



# Understanding Ethernet and TCP/IP

## Introduction

This course is designed for those who require a broad yet thorough understanding in the areas of Ethernet and TCP/IP. In essence a consolidation of two other courses, this combined course covers many of the technologies necessary to implement local and wide area networks.

## Learning Objectives

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

- How Ethernet operates
- How Ethernet cabling systems work
- How an Ethernet switch operates
- How VLANs work
- 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

## Hands-on Exercises

- The use of an Ethernet LAN Network Analyser
- Configuration of an Ethernet switch including VLANs
- Configuration of STP and RSTP on an Ethernet switch
- Network design using Ethernet switches and IP routers
- Implementation of network design as given above and proof of its operation using both static and dynamic routing
- Use of network tools to troubleshoot issues with a network
- Configuration of Access Control Lists

## Course Length

4 days

## Course Agenda

- Layered Communication Models: OSI and TCP/IP Models
- Ethernet Fundamentals
- LAN Switching Fundamentals
- Virtual LANs (VLANs) and Trunking
- Internet Protocol (IP) Fundamentals

- Other Layer 3 Functions
- Routing IP, Static Routing and Routing Protocols
- Network Design and Implementation Hands-on exercises
- Internet Control Message Protocol (ICMP)
- Transport Layer Protocols - Transmission Control Protocol (TCP) and User Datagram Protocol (UDP)

#### Fundamentals

- Application Layer Protocols
- Firewalls

## 1 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
- Section summary and end-of-section review questions

## 2 Ethernet Fundamentals

- Introduction to Ethernet
- Ethernet and the OSI model
- Layer 1 functions
- Layer 2 functions -
- Arbitration, Addressing (MAC), Error Detection (FCS), Encapsulated data identification
- The various forms of cabled Ethernet
- The older Ethernet standards - 10BASE5 (Thick Ethernet) and 10BASE2 (Thin Ethernet) (brief)
- Unshielded Twisted Pair (UTP) and Shielded Twisted Pair (STP)
- Fibre-optic
- UTP forms of Ethernet:
- 10BASE-T
- 100BASE-T (Fast Ethernet)
- 1000BASE-T (Gigabit Ethernet)
- 10Gigabit Ethernet
- Ethernet frame formats:
- Ethernet V2
- IEEE 802.3
- Sub Network Access Protocol (SNAP)
- Ethernet addresses - The MAC address - Physical/Unicast, Multicast and Broadcast
- Carrier Sense Multiple Access with Collision Detect (CSMA/CD)
- Performance limitations as a result of collisions
- Methods to reduce collisions

- LAN switching
- Full-duplex Ethernet
- Wireless LANs - IEEE 802.11
- Introduction to the Ethernet LAN Analyser with hands-on exercises
- Section summary and end-of-section review questions

### 3 LAN Switching Fundamentals

- Introduction to bridging and switching
- Separation of collision domains - LAN segmentation
- Overview of transparent bridging
- Ethernet switching:
  - MAC address learning
  - Forwarding and filtering of frames
  - Broadcast, multicast and unknown unicast frame handling
  - Cut-through switching / Fragment-free switching / Store and forward switching
- Full duplex operation
- Auto-negotiation
- Loops in bridged/switched networks
- The problem
- The solution - Spanning Tree Protocol (STP)
- The IEEE 802.1d Spanning Tree Protocol explained
- Ports and The Spanning Tree
- Root Bridge election
- Root Port selection
- Designated bridge and Designated Port selection
- Bridge (Switch) Port States
- Responding to network changes
- The IEEE 802.1w Rapid Spanning Tree Protocol (RSTP)
- Port Roles
- Root port, designated port, alternate port, backup port and disabled port
- Port States
- Rapid Convergence
- Hands-on configuration of STP and RSTP
- Section summary and end-of-section review questions

### 4 Virtual LANs (VLANs) and Trunking

- Overview of VLAN concepts and operation
- Trunking between switches
- IEEE 802.1Q
- Trunking Between a Switch and a Router
- VLAN configuration on the Cisco 2950
- VLAN trunking configuration on the Cisco 2950
- Hands-on exercises of configuring and testing VLANs

- Section summary and end-of-section review questions

## 5 Internet Protocol (IP) 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)
- Static NAT
- Dynamic NAT
- Port Address Translation (PAT)
- Using secondary IP addresses
- Section summary and end-of-section review questions

## 6 Other layer 3 functions

- Address Resolution Protocol (ARP)
- How ARP works
- What does ARP do?
- Proxy ARP
- Internet Control Message Protocol (ICMP)
- Reverse Address Resolution Protocol (RARP)
- Bootstrap Protocol (BOOTP)

- Dynamic Host Configuration Protocol (DHCP)
- DORA &ndash; 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
- DNS domains
- DNS name format
- Resolving domain names
- Section summary and end-of-section review

## 7 Routing IP, Static Routing and Routing Protocols

- Routing
- 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

## 8 Network Design and Implementation Hands-on Exercises

- Network design using Ethernet switches and IP routers

- Implementation of network design using static routing
- Network tools used to troubleshoot issues with the network
- Implementation of network design using automatic routing protocols

## 9 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

## 10 Transport Layer Protocols &ndash; 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

## 11 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)

- Voice over IP
- Section summary and end-of-section review questions

## 12 Firewalls

- Overview of firewalls
- Network address translation and port address translation
- Access control lists (ACL) &ndash; Access lists
- Virtual Private Networks (VPNs)
- Hands-on configuration of Access Control Lists
- Section summary and end-of-section review questions

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