Society of Cable Telecommunications Engineers

SCTE Broadband TelecomCenter Specialist (BTCS) Competencies

Scope

The Broadband TelecomCenter Specialist (BTCS) Certification certifies knowledge in maintenance and troubleshooting of the inside plant facilities to ensure minimal system outages, maximum reliability, and standards compliance for optimal operations. This certification includes knowledge of the Building Management Systems (BMS) control and monitoring, grounding practices, backup powering, advanced entertainment, data and voice networks within the headend. Topic categories include:

- Facilities
- Cabling and Fiber Transport
- RF Signal Modulation, Demodulation, and Processors
- Baseband and Digital Signaling
- Signal Transmission and Reception
- Network Fundamentals
- MPEG Systems
- Video Services
- Circuit Switched Telephony
- Cable Telephony
- Data Services and DOCSIS
- Test Equipment and its Applications
- Testing and Maintenance

I. Facilities

Competency	Knowledge, Skills, & Abilities
A. Planning Resources: Demonstrate an understanding of facility resources at the hands of critical facility managers.	1. Facility resources
	a. Best practices
	b. Codes
	c. Efficiency and availability
	d. Goals
B. HVAC Principles: Demonstrate an	1. HVAC principles

understanding of the important principles regarding planning, installing, and caring for an effective headend operating climate.	a. Equipment optimization
	b. Operational efficiency
	c. Common issues
	d. Equipment considerations
	e. Room management
	f. Planning
C. Fire Safety and Security: Demonstrate working knowledge of the purpose, procedures, theory, and operation of headend fire protection equipment and its related components. Demonstrate familiarity of OSHA, safety, and security regulations and practices relating to headend site layout and personnel.	1. Fire protection equipment
	a. Fire suppression
	b. Combustion science
	c. Extinguisher operations
	2. Safety and security
	a. Personnel safety practices
	b. Protecting the building
	c. Confined space operations
D. Monitoring and Cabinets: Demonstrate working knowledge of the operation, procedures, and practices relating to headend and network system monitoring. Demonstrate an understanding of headend rack design relating to organization, specifications, and environmental performance.	1. Headend monitoring
	a. What to monitor
	b. Electrical components to monitor
	c. Environmental components to monitor
	d. Mechanical components to monitor
	i. Monitoring solutions
	ii. Monitoring benefits
	iii. Efficiency metrics
	e. Air distribution
	f. Temperature containment theory
E. Grounding and Bonding: Demonstrate working knowledge of the theory, architecture, methods, procedures, and specifications used to ensure proper headend and	1. Headend and facility bonding and grounding practices
	a. Common grounding practices and techniques
	i. Lightning/Surge Protection

facility grounding practices.	b. HALO
	c. Building grounding
	d. Building bonding
	e. Phases of power
	f. Three Phase
	g. Automatic transfer switches
	h. Safety
	i. Power flow
F. Emergency Power Generation: Demonstrate an understanding of commercial and backup headend powering and the associated safety implications.	1. Powering
	a. Standby generators
	b. Emergency power flow
	c. UPS
	d. DC battery
	e. Power distribution
	f. Bypass isolation breaker
	g. DC Power distribution and flow
G. Cabling and Towers: Demonstrate working knowledge of headend towers, cable routing methods and practices, including labeling, as well as cable and connector types.	1. Cable routing methods and practices
	a. Cabling selection
	b. Cable topologies
	c. Cable routing
	2. Tower Structures and Requirements
	a. Tower classification
	b. Tower safety
	c. Tower grounding

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II. Cabling and Fiber Transport

Competency	Knowledge, Skills, & Abilities
A. Cabling and Fiber Transport Systems. Describe the basic technology of coaxial cable, optical fiber and optical fiber transport systems	1. Coaxial cable. Define the following RF principles and identify considerations when designing coaxial cable plant:
	a. Impedance
	b. Characteristic impedance of coaxial cable
	c. Minimum Bend Radius
	d. Coaxial cable construction
	e. Signal attenuation properties
	f. Passive splitters
	2. Fiber Transport. Describe the basic principles and components of optical fiber.
	a. Optical Fiber Link
	b. Optical theory
	c. Optical Wavelength
	d. Wavelength vs. Frequency
	e. Index of Refraction
	f. Critical Angle
	g. Optical fiber construction
	h. Acceptance cone
	i. Total Internal Reflection
	j. Single Mode and Multimode Fiber
	3. Sources of Fiber Loss
	a. Absorption
	b. Scattering
	i. Rayleigh scattering
	c. Macrobend loss
	4. Optical Modulation
	a. Baseband digital modulation

	b. Analog intensity modulation
	c. Laser transfer characteristic
	d. Direct modulation
	e. External modulation
	5. Dispersion
	a. Chromatic dispersion
	i. Source linewidth
	b. Waveguide dispersion
	c. Polarization-mode dispersion
	6. Wavelength Division Multiplexing (WDM)
	a. Dense WDM (DWDM)
	b. Coarse WDM (CWDM)
	7. Headend cabling
B. Microwave Links. Explain the use of microwave links for the transport and distribution of voice, video and data.	1. Typical Microwave Antennas
	a. Horn antennas
	b. Flat panel antenna
	c. Vertical array
	2. Microwave Link Considerations
	a. Antenna gain
	b. Antenna bearing
	c. Antenna height
	d. Path distance and path loss
	e. Transmit power
	f. Minimum required receive power
C. Channelization. List the channel frequency assignments used in broadband hybrid fiber/coax	1. Broadcast Television Spectrum (North America)

	2. HRC and IRC Band Plans (North America)
	3. Channel spectrum
	a. QAM modulated channel
	4. EIA/CEA-542d Channel Numbers (North America)
D. Business Services. Describe the use of hybrid fiber coax networks for business services and cellular backhaul applications.	1. Cellular Networks
	a. Air interface
	b. Base Transceiver Station (BTS)
	2. 4G Backhaul Facilities
	a. Wide Wireless Area Network (WWAN)
	b. TDM
	3. Interim 4G Voice Solutions
	a. Circuit Switch Fall-back (CSFB)
	b. Simultaneous Voice and LTE (SVLTE)
	c. Voice over LTE (VoLTE)
	d. VoIP over LTE (VLTE)
	4. Cellular Backhaul
	a. Service Level Agreement

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III. RF Signal Modulation, Demodulation, and Processors

Competency	Knowledge, Skills, & Abilities
A. Understand the relationship of symbol rate, bandwidth and channel size to the cable system.	1. Recognize the available symbol rates used in modulation.
	2. Explain the bandwidth associated with a communication channel.
	3. Discuss the different channel size used in cable.
	a. Recognize return path and forward path options.
	b. Understand bonded channels.
B. Recognize the analog and digital modulation orders used in the cable access network.	1. Understand the features and benefits of different modulation types.
	a. Recognize analog modulation orders
	i. AM
	ii. PM
	iii. FM
	iv. NTSC Signals
	b. Recognize digital modulation orders
	i. ASK
	ii. PSK
	iii. BPSK
	iv. QPSK
	(a) Out of Band
	(b) Satellite Signals
	v. QAM
	(a) 4096
	(b) 1024
	(c) 256
	(d) 64
	(e) 16

	vi. 8 Symbol Vestigial Sideband
	vii. ATSC signals
	c. Understand the components of a constellation and polar diagram
	i. Symbols
	ii. States
	iii. I and Q components
	iv. Phase shift
	v. Decision boundaries
	vi. Spectrum view
	(a) Horizontal axis
	(b) Vertical axis
	vii. Spectral efficiency
	d. Determine the health of a constellation diagram.
	i. Interference
	ii. Phase noise
	iii. Phase and amplitude disturbance
	iv. Reflections / ghosting
	v. Bit errors
	(a) Error free seconds
	vi. QAM S/N requirements
	vii. QAM C/N requirements
	viii. Trellis Code Modulation
C. Understand demodulation and the demodulation process.	1. Demodulation
	a. Demodulation process
D. Recognize the many choices for multiplexing signals; the differences and features between them.	1. TDM
	2. TDMA
	3. FDMA
	4. Advanced TDMA
	5. S-CDMA
	a. Burst Noise

	b. Orthogonal Codes
	c. Trellis coded modulation
	6. OFDM
	a. Sub carriers
E. Explain the cable operator devices used to format video signals for transmission over the HFC network.	1. Explain how signal processors were used in cable.
	2. Explain how encoding and decoding is used with video.
	a. MPEG SPTS
	b. MPEG MPTS
	3. Recognize the features and benefits of statistical multiplexing.
	a. VBR
	4. Understand the purpose of edge QAM devices.

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IV. Baseband and Digital Signaling

Competency	Knowledge, Skills, & Abilities
A. Analog Demonstrate an understanding of the concepts of analog RF and baseband audio and video signals, the various types, their standards, testing procedures, and maintenance operations.	1. Baseband Audio
	a. Fundamental Concepts
	i. Loudness
	ii. Phase
	iii. Sound Pressure
	iv. Balanced/Unbalanced
	b. Stereo
	i. BTSC
	ii. Dolby AC3
	c. Audio Processing
	i. Unity Gain
	ii. Equalization
	iii. Headroom
	d. Levels, standards, measurements, testing, distribution
	2. Baseband Video
	a. Fundamental Concepts
	i. Interlace Scanning
	ii. Aspect Ratio
	iii. Chrominance
	iv. White Peak
	v. Viewing Distance
	b. NTSC Components
	i. Synchronization and Timing
	ii. Picture Components
	iii. Color Components
	iv. Vertical Blanking Interval
	(a) Data
	(b) Structure

	c. Other Video Formats
	i. PAL
	ii. SECAM
	d. Video Processing Equipment
	i. Distribution Amplifiers

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V. Signal Transmission & Reception

Competency	Knowledge, Skills, & Abilities
A. Explore analog and digital transmission systems and describe how these two systems work over metallic, fiber and RF based facilities	1. Transmission characteristics
	a. Digital and Analog
	2. Modes of transmission – one-way vs. two-way
	a. Simples
	b. Duplex
	c. Half-Duplex
	3. Reception – analog and digital & fixed vs. RF facilities
	a. Digital and Analog
	4. CODing and DECoding, or “CODEC”
	a. Video
	b. Audio
	5. Transmission system gain and loss measurements
	a. Transmission loss
	b. Insertion loss
	6. Describe Fixed facilities and RF facilities
	a. Metallic: copper and coaxial
	b. Microwave
	7. Error correction and detection
	a. RF reflections and loss
	b. Frequency agility
	c. In phase “I & Q”
	d. Frame Check Sequence (FCS)
	e. Parity
	f. Forward Error Correction (FEC)
	g. Modulation Error Ratio (MER)
	8. Digital Audio and Video transmission
	a. DVB-S
	b. DVB-S2

	c. OPSK
	d. QAM
	9. Satellite signal (“content”) protection/encryption
	a. Subscriber Management System (SMS)
	b. Subscriber Authorization System (SAS)
	c. Data scrambling
	d. DigiCipher 2
B. Describe fiber based facilities and the different types of fiber optic cables	1. Wave Division Multiplexing (WDM)
	a. Course WDM (CWDM)
	b. Dense WDM (DWDM)
	2. Fiber types
	a. Multi-Mode
	b. Single-Mode
C. Describe several aspects of satellite systems from – the orbital and satellite itself to the equipment used to make it all happen	1. Different satellites
	a. Low Earth Orbit (LEO)
	b. Geostationary Orbit (GEO)
	c. Fixed Service Satellite (FSS)
	d. Direct Broadcast Service (DBS)
	2. Orbital characteristics
	a. Clarke Belt
	b. Angular velocity
	c. Delay
	3. Satellite antennas
	a. Parabolic
	b. Offset
	c. Very Small Aperture Terminal (VSAT)
	4. Uplink and Down-Link paths and equipment
	a. Modulator
	b. Up-converter
	c. Demodulator
	d. Down-converter

	e. Low Noise Amplifier (LNA)
	f. A Low Noise Block-down converter (LNB)
	5. Polarization and Transponders
	a. C-Band
	b. Ku-Band
	c. Liner
	d. Circular
	e. Transponder and satellite capacity
	f. Oscillators and Mixers
	g. Filters
	h. Azimuth
	i. Elevation
	6. Satellite performance
	a. Carrier-to-Noise (C/N)
	b. G/T
	c. Footprints
	d. Solar flares

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VI. Network Fundamentals

Competency	Knowledge, Skills, & Abilities
A. Demonstrate understanding of various network topologies and explore five distinct types of networks, and the numbering behind them	1. Network Topologies
	a. Bus
	b. Star
	c. Mesh
	d. WLAN
	e. VLAN
	f. Peer-to-Peer
	g. Client/Server
	h. Interconnection
	2. Network Components
	a. Repeaters and hubs
	b. Switches
	c. Routers
	d. Repeater
	e. Hub
	f. Switch
	3. IP and MAC based numbering
	a. HEX
	b. Binary
	c. Decimal
B. Demonstrate understanding of Ethernet, describe VLAN technology, and define various Ethernet cabling standards.	1. Ethernet Concepts
	2. Ethernet
	a. Frame description
	b. Encapsulation
	c. Virtual Local Area Network (VLAN) overview
	3. Ethernet Functional Concepts
	a. Hop-by-Hop
	a. Maximum transmit unit
	b. CSMA/CD

	c. Collisions
	d. Ethernet cabling
	4. 10/100 Base X
	a. Ethernet cable standards
	b. Error Management
	5. Packet Flow
	a. Unicast
	b. Broadcast
	c. Multicast
C. Describe how networks indicate errors and in some cases have the ability to correct them and also define various packet flows	1. OSI Model
	a. Application
	b. Presentation
	c. Session
	d. Transport
	e. Network
	f. Data Link
	g. Physical
D. Define the OSI model and the TCP/IP model, explore a few of the more common network protocols found in today's networks, and finally, describe the way media is digitized and sent over IP based networks	1. Protocol reference models
	a. Comparison OSI and TCP
	b. Network hardware in the models
	c. Network Protocols
	d. IP
	e. TCP
	f. TCP vs. UDP comparison
	g. TCP three way handshake
	h. ARP
	i. ICMP
	2. Digital Media
	a. VoIP
	3. IP video
	a. MPEG
E. Explore Network IP addressing, describe static & dynamic routing	1. Address class
	a. IPv4 Public IP addresses

techniques and error detection & correction	b. IPv4 Private IP addresses
	c. IPv4 to IPv6 comparison
	2. IPv6 structure
	3. IPv6 “zero” compression
	4. Dynamic & Static Routing
	a. Static routes
	b. Dynamic routing protocols
	5. Error correction
	a. Error Management
	b. Error detection

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VII. MPEG Systems

Competency	Knowledge, Skills, & Abilities
A. Describe why cable operators are interested in compressing digital video.	1. Recognize the RF channels used for video transmission.
	a. VHF
	b. UHF
	c. NTSC
	d. PAL
	2. Explain why operators deployed digital cable.
	a. MPEG
	b. SDTV
	c. HDTV
	d. Ultra HDTV
	3. Discuss the analog to digital conversion process.
	a. CODEC
	b. ADC
	i. Sampling
	ii. Quantization
	iii. Encoding
	iv. Decoding
	4. Recognize the scanning methods used for SD and HD video.
	a. Interlace
	b. Progressive
	c. Horizontal
	d. Vertical
	e. Resolutions
	f. Aspect Ratio
	i. Letter box
	ii. Pillar box
B. Understand the basics of compression.	1. Explain the MPEG-2, MPEG-4 and MPEG-H video bit rates.

	2. Understand how video signals are encoded.
	a. CBR
	b. VBR
	3. Describe MPEG compression.
	a. ISO and IEC
	b. Lossless vs. Lossy
	c. Compression processing blocks
C. Understand the block elements of encoding.	1. Encoding Eco-system
	2. Components of an encoder.
D. Explore how MPEG is used in cable to compress and transport digital video.	1. Discuss the features of MPEG.
	2. Explain how compression factors reduce the size of video.
	a. Spatial
	b. Temporal
	3. Explain how MPEG is used to transport video frames.
E. Understand the ATSC standard.	1. Understand ATSC features.
	a. Aspect ratio
	b. Resolution
	i. 1920 x 1080
	ii. 1280 x 720
	iii. ITU R BT 601-5
	c. Audio
	i. AC-3
	d. Payload
	2. Understand A/53 ATSC standard.
	3. Understand A/54A ATSC standard.
	4. Understand A/52 ATSC standard.
F. Explain the difference between the MPEG standards.	1. Explain how MPEG-1 supports compression.
	a. ISO/IEC 11172
	2. Explain how MPEG-2 supports compression.
	a. ISO/IEC 13818
	3. Explain how MPEG-3 supports

	compression.
	4. Explain how MPEG-4 supports compression.
	a. ISO/IEC 14496-10
	5. Explain how MPEG-H supports compression.
	a. ISO/IEC 23008
	b. 4K format
	c. 8k format
	6. Explain how VC-1 supports compression.
	a. SMPTE 421M
G. Explore MPEG digital audio standards.	1. Explain audio compression.
	a. Companding
	2. Explain audio standards.
	a. MPEG-1 Audio
	b. MPEG-2 BC
	c. MPEG-2 AAC
	d. Dolby AC-3
	e. ATSC A/52 AC-3
	f. AES 3

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VIII. Video Services

Competency	Knowledge, Skills, & Abilities
A. Video Connections: Understand the physical interfaces and common protocols used for video transport and the role headend controllers play in accessing video content in the cable network. Explain the components of interactive television, also known as iTV.	1. Physical Interfaces-ASI
	2. Physical Interfaces-Ethernet
	3. Physical Interfaces-ATM/SONET/Carrier Ethernet
	4. Headend Controllers-Architecture
	5. Headend Controllers for Conditional Access Systems-Addressable Systems
	a. Controllers
	i. Data Streams
	ii. Addressing
	iii. Switched Digital Video
	b. Terminals
	i. Address Schemes
	ii. Data Stream Location
	6. Interactive TV (iTV)
	a. Enhanced TV (ETV)
	b. Enhanced TV Binary Interchange Format (EBIF)
	c. True-2way Applications
	d. Service impairments
	i. Latency
	ii. Communication Interruptions
B. Video Infrastructure: Recognize the types, characteristics and operation of narrowcast services. Explain the architectures used by VoD systems. Understand the types of server management used by operators in the cable network.	1. Narrowcast-VOD
	a. Characteristics
	b. Operation
	2. Narrowcast-NVOD
	3. Narrowcast-PPV
	a. Characteristics
	b. Operation
	(Note: headend techs install but other groups manage these)

	4. Server Management-Centralized Servers
	a. Content Management
	b. Content Provisioning
	5. Server Management-Decentralized Servers
	a. Content Management
	b. Content Provisioning
	6. Server Management-Server Equipment
	a. Disk Arrays
	b. Failover Architectures
	c. Platforms
	7. VOD-Architectures
	8. DOCSIS Set Top Gateway
C. Commercial and Emergency Alert Program Insertion (Analog and Digital): Explain the components of commercial or digital program insertion. Recognize how emergency alert systems are used by cable operators.	1. Analog Commercial Insertion
	a. Cueing Systems
	b. Performance Impairments
	2. Digital Commercial Insertion
	a. SCTE 30
	b. SCTE 35
	c. Cueing Systems
	d. Audience Segmentation
	e. Performance Impairments
	3. Emergency Alert Systems CAP

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IX. Circuit Switched Telephony

Competency	Knowledge, Skills, & Abilities
A. Explore various phone company entities and switching concepts, such as: call processing, PSTN switches, ISDN and SS7 signaling	1. Phone company entities and switching concepts
	a. ILEC
	b. RBOC
	c. CLEC
	d. IXC
	e. LATA
	2. Describe ISDN services
	a. PRI
	b. BRI
	3. Explain Circuit Switched Voice (CSV)
	a. 64kbps lines
	b. CLASS-IV switches
	c. CLASS-V switches
	4. Describe Dual Tone Multi-Frequency (DTMF) & System Signaling-7, or "SS7"
	a. SS7 messages
	b. DTMF tone generation
B. Describe PSTN call features, which allow customers to adapt their telephony user experience to their needs	1. Custom Local Area Signaling Services, or "CLASS" features
	a. Automatic callback
	b. Automatic recall
	c. Customer originated trace
	d. Distinctive ring
	e. Selective call waiting
	f. Selective call forwarding
	g. Selective call acceptance
	h. Selective call rejection
C. Introduce various aspects central office configuration and PSTN supported Customer Premise	1. Explore Central Office layout
	a. Powering
	b. CO equipment

Equipment (CPE)	c. Unshielded Twisted Pair (UTP)
	d. Shielded Twisted Pair (STP)
	e. Centrex
	2. Define the “DS” and “OC” hierarchy
	a. DS0
	b. DS1
	c. DS3
	d. OC-3
	e. OC-12
	f. OC-48
	g. OC-192
	3. Introduce PSTN color code for cable pair identification
	a. Colored pairs
D. Investigate how PSTN facilities; digital hierarchy, local loops, trunk groups transport CSV traffic and also how cellular networks provide wireless coverage.	1. Transmission technologies
	a. 2-wire loops (POTS)
	b. SONET
	c. Multiplxers
	d. Trunks
	2. Wireless access methods
	a. Dial tone using Basic Exchange Telecommunication Radio Service (BETRS)
	b. Broadband Wireless Access (BWA)
	c. Worldwide Interoperability for Microwave Access (WiMAX)
	d. Long Term Evolution (LTE)
	e. Femto-Cells
E. Learn about the two most prevalent PSTN versions of broadband delivery.	1. DSL
F. Introduce, from a very high level, the different methods of testing used to validate PSTN networks.	1. Pulse Code Modulation (PCM) analysis (DS0)
	2. Bit Error Rate Testing (BERT) DS1 and DS3
	3. STS testing

	4. Power meters [fiber]
	5. Demarc Testing
	6. Channel Service Unit/Data Service Unit (CSU/DSU)
	7. Remote testing – headend to PSTN End-Office
G. Describe PSTN reference architecture documentation and applicable standards	1. Listing of relevant standards

X. Cable Telephony

Competency	Knowledge, Skills, & Abilities
A. Describe how VoIP packets are created, from a high level overview	1. 5-step approach
	a. Transduction
	b. Sampling
	c. Quantization
	d. CODEC
	e. Packetization
	2. Define VoIP related terms and protocols necessary to provide quality IP based telephony services
	a. OSI model
	b. TCP/IP model
	c. Real Time Protocol (RTP)
	3. Introduce the “Offer/Answer” call model
	a. Session Description Protocol (SDP)
	b. RFC-4566
B. Explain the necessary VoIP signaling protocols needed to make a call	1. Explore two common VoIP signaling protocols
	a. Media Gateway Control Protocol (MGCP)
	b. Session Initiated Protocol (SIP)
C. Describe IP Multimedia System (IMS) networks	1. Access Network
	a. UE
	b. P-CSCF
	2. Core Network
	a. S-CSCF
	b. I-CSCF

	c. HSS
	d. SLF
	e. BGCF
	f. IBCF
D. Explain the CableLabs “cable-VoIP” solution “PacketCable”	1. PacketCable 1.5 architecture is MGCP based
	a. MTA
	b. CMS
	c. CMTS
	d. MGC
	e. MG
	f. Announcement server
	2. PacketCable 2.0 architecture is SIP based
	a. E-MTA
	b. Similar components to IMS

XI. Data Services and DOCSIS

Competency	Knowledge, Skills, & Abilities
A. Recognize how the DOCSIS protocol is used within the cable network.	1. Understand an overview of the DOCSIS and related specifications.
	a. Multimedia Cable Network System
	b. SCTE Data Standards Subcommittee
	c. International Telecommunication Union Standardization Sector J.112
	d. DOCSIS 1.1
	e. DOCSIS 2.0
	i. DOCSIS 2.0 + IPv6
	f. DOCSIS 3.0
	g. DOCSIS Set-top Gateway
	h. DOCSIS 3.1
B. Understand the components that make up the DOCSIS protocol.	1. Explain HFC architecture, CMTS, cable modem and back office servers.
	a. Dynamic Host Configuration Protocol
	b. Time of Day
	c. Trivial File Transfer Protocol
	2. Explain the components of the CMTS.
	a. Downstream
	b. Upstream
	c. Point of Presence
	d. Network Access Point
	e. Upconverter
	i. Intermediate frequency
	3. Explain packet switching.
	a. Multiple Program Label Switching
	4. Understand the reference architecture for DOCSIS.
	a. CMTS interfaces
	b. Distribution Network
	c. CMCI
	d. WAN

	5. Discuss the advantages of DOCSIS Settop Gateway.
	a. DSG communications path
	i. Tunnels
C. Understand how RF operates in the upstream and downstream.	1. Recognize the multiplexing methods used in the upstream and downstream.
	a. Frequency Division Multiplexing
	b. Time Division Multiplexing
	c. Time Division Multiple Access
	d. Advanced Time Division Multiple Access
	e. Synchronous Code Division Multiple Access
	f. Orthogonal frequency-division multiplexing
	2. Recognize the modulation methods used in the upstream and downstream.
	a. Amplitude Shift Keying
	b. Frequency Shift Keying
	c. Phase Shift Keying
	d. Bit Quadrature Shift Keying
	e. Quadrature Phase Shift Keying
	f. Quadrature Amplitude Modulation
	3. Understand RF characters required for the upstream and downstream.
	a. BERT
	b. Distance
	c. Channel Spacing
	i. Channel Bonding
	d. Transmit Delay
	e. Carrier to Noise Ratio
	f. Analog video carrier level
	g. Frequency range
	h. Transmit power
	i. Data rates
D. Explain how DOCSIS cable modems function and initialize in	1. Explain how data flows from the CMTS stack to the cable modem stack.

the cable network.	a. CMTS-NSI
	b. IEEE 802.2 LLC/MAC
	c. Transmission convergence
	d. Physical Media Dependent sub-layers
	i. upstream
	ii. downstream
	e. CMCI
	2. Explain the difference between bridging and routing.
	3. Understand the components of the cable modem.
	4. Describe the DOCSIS cable modem initialization process.
	a. Downstream Acquisition
	i. DOCSIS PID
	ii. UCD
	iii. Sync
	iv. MAP
	(a) mini slot
	b. Power Ranging
	i. RNG-REQ
	ii. RNG-RSP
	iii. Timing offset
	iv. Power offset
	v. Automatic gain control
	vi. SID
	c. IP Connectivity
	i. DHCP
	(a) IPv4
	(b) IPv6
	(i) MAC Domain Descriptor
	(ii) Duplicate Address Detection
	(iii) Router Solicitation

	(iv) Router Advertisement
	(c) DHCP Options
	ii. ToD
	iii. TFTP
	iv. Relay Agent
	v. Application layer protocols
	(a) FTP
	(b) SMTP
	(c) HTTP
	d. Registration
	i. REG-REQ
	ii. REG-RSP
	e. Security Establishment
	i. BPI initialization process
	f. CPE Provisioning
	i. http://192.168.100.1
	ii. Configuration files
	iii. Firmware
E. Understand the security concerns and how DOCSIS addresses these concerns.	1. Explain how security is implemented in DOCSIS.
	a. BPI
	b. BPI+
	c. Conditional Access
F. Describe the tools used for DOCSIS traffic management and bandwidth efficiency.	1. Understand the DOCSIS 1.1 QoS mechanisms.
	a. Real-time
	b. Non real-time
	c. Unsolicited Grant Service
	d. Unsolicited Grant Service with Activity Detection
	e. Best Effort
G. Recognize the function of service identifiers and how they are used in DOCSIS.	1. Understand how SIDs operates in the DOCSIS network.
	a. Broadcast

	b. Multicast
	c. Unicast
	d. Null
	2. Understand the allocation of a service flow.
	a. Service flow id
	b. QoS vs. service flow
	c. Classifiers
	i. CoS
H. Understand the feature set of DOCSIS 3.x.	1. Recognize the features of DOCSIS 3.x.
	a. Capacity
	i. upstream
	ii. downstream
	b. Low Density Parity Checking
	c. OFDM
	d. Migration strategy

XII. Test Equipment and its Applications

Competency	Knowledge, Skills, & Abilities
A. Baseband Equipment. Demonstrate working knowledge of the theory and operation of the various types of test equipment, as well as their applications.	1. Digital Multimeters
	2. Current Measurement
	3. BERT
	a. Headend/Lab
	b. Handheld
	c. Codeword Error Rate (BER Proxy)
	4. Oscilloscope
	a. Basic
	b. Advanced (FFT/Real Time Analyzer, DSO, w/Spectrum Analyzer
	c. Pocket
	5. Waveform Monitor
	6. Vectorscope
	7. Signal Generators
	a. Video
	b. Audio
	8. Precision Demodulators
	9. MPEG Analyzer
	10. Video Quality Monitor/Analyzer
	11. Protocol Analyzers
	a. Telecom
	b. Network/Protocol/VOIP
B. RF Equipment Theory and Application	1. Spectrum Analyzer- in the master headends only
	a. Basic Use/Theory
	b. Specifications, Tolerances
	c. QAM Based
	2. Signal Level Meter/HDSA
	a. Basic/Handheld

	b. Power Meter
	c. Specifications, Tolerances
	d. Centralized Monitoring/Forward+Return Sweep/Testing
	3. Return Path Monitoring Systems
	a. Upstream testing
C. Leakage Measurements	1. Field (ComSonics, JDSU, VeEX, Arcom)
	2. Centralized (PathTrak, VeEX, Arcom)
	3. NPR Measurement
D. Photonic Equipment	1. One-click fiber/bulkhead cleaner
	2. Optical Tracer
	3. Optical Modulation Index (OMI)
	4. Optical Power Meter/CWDM Level Checker
	5. OTDR
	6. Optical Spectrum Analyzer
	7. Optical Modulation Analyzer
	8. MetroEthernet Test Equipment
E. Other Headend Equipment	1. Infrared cameras
	2. DC Battery Testers

XIII. Testing and Maintenance

Competency	Knowledge, Skills, & Abilities
A. Digital Performance Metrics and Tests. Demonstrate working knowledge of the equipment and methods used to test Digital Video, Audio, and Digital Performance. Demonstrate an understanding of measurement techniques and troubleshooting procedures, and how these techniques can be used to correct impairments.	1. Video Tests
	a. Types of Tests
	b. Test Signals
	c. Performance Standards and References
	2. Audio Tests
	a. Insertion Gain
	b. Gain vs. Frequency Distortion

	c. Channel Separation
	d. Signal-to-Noise
	e. Level and Relative Loudness Measurements
	3. Digital Tests
	a. QAM Level
	b. Eb/No
	c. MER
	d. EVM
	e. Constellation
	f. Bit Error Rate (BER) (pre- and post-FEC)
	g. Equalizer graphs
	h. Adaptive Equalizer Performance
	4. Data Tools
	a. SNMP
	b. CMTS
	c. OSS
	d. OAMP&T
	e. Packet Loss
	f. MOS
	g. Temporal
	i. Jitter
	ii. Delay or Latency
	iii. Group Delay
B. Measurement Techniques	1. Transmission Channel
	a. Amplitude
	b. Carrier-to-Noise
	c. Carrier-to-Interference
	d. Zero-span
C. Testing and Troubleshooting	1. HFC Network
	a. Downstream Monitoring
	b. Upstream Monitoring
	2. PSTN Interface

	b. BERT
	c. Calculation
	3. Round Trip Delay/Latency
D. Impairments and Mitigation	1. Impairment Sources
	a. Baseband Impairments
	i. Sampling Error
	ii. Quantizing Error
	b. Eye Diagram
	c. In-Channel Response
	d. Group Delay
	e. RF Impairments
	i. Ingress
	ii. Noise
	iii. Distortions
	(a) Linear
	(b) Nonlinear
	iv. Interference
	(c) Power per Hertz Theory
E. Proactive Network Maintenance	1. Pre- Equalization
	a. Upstream
	b. Limitations
	2. Proactive Management
	a. Impulse coefficients
	b. Phase