

Internet Protocol Engineering Professional (IPEP) v2

Scope

The SCTE·ISBE **Internet Protocol Engineering Professional (IPEP)** certifies knowledge in the engineering aspects of Internet Protocol systems as deployed in the Cable Telecommunications Industry. The scope of this certification includes the design, analysis, testing, integration, deployment considerations and troubleshooting of a variety of IP systems.

Specific categories include:

- I. General Networking Theory
- II. IP Theory (IPv4, IPv6)
- III. Network Design & Performance Analysis (IPv4, IPv6)
- IV. IP Network Test & Integration and Troubleshooting
- V. IP Network Deployment & Operation
- VI. Multi-media over IP
- VII. Standards and Internet-Related Organizations

I. General Networking Theory

Competency	Knowledge, Skills, and Abilities
A. Protocols and Protocol Layer Comparisons	1. Layers and their functions
	a. OSI
	i. Application
	ii. Presentation
	iii. Session
	iv. Transport
	v. Network
	vi. Data link
	vii. Physical
	b. TCP/IP
	c. DOCSIS
	d. FCAPS model
	B. Data Encapsulation
a. IPv4 Encapsulation	
b. IPv6 Encapsulation	

	2. Transport considerations:
	a. IP fragmentation
	b. Sockets
	c. Ports
	3. Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) protocol properties comparisons
	a. TCP Packet format
	b. UDP Packet format
C. Ethernet (CSMA/CD, 802.x, Ethernet II)	c. Well-Known Application Port Numbers
	1. Network speeds (10/100/1000/10000)
	2. Collision and Backoff
	3. Auto-negotiation
	4. Composition of an IEEE 802.3 MAC frame
D. General Networking Concepts	5. Broadcast messages
	1. Routers
	2. Switches
	3. CCAP
	4. Broadcast/Collision Domains
	5. Virtualization
E. General Routing Concepts	a. OPNFV
	1. Difference between switching and routing
	2. Split horizon
	3. Summarization
	4. Link State vs. Distance Vector
	5. Loops
F. Standards	6. Tunneling
	1. 802.x
	2. Protocol limitations
	3. SDH/SONET
G. Protocol Mechanics	4. MEF SD-WAN
	1. Windowing/Acknowledgements (ACK)
	2. Fragmentation
	3. Maximum transmission unit (MTU)
	4. Handshaking
	5. Termination

H. Services	1. Domain Name System (DNS)
	2. Bootstrap Protocol (BOOTP)
	3. Dynamic Host Configuration Protocol (DHCP)
	4. Internet Control Message Protocol (ICMP)
	5. Terminal Services
I. Applications	1. Telnet
	2. File Transfer Protocol (FTP)
	3. Secure File Transfer Protocol (sFTP)
	4. Trivial File Transfer Protocol (TFTP)
	5. Hyper Text Transfer Protocol (HTTP)
	6. Hyper Text Transfer Protocol Secure (HTTPS)
	7. Secure Shell (SSH)

II. IP Theory (IPv4, IPv6)

Competency	Knowledge, Skills, and Abilities
A. Standards and Protocols IPv4	1. IPv4 Topics
	a. Addressing
	b. Classless Inter-Domain Routing (CIDR)
	c. Subnetting/Variable Length Subnet Masks (VLSM)
	d. Address Resolution Protocol (ARP)
	e. Network Address Translation (NAT)
	f. Hot Standby Router Protocol (HSRP)
	2. IPv4 Coverage
	a. Internetworking
	b. CCAP, Routers, Switches, Modems
	c. Cabling (Coax, Fiber, Twisted Pair)
	d. Wireless Standards 802.11x, 4G, 5G
	3. Internet Protocols
	a. IPv4 Protocol Packet
	b. Well-known Application Protocol Numbers
	c. TCP Packet
	d. UDP Packet
	e. Well-Known Application Port Numbers
	f. IPv4 Encapsulation
	g. IPv4 Applications:
	i. ARP
	ii. DHCP
	iii. ICMP processes
	iv. Other protocols
	h. Basic Binary, Hexadecimal, Decimal Conversions
	i. IPv4 Dotted Decimal Addressing:
	i. Class A, B, C, D
	ii. Broadcasts
	iii. Private
	j. IP Subnetting and Supernetting Calculations
	i. Masking
ii. Variable Length Subnet Masks (VLSM)	
iii. Classless Inter-Domain Routing (CIDR)	

	iv. Summary Routes
B. Standards and Protocols IPv6	1. IPv6 Topics (Addressing, Subnetting, Features)
	a. IPv6 Coverage
	i. IPv6 Protocol Packet
	ii. IPv6 Encapsulation
	iii. IPv6 Applications
	iv. IPv6 Hexadecimal Addressing
	(a) Shorthand Notations
	(b) Address Types
	(c) Zero Compression
	b. IPv6 Subnetting Calculations
	c. IPv6 Services:
	i. Neighbor Discovery
	ii. ICMPv6
	iii. DHCPv6
	iv. DNSv6
	d. IPv6 Interior/Exterior
C. Routing Basics, Route Forwarding and Routing Protocols	1. Routing Basics
	a. Routed Protocols
	b. Static Routing
	i. Default Route
	ii. Network Route
	iii. Host Route
	iv. Floating Static
	c. Route Forwarding
	i. Routing Metrics
	ii. Administrative Distance
	iii. Hop Counts
	iv. Longest Match Rule
	d. Routing Loops
	i. Hop Counts
	ii. Split Horizon
	iii. Route Poisoning
	iv. Holddown (flapping)
	e. Routing between VLANs
	2. Routing Protocols
	a. Link State

	b. Shortest Path First
	c. OSPF
	d. BGP
	3. Process to add a new device, switch or router to an existing router
	4. Access Control Lists (ACLs)
	a. Inbound
	b. Outbound
	c. Standard
	d. Extended
	e. Named
	f. Wildcard Masking
	g. Distribute Lists
	5. Network Address Translation (NAT)

III. Network Design & Performance Analysis (IPv4, IPv6)

Competency	Knowledge, Skills, and Abilities
A. Design Guidelines	1. Network Topological Design
	2. Switching
	a. Address Learning
	b. Port States
	c. Forwarding
	d. Filtering
	e. Loop Avoidance
	3. Spanning Tree Protocol (STP)
	a. Root Bridge
	b. Designated Port
	c. Port States
	d. Bridge ID
	4. Rapid Spanning Tree Protocol (RSTP)
	5. LAN Switch Types
	a. Cut-through
	b. Fragment-free
	c. Store and Forward
	6. Process to add a new device to a Layer 2 switch
B. VLANs (access/trunk lines, frame tagging, routing)	1. Static, Dynamic, Memberships, Security
	2. Access and Trunk Links
	3. Frame Tagging, IEEE 802.1Q
	4. VLAN Trunk Protocol
	a. Client and Server
	b. Pruning
	1. Multicast:
	a. Design

C. Routing Protocols - Standard protocols (DVMRP, OSPF, BGP, MPLS)	b. Protocol Independent Multicast (PIM - both sparse and dense)
	c. Distance Vector Multicast Routing Protocol (DVMRP)
	d. Internet Group Management Protocol (IGMP)
	2. Access lists
	a. Distribute lists
	b. Route maps
	c. Policy routing
	d. Redistribution
	e. Route tagging
	3. Open Shortest Path First (OSPF)
	a. Design
	i. Areas
	ii. Virtual links
	iii. Stub
	iv. Not So Stubby Areas (NSSA)
	v. Area Border Router (ABR) / Autonomous System Boundary Router (ASBR) redistributions
	vi. Media dependencies
	vii. External vs. internal
	viii. Summarization
	b. Operation
	i. Designated Router (DR)
	ii. Backup Designated Router (BDR)
	iii. Adjacencies
	iv. Link-State Advertisement (LSA) types

	v. Link-state database
	vi. Shortest Path First (SPF) algorithm
	vii. Authentication
	4. Border Gateway Protocol (BGP)
	a. Design:
	i. Peer Groups
	ii. Route Reflectors
	iii. Confederations
	iv. Clusters
	v. Attributes
	vi. Autonomous Systems (AS)
	b. Operation:
	i. Route Maps
	ii. Filters
	iii. Neighbors
	iv. Decision algorithm
	v. Interior Border Gateway Protocol (iBGP)
	vi. Exterior Border Gateway Protocol (eBGP)
	c. Multi-protocol BGP – Multicast and VPN Address families
	d. Switching Protocols
	e. Addressing/Numbering
	f. Network Capacity
	g. Port Utilization
	h. Traffic Analysis
D. Virtualization	1. Technologies
	a. Cloud Service Categories
	i. Software as a Service (SaaS)

	ii. Platform as a Service (PaaS)
	iii. Infrastructure as a Service (IaaS)
	iv. Anything as a Service (XaaS)
	b. Cloud Deployment Models
	i. Private
	ii. Community
	iii. Public
	iv. Hybrid
	c. Virtual machine
	d. Virtual switching
	2. Path virtualization
	a. Pseudowire
	i. Virtual Private LAN Service (VPLS)
	b. Virtual Routing and Forwarding (VRF)
	c. GRE and IPsec tunneling
	3. Network virtualization concepts
	a. Network Function Virtualization (NFV)
	b. Locator ID Separation Protocol (LISP)
	c. Virtual Extensible LAN (VXLAN)
	4. Software-defined Networking (SDN)
	a. OpenFlow protocol

IV. IP Network Test & Integration and Troubleshooting

-Competency	Knowledge, Skills, and Abilities
A. IP Network Impairments	1. TCP/IP
	2. Addressing
	3. Routing
	4. Switching
B. Effective Testing Practices	1. Connectivity
	2. Functional testing
C. System Level Test Methods	1. System testing
D. Isolating Problems	1. DNS
	2. DHCP
	3. IP
E. Troubleshooting Network Problems	1. OSPF
	2. Tracroute
	3. SNMP
	4. NAT
F. Security	1. IPSec
	2. 802.1x
	3. Secure File Transfer Protocol (SFTP)
	4. Secure Shell (SSH)
	5. Virtual Private Network (VPN)

V. IP Network Deployment & Operation

Competency	Knowledge, Skills, and Abilities
A. Network Architecture	1. Public vs. Private
	2. Network elements
	3. Network diagrams
B. Network Management	1. SNMP
C. Network Monitoring	1. SNMP
	2. IPDR
D. Growth/Capacity Planning	
E. Maintenance	
F. System Upgrades	
G. Disaster Recovery	
H. Security	1. Policy
	2. Access Lists
	a. Firewall
	3. Security Protocols
	a. Secure Shell (SSH)
	b. Secure FTP (SFTP)
	c. Terminal Access Controller Access Control System (TACACS)
	d. Remote Access Dial-In User Service (RADIUS)
	e. Kerberos
	4. VPN
5. 802.1x	
I. Home Networking Awareness	1. Cabling, Wireless Standards 802.11x

VI. Multimedia over IP

Competency	Knowledge, Skills, and Abilities
<p>A. Video/Audio and Associated Data</p>	1. MPEG
	a. Systems
	b. Video
	2. SCTE/ATSC standards
	a. MPEG
	i. H.262 transport
	ii. H.262 video
	iii. H.264
	iv. H.265
	b. AC-3 audio
	3. IETF RFCs and standards
	a. IP
	b. UDP
	c. TCP
	d. ARP
	e. IGMP
	4. Rate-shaping and re-multiplexing
	5. Ad Insertion over IP
	a. SCTE 30
	b. SCTE 35
<p>B. Voice over IP</p>	1. QoS Attributes
	a. Packet loss, jitter & latency
	b. DSCP
	c. IP Precedence
	d. Type of Service
	e. Traffic
	2. IP transmission
	1. Video/audio/related data
	a. MoCA

C. Network Requirements for Multimedia over IP	2. Computer data communications
	3. Voice
	a. SIP
	b. IMS

VII. Standards and Internet-Related Organizations

Competency	Knowledge, Skills, and Abilities
<p>A. Understand the standards organizations that manage, regulate, and create standards for the cable/telecommunications industry; outline due process standards creation and maintenance; identify by SDO number and title</p>	1. IETF
	a. List of IETF Standards: STD01
	b. IP: IETF STD05/RFC 791
	c. UDP: STD06/RFC 768
	d. TCP: STD07/RFC 793
	2. IEEE
	3. IEC
	4. CableLabs
	5. SCTE
	a. Data Standards Subcommittee
	b. Digital Video Subcommittee (DVS)
	i. TS Verification RP: SCTE 142
	ii. AVC Video/Transport: SCTE 128
	iii. MPEG-2 Multiplex/Transport: SCTE 54
	iv. MPEG-2 Video: SCTE 43
	v. DPI - Automation Trigger Protocol: SCTE 104
	vi. DPI - Cue Message Protocol: SCTE 35
	vii. DPI - Splicer/Server Protocol: SCTE 30
	6. ATSC
	a. ATSC Digital Television: A/53 (Parts 1 through 7)
	b. AC-3 Audio: A/52
	c. PSIP: ATSC A/65
	7. CEA
	a. CEA-608 (Analog Line 21 Closed Captions)
	b. CEA-708 (Digital TV closed captions)
	8. MPEG-2 Systems: ISO/IEC 13818-1 (also ITU-T H.222.0)
	a. MPEG-2 Video: ISO/IEC 13818-2 (also ITU-T H.262)
	b. MPEG-4 Video: ISO/IEC 14496 (also ITU-T H.264)

	c. MPEG-HEVC Video: ISO/IEC 23008-2 (also ITU-T H.265)
	9. SMPTE
	a. SD analog video: SMPTE 170M
	b. SD digital video: SMPTE 125M
	c. HD 1080i video: SMPTE 274M
	d. HD 720P video: SMPTE 296M
	e. SD SDI transport: SMPTE 259M
	f. HD SDI transport: SMPTE 292
	10. AES
	a. Digital audio: AES3
	11. DVB
a. Video/Audio Coding: ETSI TS 101 154	
B. Identify specific RFCs as they pertain to specific Internet protocols.	1. RFCs
	a. RFC 1577
	b. IP: IETF STD05/RFC 791
	c. UDP: STD06/RFC 768
	d. TCP: STD07/RFC 793
	e. ICANN