

SCTE Broadband Transportation Specialist (BTS)

Scope

The SCTE **Broadband Transport Specialist (BTS)** certifies knowledge in the subject matter related to the transport of signals, including aspects of the network from the headend to the hub and from the hub to the optical node. Specifics include:

- Fiber Optics Theory—lightwave theory; optical fiber characteristics; equipment; transmitters; light sources; receivers; detectors; connectorization
- Optical Transport Systems—architectures; transmission techniques
- Link performance—operating principles
- Troubleshooting and Maintenance—test equipment; troubleshooting process; measurements, restoration
- Construction—aerial and underground installation practices and considerations; splicing
- Alternative Transport Systems—basic microwave theory

I. Fiber Optic Theory

Competency	Knowledge, Skills, and Abilities
A. Describe the characteristics and properties of optical fiber and cables used for transporting signal through the telecommunications network	1. Define, contrast, and describe the characteristics of the following optical fiber types:
	a. Single Mode
	b. Multimode
	2. Identify the physical properties of optical fiber
	a. Core
	b. Cladding
	c. Color code
	i. Color identifier
	d. Single mode fiber specification
	i. Mode Field Diameter
	e. Cables
	i. Loose Tube
	ii. Tight Buffer



	iii. Ribbon Fiber
	f. Index of Refraction
	3. Describe the types of optical fiber losses and factors that influence these losses
	a. Intrinsic
	i. Impurities
	ii. Spectral
	iii. Scattering
	(a) Zero water-peak (ZWP) - Rayleigh
	iv. Absorption
	v. Dispersion
	vi. Reflection
	b. Extrinsic
	i. Microbends
	ii. Macrobends
iii. Fiber Alignment	
iv. Light Insertion and Detection (LID)	
B. Describe the transmit and receive equipment used in the optical transport network	1. Identify the types of lasers
	a. Types
	i. Direct modulated lasers
	(a) FP
	(b) DFB
	ii. Externally modulated lasers
	(a) YAG
	iii. Digital transmitters
	c. Performance Characteristics
	i. Chirp
	ii. Spectral Line Width
	iii. Optical modulation index (OMI)
	iv. Power-per-hertz
	d. Classes
	e. Safety
	2. Receivers/Nodes
	a. Detectors
	i. Pin Diode
	ii. Avalanche photodiode (APD)
	iii. Wavelength
	3. Amplifiers
	a. RF Launch Amplifiers
	b. EDFAs
	i. Theory of operation
ii. Wavelength	
iii. Gain	
iv. Amplification Bandwidth	



	v. Input requirements
	vi. Cost considerations
	4. Regenerators
	a. Defined
C. Describe the hardware used in the optical transport network	1. Connectorization
	a. Describe the types of connectors
	i. APC
	ii. UPC
	b. Pig-tails
	c. Defects
	i. Alignment
	ii. Incompatibilities
	2. Patch Panels
	3. Optical Couplers
	a. Nomenclature
	b. Multiple outputs
	c. Styles
	i. Cartridge
	ii. Tails
	iii. Pre-connectorized
D. Describe the fundamental architectures that may be incorporated within the transport network	1. Compare the following architectures:
	a. Bus
	b. Star
	c. Ring
	2. Self-Healing Ring
	3. Hubs
	4. OTNs
E. Describe the fundamentals of basic optical link design	1. Loss budget calculations
	a. Loss per wavelength
	b. Coupler losses
	c. Mechanical splice loss
	d. Fusion splice loss
	e. Surplus fiber
	i. Snow shoes
	ii. Tails
	f. Optical output power
	g. Minimum input power
	h. Carrier-to-noise vs. input power



II. Optical Transport Systems

Competency	Knowledge, Skills, and Abilities
<p>A. Describe the architectures that may be deployed in the optical transport network</p>	1. SONET
	a. Hierarchy
	2. Proprietary
	3. Gigabit Ethernet (GigE)
	a. Advantages
	b. 10GigE/10Gbase
	4. Fiber-to-the-curb (FTTC)
	a. Defined
	b. Benefits
	c. Operating principles
	5. Fiber-to-the-home (FTTH)
	a. Defined
	6. Passive Optical Networks (PONs)
	a. Defined
	7. DOCSIS-based FTTH
	8. RFoG solutions
a. BrightPath (example)	
b. D-PON (example)	
<p>B. Describe the transmission techniques that may be deployed in the optical transport network</p>	1. Modulation Schemes
	a. AM
	i. Principles of Operation
	(a) Multiplexing
	(b) Optical to RF Conversion
	(c) Optical to Optical conversion
	ii. Advantages
	iii. Applications
	b. Digital
	i. Define the basic principles of operation
	(a) Multiplexing
	(b) Optical to RF Conversion
	ii. Advantages
	2. Multiplexing
	a. DWDM
	i. Define the basic principles of operation
	ii. Channel Plans
	(a) ITU Grid
(i) 100 GHz spacing	



	(ii) 200 GHz spacing
	ii. Advantages and applications
	iii. Polarization Mode Dispersion
	b. CWDM
	i. Define the basic principles of operation
	ii. Applications
	iii. Frequency plan
	c. WDM
	i. Define the basic principles of operation
	ii. Frequency plan
	iii. Dispersion Compensation
	iv. Isolation
	3. Return Techniques
	a. Digital
	b. Frequency Stacking
	i. Defined
	ii. Benefits
	iii. Disadvantages
	iv. Principles
	c. Setup
C. Explain how to apply optical fiber design principles to the optical transport network	1. Explain how to choose the best transportation methods
	a. Applications



III. Link Performance

Competency	Knowledge, Skills, and Abilities
<p>A. Describe the operating principles associated with the operation of the optical fiber transport network</p>	1. Link Budget
	a. Losses
	b. Calculations
	2. Input/Output Levels
	a. Voltage/Current/Power
	b. RF Input to lasers
	c. Optical Input to photodetectors
	i. Test Point
	d. RF output of Optical receivers
	i. Converting between dBm and mw
	e. Stimulated Brillouin Scattering (SBS)
	3. Component Contributions to Noise and Distortions
	a. C/N
	i. RIN
	ii. Shot Noise
	iii. Post-amplifier noise
	iv. Interferometric Intensity Noise
	(a) Double Rayleigh Backscatter
	v. Reducing the effects
	b. Distortions
	i. Second Order
	ii. Third Order
	iii. Reducing the effects
	iv. Clipping
	4. BER
a. Defined	
b. Specifications	
c. Causes	
d. Reducing the effects of BER	
5. Immunity to EMF Interference	
a. Define	



IV. Troubleshooting and Maintenance

Competency	Knowledge, Skills, and Abilities
<p>A. Identify the test equipment associated with troubleshooting and maintaining the optical fiber network</p>	1. Spectrum Analyzers
	a. RF
	i. Defined
	ii. Operation
	iii. Testing
	iv. Increasing measurement accuracy
	b. Optical
	i. Defined
	ii. Operation
	iii. Testing
	iv. Increasing measurement accuracy
	2. Optical Power Meter
	a. Defined
	b. Operation
	c. Testing
	d. Increasing measurement accuracy
	3. OTDR
	a. Defined
	b. Operation
	i. Deadzone
	c. Testing
	d. Increasing measurement accuracy
	e. Splice loss
	4. Power meter/light source
	a. Defined
	b. Applications
5. Identifiers	
a. Defined	
6. Visual Fault Indicator	
a. Defined	
<p>B. Describe the processes necessary to troubleshoot the optical fiber network and its associated components</p>	1. Transmitters
	a. Components
	i. Cooling Circuit
	ii. Laser
	b. Optical Modulation Index (OMI)
	c. Troubleshooting Process
	i. Optical
	ii. RF
	iii. Power



	2. Receivers
	a. Optical Input
	i. Photodetector Current
	ii. Optical input vs. Carrier-to-noise
	iii. Non-linearities
	iv. Test points
	b. RF Output
	c. Troubleshooting Process
	i. Optical
	ii. RF
	iii. Power
	3. Return
	a. Monitoring
	b. Testing
	c. Sweeping
	i. Signal Injection
	d. Troubleshooting Process
	i. Optical
	ii. RF
	iii. Power
	4. Optical Fibers
	a. Chromatic Dispersion
	b. Backscatter
	5. Optical couplers
	a. Performance Characteristics
C. Describe the processes necessary for preventive maintenance of the optical fiber network and its associated components	1. DWDM
	a. Carrier-to noise (all)
	b. Crosstalk
D. Describe the status monitoring processes associated with the optical fiber network	1. Forward
	2. Return
	3. Transponders
E. Identify the potential causes of optical fiber system interruptions	1. Potential causes
F. Describe the Emergency Restoration processes associated with the optical fiber network	1. Restoration kit components
	a. Splice trays
	b. Splice closures
	c. Prepped cable
	d. Mechanical splices



	e. Cleaving tool
	f. Snips
	g. Cleaners/tools/wipes
	2. Splicing
	a. Fusion
	b. Mechanical
	c. Fiber Alignment
	3. Safety
	a. Electro-static discharge (ESD)
	b. Fiber
	c. Driving / parking
	4. Emergency Restoration Investigation and Documentation



V. Construction

Competency	Knowledge, Skills, and Abilities
A. Describe optical fiber cable handling, testing, and equipment	1. Physical Handling
	a. Laser safety
	b. Fiber handling
	2. Trenchers
	3. Tension monitoring
B. Describe aerial optical fiber cable placement	4. Lashers and spinning machines
	1. Cable reel documentation
	2. Safety precautions
	3. Figure-eighting cable
	4. Cable cutting and precautions
	5. Planning and preparation
	6. Clearances
	7. Right-of-way operations
	8. Splice locations
	9. Suspension strands
	10. Moving-reel (drive-off) method
	11. Stationary-reel (back-pull) method
	12. Mid-point pulling
	13. Overlashing
	14. Lashing
	15. Sag and tension
	16. Post-construction inspection
17. Aerial equipment	
C. Describe underground optical fiber cable placement	c. Cable blocks
	i. Corner block (90)
	ii. Corner block (45)
d. Pulling grips and devices	
e. Swivels	
f. Reel carriers	
C. Describe underground optical fiber cable placement	1. Cable reel documentation
	2. Safety precautions
	3. Figure-eighting cable



	4. Cable cutting and precautions	
	5. Planning and preparation	
	6. Right-of-way operations	
	7. Splice locations	
	8. Riser cables	
	9. Trenching	
	10. Plowing	
	11. Boring	
	12. Underground locates	
	13. Cable installation through conduit	
	D. Describe the bonding and grounding considerations when installing optical fiber	1. Grounding procedures
		a. Tools
		b. Materials
E. Describe the fiber enclosures associated with the optical fiber network	1. Enclosure types	
	a. Sealed Aerial Enclosures	
	b. Vented enclosures	
	c. Underground enclosures	
	2. Pedestals and cabinets	
	3. Vaults	
	4. Grade-level manholes	
	5. Fiber storage and organizing housings	
6. Cable storage devices		
F. Explain the steps necessary to prepare and splice optical fiber	1. Fiber splice preparation	
	a. Cable prep	
	b. Fiber strip	
	2. Splicing	
	a. Mechanical	
	b. Fusion	
	3. Splice protection	
G. Describe optical fiber connector and termination methods	1. Connector types	
	a. SC connectors	
	b. FC connectors	
	2. Connector endface configurations	
	3. Termination Methodology	



H. Describe optical fiber testing	1. OTDR
	2. Power meter and light source
	3. Acceptance
	4. Documentation



VI. Alternative Transport Systems

Competency	Knowledge, Skills, and Abilities
A. Explain basic microwave system theory	1. Equipment
	a. Transmitter
	b. Tower
	c. Receiver
	d. Waveguide
	i. Dehydrator
	2. Test instruments
	a. Power meter
	b. SLM
	c. Frequency counter
	3. Antennas and Alignment
	a. Radio Horizon
	b. Fresnel Zone
	c. Line-of-sight
	4. Types
	a. AML
	i. Modulation
	ii. Uses
	iii. Components
	iv. Operation
	b. FML
	i. Modulation
	ii. Uses
	iii. Components
	iv. Operation
	5. Advantages
	6. Rules and Regulations
a. Towers	
b. Frequencies	
i. CARS Band	
c. Operation	
7. RF Safety	
a. RF Safety Considerations	
B. Applications	1. Wireless Broadband
C. Supertrunking	1. Technologies