Industrial Networking and TCP/IP

Course description

This course covers the basics and advanced networking topics related to Ethernet and TCP/IP networks with an emphasis on industrial and substation network architectures.

Numerous topics are covered such as the technology required for interconnecting LAN segments as well as the various advanced features that managed-network devices offer, how these features are configured and how they are applied. An overview of industrial Ethernet and networking technologies that are applicable to industrial and substation network environments are also discussed.

Practical Sessions

The nature of the course is such that the bulk of the learning experience is conveyed with practical applications and sessions. The delegate is expected to bring along a laptop with administrative rights for installing software in order to benefit fully from the practical sessions.

Course prerequisites

None

Duration: 4 days

Contents

Data Communications and Networking
Communication Fundamentals, the OSI reference model, network topologies, LANs

Introduction, Overview and History of Ethernet
Ethernet history, standards, Ethernet operation, CSMA/CD.

802.3 physical specifications
Ethernet on Coaxial cable – 10BASE-5 (Thick Ethernet) and 10BASE-2 (Thin Ethernet), Distance limitations, hubs and repeaters, 5-4-3-2-1 rule, Ethernet on Cat 3, 4, 5, 5e, 6 & 7 UTP – 10BaseT, 100BaseTX, 1000BaseT, 10gbe. Ethernet on multi-mode and single-mode fibre optic cable - 10BaseF, 100BaseFX, 1000BaseSX

Ethernet layer 2
Overview, NICS, device drivers, MAC addresses, broadcasts, multicasts, frame formats, Ether II, 802.3, 802.2, compatibility, Ethernet type numbers, Ethernet multicasting, IEEE vendor identifiers.

Ethernet extensions
Full/half duplex, auto negotiation, flow control methods.

Interconnecting LANS
Broadcast domains, Collision domains, Bridges, transparent bridging, Switches, STP, VLANS, Routers and Layer 3 switches, Connecting Ethernet to WANs.

Ethernet extensions
802.3ad, 802.3af, 802.3ah.

Ethernet speed enhancements and Determinism
Encoding, Carrier extension, packet bursting, jumbo frames. Prioritization with
802.1P, 802.1Q, TOS, WRR, QOS, VLANs.

Bridges
Bridge operation, frame forwarding, filtering.

Switches
Switch review, reasons for segmentation, 802.1x, switch clustering, Switch backplanes, Ports, buffers, store and forward vs. cut through, fragment free, adaptive switching, blocking and non-blocking architectures.

Configuring switches
Products, accessing the switch, installing the switch, switch interfaces, Speed, Full/half duplex, auto negotiation, flow control methods. MAC based security.

Backbone architectures
Fast Ethernet, Gigabit Ethernet, 10Gig, Ethernet bundles.

Redundant links
Spanning Tree, Loops, effect, root bridges, bridge port states, STP reconfiguration. Resilience and load sharing, speeding STP.

Managing switches
SNMP, RMON, RMON II.

VLANs
Introduction, reasons for VLANs, VLAN tagging. Planning VLANs, Dynamic VLANs, multi VLAN ports.

Troubleshooting and maintaining Ethernet
Utilization, performance, bottlenecks, statistics, RMON.

Trunking
Trunks, Link types, ISL, DISL, 802.1Q, DTP.

VTP
VTP modes, how VTP works, VTP pruning.

Spanning Tree Protocol
Common Spanning Tree, load balancing

Advanced STP issues
STP convergence, STP states, STP timers, BPDUs, topology changes, placing the root bridge, tuning STP timers, troubleshooting STP, disabling STP, alternatives to STP.

Rapid STP
802.1w, new port roles and states, new BPDUs, rapid convergence, topology changes, compatibility issues.

Ethernet switches and multicasting
Mapping multicast addresses to VLANS, static configuration, IGMP snooping, CGMP, broadcast suppression.

What is TCP/IP?
Protocols, services. The Internet, RFCs,

Host-to-Host Layer Protocols TCP and UDP
Role of the transport protocol, reliable vs. best-effort services, Transmission Control Protocol, port numbers and process addressing, TCP packet structure and troubleshooting, TCP performance issues, User Datagram Protocol, Connectionless protocol operation and reliability issues. Comparison with OSI 7 layer model.

TCP/IP networks
Application services and multivendor capabilities, TCP/IP and the Internet, Internet RFCs and Standards, TCP/IP protocol architecture, protocol layering concepts, TCP/IP layering, Client-Server Communications Model

TCP/IP Configuration and Utilities
Host configuration of IP addresses, subnet masks and default gateways, *ipconfig*, *ping*, hostnames, hosts file.

Internet Layer Protocols
Internet Layer functions, internetworking concepts, physical layer interface and independence, IP addressing, classful addressing A, B, C, D, E, classless addressing and CIDR, address resolution, RARP, BOOTP and DHCP, IP networks, private IP addresses, IPv6

IP addressing
Format of addresses, registering, Address classes, dotted decimal notation, choosing addresses, DHCP.

Subnetting
When to subnet, subnet masks, working with subnetting, CIDR notation.

IP
IP datagram format, ICMP datagram format.

IP and the lower layers
ARP, RARP, Ethernet, PPP, other media.

Routing
Reason for routing, network addressing, default gateways, how routing works, routing and addresses, routing tables, *traceroute*. Implementing routed networks, router technology, IP routing protocols, routing problems, subnetting IP networks, control messages on IP networks (ICMP), supernetting Classless Inter-Domain Routing, Network Address Translation

InterVLAN routing

Internal/External router, router on a stick, speeding the routing process, multi-layer switching, content aware switching.

Routing protocols
IGPs, EGPs, RIP & OSPF.

The transport layer
UDP, Ports, TCP, acknowledgements, sliding windows.

Internet services
DNS, WWW, SMTP, POP3, NTP.

Network management
Issues, SNMP, MIB's, configuring SNMP.

Diagnostics and troubleshooting
A methodology, Important files, Standard tools, Performance tuning.

TCP/IP security considerations
Firewalls, architectures, packet filtering, proxy servers, VPNs, IPSec, anonymous ftp.

Using TCP/IP Applications
Clients and daemons, services, *ftp*, *telnet*, *tftp, ssh, snmp*

Application Layer Protocols
Functions and operation of application protocols, file transfer protocols, TELNET, DNS, mechanisms of VoIP

Managing TCP/IP networks
SNMP management, Simple Network Management Protocol, management database

Industrial Ethernet Protocols and Standards
Ethernet/IP, Foundation Fieldbus HSE, Modbus/TCP, DNP/IP, IEC 60870-5-104