: Ethernet switches and IP/MPLS routers, comparing costs and capabilities. Then, we'll review the different types of customer premise equipment for broadband. To explain soft switches, call managers and SIP servers, we'll begin with legacy CO switches and PBXs to see the fundamental differences. Gateways and how they convert packets to channels completes the chapter.

- A. Broadband Network Equipment: Routers and Ethernet Switches
- B. Broadband Customer Premise Equipment
- C. CO Switches, PBXs and Remotes
- D. Soft Switches, Call Managers and SIP Servers
- E. Gateways

11. Carriers and Interconnect

To allow communications between customers of different carriers, the carriers must implement physical connections between their networks. In this chapter, you'll learn how the Internet is actually implemented, with peering and transit agreements at Internet Exchange buildings. You will also learn about POPs in toll centers: how and where local exchange service providers: ILEC, mobile providers and CATV connect together and to other carriers for phone calls with a PSTN phone number; and SS7 to set up the calls. We'll finish by understanding where a CLEC fits into the picture with equipment collocated in wire centers.

- A. IX: Interconnect for Internet Traffic
- B. Toll Center: Interconnect for PSTN Telephone Calls
- C. Implementing Long-Distance Competition: LECs and IXCs
- D. Switched Access and POPs
- E. Wireless and CATV Local Exchange Carriers
- F. SS7
- G. COs and Wire Centers
- H. CLEC: Local Competition – Collocation plus ILEC Dark Fiber

Part 4: Networking

The fourth part of BOOT CAMP and the final part of Course 101 is devoted to IP networking and MPLS. We begin with the OSI Reference Model and its layers to provide a structure for the discussion: what a layer is, what the layers are, the functions of each, and the standard protocols at each layer. Next is a chapter on Layer 2: Ethernet, 802 standards, broadcast domains and VLANs. Then, Layer 3: IP routers, IP addresses, DHCP, public and private addresses, Network Address Translation and IPv6. Chapter 15 covers the core traffic management system MPLS, and how MPLS is used to implement VPNs, classes of service, service integration and traffic aggregation. We'll conclude with a top-down review and roundup of technologies and a peek at the future of telecommunications.

12. The OSI Layers and Protocol Stacks

There are so many functions that must be performed to interoperate systems, a structure is required to organize the functions so that separate issues can be treated separately. We'll begin the fourth part of the course with the most commonly-used structure, the ISO Open Systems Interconnection 7-Layer Reference Model. You'll learn what a layer is, the purpose of each layer, examples of protocols like TCP and IP used to implement layers, and gain a true understanding of how a protocol stack works for applications like web surfing and VoIP.

- A. Protocols and Standards
- B. ISO OSI Reference Model
- C. OSI 7-Layer Model
- D. Physical Layer: 802.3, DSL, DOCSIS
- 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

Ethernet is now used in all parts of the network for point-to-point links between devices, implementing Layers 1 and 2 of the OSI model together. In this chapter, we'll review the basic principles of Ethernet and LANs, how it was formalized in the 802 series of standards, the concepts of MAC addresses, MAC frames and broadcast domains. You'll understand how LAN switches, also called Layer 2 switches, connect devices, and how VLANs separate devices as a basic network security function.

- A. Broadcast Domains, MAC Frames and MAC Addresses
- B. Ethernet and 802 standards
- C. Ethernet / Layer 2 Switches
- D. VLANs

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

15. MPLS and Carrier Networks

IP packets will be used to carry everything, including phone calls and television. 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, you'll learn 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 VPNs, different Classes of Service, service integration and traffic aggregation.

- 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

16. Wrapping Up Course 101

The final chapter of Course 101 brings all of the concepts together with a top-down review. You'll learn valuable insight into telecom project management and methodology, and review telecom, datacom and networking technologies, services and solutions. We'll conclude with a peek at the future of telecommunications, where the telephone network and Internet become the same thing.

- A. Technology Deployment Steps
- B. Requirements Analysis
- C. High-Level Design
- D. Review: Circuits and Services
- E. Technology Roundup
- F. Private Network
- G. Carrier IP Services
- H. The Future

Course 130 Thursday – Friday

Part 1: Voice over IP and SIP

Thursday morning of BOOT CAMP begins with Course 130 and chapters on VoIP and SIP, filling the gaps, demystifying jargon and getting you up to speed on Voice over IP, VoIP phone system components, Internet VoIP phone service, different choices for business VoIP phone systems, what SIP is and how it works, SIP trunking, how voice in packets works, what affects voice quality, and finishing with carrier VoIP connections.

1. VoIP Components, Systems, Standards, Jargon and Buzzwords

We'll start with VoIP jargon and buzzwords, basics of communicating voice in IP packets, what the components of VoIP systems are and what each does: soft switches, media servers, gateways and terminals, plus the main standards and protocols used in VoIP systems. The last lesson is “where this is headed”: what will people have as basic “telephone” service 20 years from now.

- A. The Big Picture
- B. VoIP System Components
- C. Terminals
- D. Voice in IP Packets
- E. Softswitches / SIP Servers / Call Managers
- F. Media Servers and Unified Messaging
- G. Gateways
- H. LANs and WANs
- I. Key VoIP Standards
- J. Where This is Headed: Broadband IP Dial Tone

2. VoIP for Individuals

“Voice over IP” can happen in many different ways. We'll begin understanding VoIP phone calls with how it all started: VoIP between individuals over the Internet. You'll learn how Internet VoIP telephone service works with a practical demonstration of Voice over IP over the Internet to a Landline (Google Hangouts). We'll trace the voice packets end to end through all of the devices, circuits and carriers involved, from a laptop in the class to the Internet then back to a cellphone in the class.

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

3. VoIP Implementations for Businesses

We will compare and contrast all the different choices for a business VoIP phone system: upgrading an existing PBX, replacing the PBX with a Call Manager / softswitch; implementing a Hosted PBX; using Softswitch as a Service, Cloud-based services, and IP Centrex from the phone company. 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. Asterisk and Open-Source Softswitch Software
- G. Phone Powering and PoE
- H. LAN Configuration for VoIP

4. SIP and Call Flow in the IP World

SIP is the open, standard protocol for setting up Voice over IP telephone calls. All standards-based VoIP systems must adhere to the Session Initiation Protocol. It defines the procedure and messages to set up a phone call – or any other kind of communication. You'll learn what SIP is, how it works, demystify jargon like proxy 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 phone calls happen in VoIP telephone systems – 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 PSTN Phone Numbers to SIP URIs
- K. Google Voice: Cloud SIP Services for Individuals

5. Voice Quality

Call quality is of primary importance, particularly for the callers! In this chapter, you'll learn what affects VoIP quality and how problems can be corrected. You'll learn how voice quality is measured and factors that affect it including codec, delay, jitter and lost packets. We'll demystify how packets actually get delayed or "lost", and listen to the resulting effects. We conclude 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, Compression and G.711
- E. Network Delay and Jitter
- F. RTP and UDP
- G. IP Networks: Layers 1-3
- H. Protocol Stack: RTP, UDP, IP, MAC
- I. Packet Loss and Sound Samples – In-Class Demo
- J. Testing and Troubleshooting Voice Quality
- K. Tips for Maximizing Voice Quality

6. VoIP Carrier Services

We round out the Voice over IP part of the course with connections to carriers, beginning with Class of Service (CoS) performance guarantees in Service Level Agreements (SLAs) and ending with selecting a VoIP carrier. 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. Class of Service (CoS)
- B. SIP Trunking
- C. VoIP at Carriers and Session Border Controllers
- D. PSTN VoIP Interconnection at the Toll Center
- E. PSTN Tandem Access Trunk Interconnection at the Toll Center
- F. Connecting with Gateways and Megaco
- G. Comparing Transmission Choices
- H. Selecting a VoIP Carrier

The VoIP section concludes with a Final Exam, fill-in-the-blanks to identify all the different pieces of information necessary to make a VoIP phone call happen, at each layer of the OSI Model. Don't panic: the class separates into groups to do the exam together, open book. It is a very useful tool to confirm BOOT CAMP knowledge gained up to this point in the week.

Part 2: Security

Communication and security go hand-in-hand, so next is a comprehensive overview of security, the threats to networks, information and systems, the measures that can be taken, and best practices.

7. Security Risks and Measures

The more things that are connected, the more ways there are for criminals to make money. In this extensive chapter, you'll get a comprehensive overview of security. We'll begin with an overview, and identification of valuable targets. We'll cover phishing and extortion, and what is actually done with data from "breaches". Next, we'll explore the risks and measures taken and best practices in network security, firewalls and ports; public and private key encryption, digital signatures, digital certificates, VPNs; viruses, trojans and exploits, and VoIP security.

- A. Security Areas, Risks and Policy
- B. Attacker Objectives
- C. Phishing and Extortion
- D. Using Stolen Usernames and Passwords
- E. Network Security: Segmentation and Perimeters
- F. Packet Forwarding vs. Packet Filtering
- G. Port Filtering & Open Ports
- H. Firewalls & Firewall Proxies
- I. Stateful Packet Inspection Firewalls
- J. Public Key and Private Key Encryption
- K. Authentication, Passwords and Digital Signatures
- L. Digital Certificates, TLS and SSL
- M. Wi-Fi Security and WPA2
- N. IP VPNs
- O. IPsec and Key Management
- P. Viruses
- Q. Trojan Horses and Spyware
- R. Exploits, Zero-Day Exploits & National Vulnerability Database
- S. VoIP Security

Part 3: 5G and IoT

BOOT CAMP and Course 130 wraps up with upcoming technologies, including 5G wireless and the Internet of Things: how everything from toasters to self-driving trucks to brain implants will be online.

8. 5G: New Radio and New Spectrum

In this chapter, you'll learn about the latest developments for the deployment of the next generation of wireless: 5G. You'll learn the immediate impact of 5G: 40% increase in bits per second per Hz, support for massive MIMO and the longer-term ultra-broadband millimeter wave applications. We'll understand the design goals for 5G and review the New Radio spectrum allocations, and finish with the chip that is the enabler for the first wave of 5G smartphones.

- A. 5G's Immediate Impact: More Bits Per Second
- B. 5G Design Goals and Use Cases
- C. New Radio: New Spectrum Allocations
- D. Millimeter-Wave Bands

- E. Massive MIMO
- F. 5G Consumer Device Enabler: Qualcomm Snapdragon X55 Chip

9. IoT

The Internet of Things: we'll start off understanding exactly what that means, exactly, what the Things could be, how and what they might communicate, how we get a computer in every Thing, and a way to power it.

- A. The Internet of Things (not)
- B. Communications for Things
- C. A Computer in Every Thing
- D. Power for Every Thing

10. Application Examples: 5G, IoT and Convergence

We complete Course 130 and BOOT CAMP with examples of VoIP and convergence, examples of IoT, and examples of 5G applications like platooning on interstate highways, ultra-low-power tracking, and optimizing traffic flow in Smart Cities.

- A. Public Safety Communications
- B. Star-Trek-Type Personal Communicators for Hospitals
- C. Converged Applications Running on Business VoIP Phones
- D. Virtual Contact Center
- E. Hosted Contact Center Services
- F. IP Contact Center Case Study
- G. Platooning: Road Trains of Automobiles
- H. Tracking: Ultra Low-Power
- I. Virtual Reality and Augmented Reality
- J. Smart Cities

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About the Author



Eric Coll is an international expert in telecommunications, data communications and networking and has been actively involved in the industry since 1983. He holds Bachelor of Engineering and Master of Engineering (Electrical) degrees.

Mr. Coll has taught telecommunications technology training seminars to wide acclaim across North America since 1992, and has broad experience working as an engineer in the telecommunications industry. He has worked for Nortel's R&D labs as a design engineer on projects including digital voice and data communications research and digital telecom network equipment design, and on satellite radar systems, consulting on Wide Area Network design, and many other projects in capacities ranging from detailed design and implementation to systems engineering, project leader and consultant.

In addition to being founder and Director of Teracom Training Institute, Mr. Coll provides consulting to the telecommunications industry, specializing in telecommunications technology R&D and as a Subject Matter Expert in tax matters

"Thank you! Thank you! I just spent an entire day talking about Session Initiation Protocol. Thanks to the course, and your instruction, I was actually able to follow the presenter (who spoke so quickly that I'm sure she must have had an oxygen tank nearby!)"

- Janette Murray, Communications Analyst, Landstar System Holdings

"The instructor was very knowledgeable and explained things at a level that I could understand."

- K.J., Novozymes NA

"New technology - installing in new sites soon, and I needed to know everything that was taught. Lots of new/good information, and it was presented in an understandable format."

- Sharon H. Eastman, Kentucky Dept. of Labor

"The instructor was excellent and presented a good, entertaining approach to the subject."

- John P. Spinks, Lockheed Martin

"Gave me an overall understanding of the workings of VoIP. The instructor was very good – he was able to answer all questions and made the course interesting." - Garry Waddell, Ricoh Corporation

"Made clear that which had previously been muddy."

- Nick Whittier, EPA

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