



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 – 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 – 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) – 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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