# 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 |

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| | 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 |

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| | 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 |
|---|---|
| A. Describe the architectures that may be deployed in the optical transport network | 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) |
| B. Describe the transmission techniques that may be deployed in the optical transport network | 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 |

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| | 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 |
|---|---|
| A. Describe the operating principles associated with the operation of the optical fiber transport network | 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 |
|---|---|
| A. Identify the test equipment associated with troubleshooting and maintaining the optical fiber network | 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 |
| B. Describe the processes necessary to troubleshoot the optical fiber network and its associated components | 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 |

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| | 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 |
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| | 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 |

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| | 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 |
| | 4. Lashers and spinning machines |
| B. Describe aerial 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. 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. 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 |

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| | 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 | 1. OTDR |

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| fiber testing | 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 |