



TCP/IP and IP Training Course

Introduction

IP, the Internet Protocol, has its roots back in the 1960s and was originally developed as part of a research project funded by the Defence Advanced Research Projects Agency (DARPA), part of the US Department of Defence (DoD). Today, IP is well known as being the world's most widely used networking protocol.

Traditionally IP has been used in the support of transporting data. However due to a whole host of driving forces, IP is now seen as the protocol of today and the future to support not just data but multimedia traffic including voice and video.

This course looks at IP and its associated protocols in terms of the technology as well as how it is applied to real-life applications. In addition, we discuss many of the issues that need to be addressed when using and considering using IP.

Who should attend the course?

This course is aimed at individuals who wish to develop a solid understanding of all aspects of IP technology. It will be beneficial for network managers, technicians, designers and consultants who are involved in supporting, managing, designing or implementing IP networks. A general understanding of data communication principles is recommended.

Learning Objectives

At the end of the course, the delegates will understand:

- How IP packets are carried in various layer 2 structures including Ethernet and PPP
- IP addressing and subnetting of IPv4 address space
- The various fields in the IP header
- Various IP support protocols including ARP, ICMP, DHCP, DNS...
- The roles of TCP and UDP in the transport of application layer protocols
- How a router makes its routing decisions
- How routing protocols such as OSPF, IS-IS, BGP do their jobs
- The key differences between IPv4 and IPv6
- How various applications work over IP including HTTP, FTP, Voice over IP and others
- How security functions such as firewalls, intrusion detection/protection systems and VPNs operate
- How Quality of Service (QoS) can be implemented in an IP network
- The basics of IP in an MPLS environment

Hands-on Exercises

- Use of network analyser to analyse the contents of data frames and IP packets
- Configuration of router interfaces
- Configuration of static routes
- Configuration of routing protocols
- Design and implement an IP network and network addressing scheme
- Configuration and proving of Access Control Lists

Course Length

4 days

Course Agenda

- Introduction to IP and Layered Communication Models: OSI and TCP/IP Models
- Internet Protocol (IPv4) Fundamentals
- IP support protocols
- Routing IP, Static Routing and Routing Protocols
- Internet Control Message Protocol (ICMP)
- IP Version 6 (IPv6)
- Transport Layer Protocols - Transmission Control Protocol (TCP) and User Datagram Protocol (UDP)
- Application Layer Protocols
- Voice over IP (VoIP)
- Security and IP
- Quality of Service (QoS) and IP
- IP and Multi Protocol Label Switching (MPLS)

1 Introduction to IP and Layered Communication Models: OSI and TCP/IP Models

- Introduction to layered models
- Benefits of Using a Layered Model
- Open Systems Interconnection (OSI) Model
 - Application, Presentation, Session, Transport, Network, Datalink, Physical
- TCP/IP Model
 - Application, Transport, Internetwork, Network Interface
- TCP/IP Data Encapsulation
- OSI vs TCP/IP
- Examples of 'layer 2' networks for carrying IP
 - IP over Ethernet
 - IP over Point-to-point Protocol (PPP)
 - IP over Frame Relay and Asynchronous Transfer Mode (ATM)
- Section summary and end-of-section review questions

2 Internet Protocol (IPv4) Fundamentals

- Introduction to the Internet Protocol (IP)
- OSI layer 3 functions
 - Path selection (routing), interaction with layer 2, network layer addressing, routing protocols
- The IP packet header
- IP addressing
 - Dotted decimal notation and binary view
 - Converting between dotted decimal notation and binary
 - Class A, Class B, Class C (Class D and Class E) addresses - The first octet rule
 - Network address masks
 - Converting IP addresses between decimal and binary format
- Subnetting
 - Subnet masks and prefix notation
 - Using the logical AND function to find network/subnet and host numbers
 - Subnetting on an octet boundary

- Breaking the octet boundary
- How many subnets and hosts per subnet are available?
- Subnet zero and the all-ones subnet
- Calculating subnet number, subnet broadcast address and the range of host addresses in a subnet using binary.
- Calculating subnet number, subnet broadcast address and the range of host addresses in a subnet without using binary.
- IP subnetting guidelines to meet a given design requirement
- Variable Length Subnet Masking - VLSM
- Classless Inter-Domain Routing - CIDR
- Private Addressing
- Network Address Translation (NAT) and Port Address Translation (PAT)
- Section summary and end-of-section review questions

3 IP support protocols

- Address Resolution Protocol (ARP)
 - How ARP works
 - What does ARP do?
 - Proxy ARP
- Internet Control Message Protocol (ICMP)
- Dynamic Host Configuration Protocol (DHCP)
 - DORA - Discover, Offer, Request, Ack
 - DHCP Renewal, Release and Refusal
 - DHCP Inform 1
 - DHCP Decline and ARP Duplicate Address Test (DAT)
 - DHCP/BOOTP Relay
- Name systems
 - The Hosts file on Windows/UNIX/LINUX systems
 - The Domain Name System
- Section summary and end-of-section review

4 Routing IP, Static Routing and Routing Protocols

- Routing
 - What does a router do
 - Routing tables
 - Static routing and its configuration
 - Summary Route
 - Floating Static Routes and Load Sharing
 - Default routes
- Routing protocols
 - Routed vs. Routing Protocols
 - Dynamic Routing Protocols
 - Interior Gateway Protocols (IGP) and Exterior Gateway Protocols (EGP)
 - Routing Metrics
 - Types of Dynamic Routing Protocol
 - Distance Vector routing protocols
 - Routing Information Protocol (RIP) Version 1
 - RIP Version 2
 - Interior Gateway Routing Protocol (IRGP)

- Link-State Routing Protocols
 - Open Shortest Path First (OSPF)
 - Integrated Interior System to Interior System (IS-IS)
 - The Internet EGP - Border Gateway Protocol (BGP)
- Classful and Classless routing
- Classful and Classless Routing protocols
- Route summarisation
- Autosummarisation
- Section summary and end-of-section review questions

5 Internet Control Message Protocol (ICMP)

- Internet Control Message Protocol (ICMP)
 - ICMP - Echo request and echo reply
 - ICMP - Destination unreachable
 - Network unreachable
 - Host unreachable
 - Protocol unreachable
 - Port unreachable
 - Fragmentation needed and DF bit set (Can't fragment)
 - Maximum Transmission Unit (MTU) and Fragmentation
 - ICMP - Time exceeded
 - ICMP - Redirect
- Section summary and end-of-section review questions

6 IP Version 6 (IPv6)

- IPv6 addressing
- Types of IPv6 address
 - Unicast
 - Multicast
 - Anycast
- Types of unicast addresses
 - Global addresses
 - Link local addresses
 - Unique local addresses
 - Special addresses
 - IPv4 compatible addresses
- IPv6 interface identifiers
- IPv6 packet header format
- IPv6 extension headers
- ICMPv6
- Neighbour discovery
- IPv6 autoconfiguration
- DNS enhancements for IPv6
- Section summary and end-of-section review questions

7 Transport Layer Protocols - Transmission Control Protocol (TCP) and User Datagram Protocol (UDP)

- OSI layer 4 functions

- Connection oriented vs connectionless protocols
- Reliable and un-reliable protocols
- The use of port numbers
- Transmission Control Protocol (TCP)
 - The TCP header
 - Connection-opening and closing
 - Segmentation of data and data sequencing
 - Error recovery
 - Flow control using windowing
- User Datagram Protocol (UDP)
 - The UDP header
- Section summary and end-of-section review questions

8 Application Layer Protocols

- Overview of some applications used with TCP/IP and UDP/IP
 - File Transfer Protocol (FTP)
 - Telnet
 - Simple Mail Transfer Protocol (SMTP)
 - Domain Name System (DNS)
 - Trivial File Transfer Protocol (TFTP)
 - Hypertext Transfer Protocol (HTTP)
 - Post Office Protocol - version 3 (POP3)
 - Simple Network Management Protocol (SNMP)
- Section summary and end-of-section review questions

9 Voice over IP (VoIP)

- Why VoIP? A view from a business perspective as to why voice over IP may be an appropriate technology to deploy in many voice related applications
- A look at voice over IP as deployed across the Internet or across a private IP network.
- A look at some of the standards for voice over IP:
 - H.323 and related protocol
 - Session Initiation Protocol (SIP)
 - Media Gateway Control Protocol (MGCP) and Megaco / H.248
 - Cisco SCCP (Skinny Call Control Protocol)
- How speech, DTMF, signalling etc.. is carried in IP packets
 - Voice coding
 - Real Time Protocol (RTP)
 - Real Time Control Protocol (RTCP)
 - Secure Real Time Protocol (SRTP) and Secure RTCP (SRTCP)
- A look at some of the devices that may be used to implement a voice over IP network
 - IP phones
 - Power to the IP phone - powered Ethernet
 - Gateways
 - Call control systems
 - IP enabled voice switches (PBX and public network switches)
- A look at some of the challenges of deploying voice over IP
- Section summary and end-of-section review questions

10 Security and IP

- Overview of security and IP
- Introduction to encryption and authentication
- Firewalls
 - Packet filtering - Access control lists
 - DMZ
 - Stateful packet inspection
 - Content filtering
 - Intrusion Detection Systems and Intrusion Protection Systems
 - Network Address Translation (NAT) and Port Address Translation (PAT)
- VPNs
 - IPSec
 - SSL VPNs
- Section summary and end-of-section review questions

11 Quality of Service (QoS) and IP

- Quality of Service with IP
- Queuing and scheduling mechanisms
 - First In First Out (FIFO)
 - Strict Priority Queuing
 - Fair Queuing
 - Weighted Fair Queuing (WFQ)
 - Class-based Weighted Fair Queuing (CBWFQ)
- Integrated services and the Resource Reservation Protocol (RSVP)
- Differentiated services - Diffserv
- Section summary and end-of-section review questions

12 IP and Multi Protocol Label Switching (MPLS)

- Introduction to MPLS
- MPLS defined
- Routing protocol overview
- Label Distribution Protocol (LDP)
- Resource reSerVation Protocol - Traffic Engineering (RSVP-TE)
- MPLS fast reroute
- MPLS VPNs
- Section summary and end-of-section review questions

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