SCTE · ISBE

SCTE®·ISBE® Internet Protocol Engineering Professional (IPEP)

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. DOCSIS
V. IP Network Test & Integration and Troubleshooting
VI. IP Network Deployment & Operation
VII. Multi-media over IP
VIII. Standards and Internet-Related Organizations

I. General Networking Theory

Competency	Knowledge, Skills, and Abilities
A. 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	1. Internet Protocol (IP): Structure and facilities

	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. Well-Known Application Port Numbers
C. Ethernet (CSMA/CD, 802.x, Ethernet II)	1. Network speeds (10/100/10000)
	2. Collision and Backoff
	3. Auto-negotiation
	4. Composition of an IEEE 802.3 MAC frame
	5. Broadcast messages
D. General Networking Concepts	1. Routers
	2. Switches
	3. Bridges
	4. Modems
	5. Broadcast/Collision Domains
E. General Routing Concepts	1. Difference between switching and routing
	2. Split horizon
	3. Summarization
	4. Link State vs. Distance Vector
	5. Loops
	6. Tunneling
F. Standards	1. 802.11x
	2. Protocol limitations
	3. ATM
	4. SDH/SONET
G. Protocol Mechanics	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. Routers, Switches, Bridges, Modems
	c. Cabling (Coax, Fiber, Twisted Pair)
	d. Wireless Standards 802.11x
	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 Calculations, Masking, Variable Length Subnet Masks (VLSM), Classless Inter-Domain Routing (CIDR), Summary Routes
	1. IPv6 Topics (Addressing, Subnetting, Features)

B. Standards and Protocols IPv6	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 (ND)
	ii. ICMPv6
	iii. DHCPv6
	iv. DNSv6
	d. IPv6 Interior/Exterior
C. Routing Basics	1. Routing Basics:
	a. Static, Default, Dynamic Routing
	b. Routing Metrics, Administrative Distance, Hop Counts
	c. Routing Protocol Classes:
	i. Distance Vector
	(a) RIP
	(b) RIPv2
	(c) EIGRP
	(d) RIPng
	ii. Link State:
	(a) Shortest Path First
	(b) OSPFv2
	(c) OSPFv3
	d. Routing Loops:
	i. Hop Counts
	ii. Split Horizon
	iii. Route Poisoning
	iv. Holddowns (flapping)

	e. Process to add a new device, switch or router to an existing router
	f. Routing between VLANs
	g. Access Control Lists (ACLs)
	h. Inbound, Outbound, Standard, Extended, Named
	i. Wildcard Masking
	j. 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, Port States, Loop avoidance
	b. Address Learning, Forward/Filter, and Loop avoidance
	3. Spanning Tree Protocol:
	a. Root Bridge
	b. Designated Port
	c. Port States
	4. Switch Types:
	a. Cut-through
	b. Fragment-free
	c. Store and Forward
	5. 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. VTP Client and Server, Pruning
C. Routing Protocols - Standard protocols (OSPF, RIP, ISIS, BGP, MPLS)	1. Routing Information Protocol (RIP) & RIP v2:
	a. Metrics
	b. Mechanics
	c. Design
	2. Multicast:
	a. Design
	b. Protocol Independent Multicast (PIM - both sparse and dense)

	c. Distance Vector Multicast Routing Protocol (DVMRP)
	d. Internet Group Management Protocol (IGMP)
	3. Access lists:
	a. Distribute lists
	b. Route maps
	c. Policy routing
	d. Redistribution
	e. Route tagging
	4. 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
	5. 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

IV. DOCSIS

Competency	Knowledge, Skills, and Abilities
A. HFC Fundamentals	1. HFC Network Elements
	a. Optical Fiber
	b. Coax
	c. Amplifiers
	d. Passive coaxial components
	e. Optical network passives
	f. Optical transmitters
	g. Optical amplifiers
	h. Optical receivers
	2. HFC Fundamental Concepts
	a. Analog/Digital signals
	b. Digital Modulation
	c. Signal-to-Noise
	d. Carrier-to-Noise
	e. Downstream/Upstream RF
	f. Channelization
	g. Topology
B. DOCSIS entities	1. CM
	2. CMTS
C. DOCSIS physical layer	1. Upstream physical layer
	a. Modulation
	b. Coding
	c. Preamble prepend
	d. Spectral shaping
	e. Transmit pre-Equalization
	f. Transmit power
	g. Burst profiles
	h. Fidelity requirements
	i. TDMA versus S-CDMA
	j. S-CDMA spreading
	k. S-CDMA framing

		2. Downstream physical layer
		a. Downstream modulation
		b. Downstream coding
		c. Interleaving
		d. BER Performance
		e. CMTS clock generation
		3. Downstream MPEG transmission convergence sublayer
		a. MPEG header for DOCSIS
		b. MPEG payload for DOCSIS
D.	DOCSIS MAC layer	1. MAC frame formats
		2. MAC Management messages
		3. Upstream bandwidth allocation
		4. Timing and synchronization
		5. Upstream contention resolution
		6. Encryption support
		7. Downstream channel bonding
		8. Upstream channel bonding
		9. Logical Channels
E.	DOCSIS QoS	1. Service Flows
		2. Classifiers
		3. QoS parameters
		4. Upstream service flow scheduling services
		5. Pre-3.0 concatenation and fragmentation
		6. DOCSIS 3.0 continuous concatenation and fragmentation
		7. Payload header suppression
		8. Service Flows
F.	Data Forwarding	1. CMTS Layer 2 forwarding
		2. CMTS Layer 3 forwarding
		3. Multicast forwarding
G.	CMTS /CM Interaction (CM registration, service flows, bandwidth allocation)	1. Cable modem initialization and registration
		a. Scanning and synchronizing to downstream
		b. Upstream channel parameters
		c. Initial ranging
		d. DHCP
		e. ToD

		f. CM configuration file download
		g. Registration
		h. Privacy initialization
		2. Dynamic service
		3. Dynamic bonding change
H.	Differences between DOCSIS 1.0, 1.1, 2.0, and 3.0	
I.	Performance aspects	1. Request/Grant mechanisms
		2. TCP windowing
		3. Channel bonding
		4. Bandwidth efficiency vs. robustness tradeoff
		5. DOCSIS latency issues
		6. System throughput versus per user data rates
J.	DOCSIS CM Software Download	

V. IP Network Test & Integration and Troubleshooting

Competency	Knowledge, Skills, and Abilities
A. IP Network Impairments	
B. Effective Testing Practices	
C. System Level test Methods	
D. Isolating Problems	
E. Troubleshooting Network Problems	1. OSPF
	2. Tracroute
	3. SNMP
	4. DOCSIS 3.0 Channel bonding
	5. RF and RF impairment on DOCSIS modem state
F. Security	1. DOCSIS 3.0 Security and Provisioning
	2. DOCSIS 1.1 Security and Provisioning
	3. DOCSIS BPI and Provisioning

VI. IP Network Deployment & Operation

Competency	Knowledge, Skills, and Abilities
A. Network Architecture	
B. Network Management	
C. Network Monitoring SNMP	
D. Growth/Capacity Planning	
E. Maintenance	
F. System Upgrades	
G. Disaster Recovery	
H. Security	1. Access Lists
I. Home Networking Awareness	1. Cabling, Wireless Standards 802.x

VII. Multi-media over IP

Competency	Knowledge, Skills, and Abilities
A. Video/Audio and associated data	1. MPEG
	a. Systems
	b. Video
	2. SCTE/ATSC standards
	a. MPEG-2 transport
	b. MPEG-2 video
	c. 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
B. Voice over IP	
C. Network requirements for Multimedia over IP	1. Video/audio/related data
	2. Voice
	3. Computer data communications
	4. SIP
	5. IMS

VIII. Standards and Internet-Related Organizations

Competency	Knowledge, Skills, and Abilities
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	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)
	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