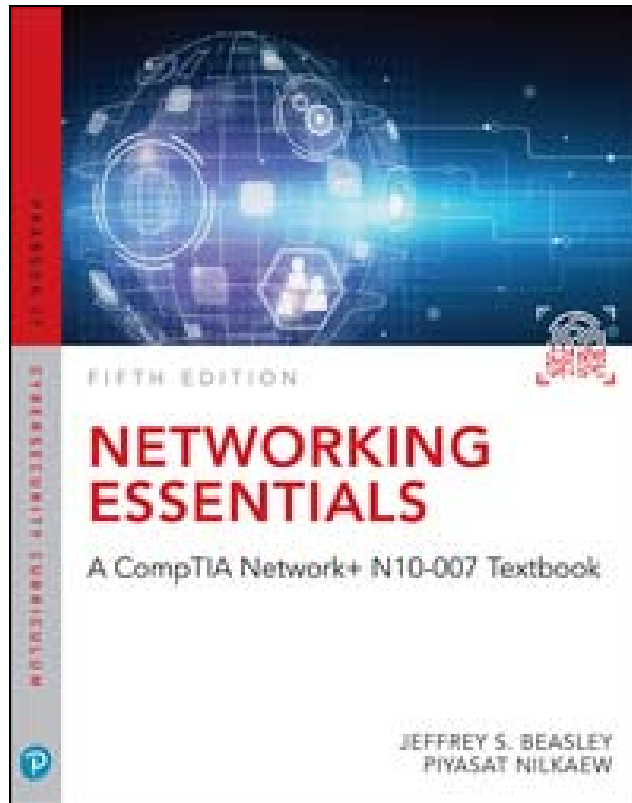


A Correlation of

# Networking Essentials

A CompTIA Network+ N10-007 Textbook

©2018



To the

## South Carolina

### Information Technology Standards

### Networking Fundamentals



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<b>NETWORKING FUNDAMENTALS</b>	
<b>Course Code 5310</b>	
<b>A. SAFETY</b>	
1. Review school safety policies and procedures.	<b>SE/TE:</b> 645-647, 652
2. Review classroom safety rules and procedures.	<b>SE/TE:</b> 645-647, 652
3. Review safety procedures for using equipment in the classroom.	<b>SE/TE:</b> 648-650
4. Identify major causes of work-related accidents in office environments.	For related content, please see: <b>SE/TE:</b> 645, 659
5. Demonstrate safety skills in an office/work environment.	This objective falls outside the scope of this program.
<b>B. STUDENT ORGANIZATIONS</b>	
1. Identify the purpose and goals of a Career and Technology Student Organization (CTSO).	Student organizations fall outside the scope of this program.
2. Explain how CTSOs are integral parts of specific clusters, majors, and/or courses.	
3. Explain the benefits and responsibilities of being a member of a CTSO.	
4. List leadership opportunities that are available to students through participation in CTSO conferences, competitions, community service, philanthropy, and other activities.	
5. Explain how participation in CTSOs can promote lifelong benefits in other professional and civic organizations.	
<b>C. TECHNOLOGY KNOWLEDGE</b>	
1. Demonstrate proficiency and skills associated with the use of technologies that are common to a specific occupation.	<b>SE/TE:</b> 657-665
2. Identify proper netiquette when using e-mail, social media, and other technologies for communication purposes.	<b>SE/TE:</b> 659

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3. Identify potential abuse and unethical uses of laptops, tablets, computers, and/or networks.	<b>SE/TE:</b> 659
4. Explain the consequences of social, illegal, and unethical uses of technology (e.g., piracy; illegal downloading; licensing infringement; inappropriate uses of software, hardware, and mobile devices in the work environment).	For related content, please see: <b>SE/TE:</b> 659
5. Discuss legal issues and the terms of use related to copyright laws, fair use laws, and ethics pertaining to downloading of images, photographs, documents, video, sounds, music, trademarks, and other elements for personal use.	<b>SE/TE:</b> 629-631, 657-661
6. Describe ethical and legal practices of safeguarding the confidentiality of business-related information.	<b>SE/TE:</b> 657-662
7. Describe possible threats to a laptop, tablet, computer, and/or network and methods of avoiding attacks.	For related content, please see: <b>SE/TE:</b> 663-665
<b>D. PERSONAL QUALITIES AND EMPLOYABILITY SKILLS</b>	
1. Demonstrate punctuality.	Personal qualities and employability skills fall outside the scope of this program.
2. Demonstrate self-representation.	
3. Demonstrate work ethic.	
4. Demonstrate respect.	
5. Demonstrate time management.	
6. Demonstrate integrity.	
7. Demonstrate leadership.	
8. Demonstrate teamwork and collaboration.	
9. Demonstrate conflict resolution.	
10. Demonstrate perseverance.	
11. Demonstrate commitment.	
12. Demonstrate a healthy view of competition.	
13. Demonstrate a global perspective.	
14. Demonstrate health and fitness.	
15. Demonstrate self-direction.	
16. Demonstrate lifelong learning.	

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<b>E. PROFESSIONAL KNOWLEDGE</b>	
1. Demonstrate effective speaking and listening skills.	This objective falls outside the scope of this program.
2. Demonstrate effective reading and writing skills.	This objective falls outside the scope of this program.
3. Demonstrate mathematical reasoning.	<b>SE/TE:</b> 98-106, 268-274, 303, 551
4. Demonstrate job-specific mathematics skills.	<b>SE/TE:</b> 98-106, 268-274, 303, 551
5. Demonstrate critical-thinking and problem-solving skills.	<b>SE/TE:</b> 55, 98-106, 200, 346, 609, 610, 640
6. Demonstrate creativity and resourcefulness.	This objective falls outside the scope of this program.
7. Demonstrate an understanding of business ethics.	This objective falls outside the scope of this program.
8. Demonstrate confidentiality.	This objective falls outside the scope of this program.
9. Demonstrate an understanding of workplace structures, organizations, systems, and climates.	This objective falls outside the scope of this program.
10. Demonstrate diversity awareness.	This objective falls outside the scope of this program.
11. Demonstrate job acquisition and advancement skills.	This objective falls outside the scope of this program.
12. Demonstrate task management skills.	This objective falls outside the scope of this program.
13. Demonstrate customer-service skills.	This objective falls outside the scope of this program.

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<b>F. NETWORKING INDUSTRY-SPECIFIC CONTENT</b>	
<b>1. NETWORK ARCHITECTURE</b>	
a. Explain the functions and applications of various network devices:	
1. Router 2. Switch 3. Multilayer switch 4. Firewall 5. HIDS 6. IDS/IPS 7. Access point (wireless/wired) 8. Content filter 9. Load balancer hub 10. Analog modem 11. Packet shaper 12. VPN concentrator.	<b>SE/TE:</b> 96-97, 213-225, 226-229, 337-340, 393-403, 405-406, 430-437, 575-587, 590-599
b. Compare and contrast the use of networking services and applications:	
1. VPN 2. Site to site/host to site/host to host 3. Protocols <ul style="list-style-type: none"> <li>i. IPsec</li> <li>ii. GRE</li> <li>iii. SSL VPN</li> <li>iv. PTP/PPTP</li> </ul> 4. TACACS/RADIUS 5. RAS 6. Web services 7. Unified voice services 8. Network controllers	<b>SE/TE:</b> 225-229, 363-369, 587-589, 468-475, 590-599, 600-605

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c. Install and configure the following networking services/applications to include:	
1. DHCP <ul style="list-style-type: none"> <li>i. Static vs. dynamic IP addressing</li> <li>ii. Reservations</li> <li>iii. Scopes</li> <li>iv. Leases</li> <li>v. Options (DNS servers, suffices)</li> <li>vi. IP helpers/DHCP relay</li> <li>vii. DNS</li> <li>viii. DNS servers</li> <li>ix. DNS records (A, MX, AAAA, CNAME, PTR)</li> <li>x. Dynamic DNS</li> </ul> 2. Proxy/reverse proxy           3. NAT <ul style="list-style-type: none"> <li>i. PAT</li> <li>ii. SNAT</li> <li>iii. DNAT</li> </ul> 4. Port forwarding	<b>SE/TE:</b> 16-23, 24-37, 207-212, 213-225, 257-267, 438-444, 480-491, 575-587, 629-633

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d. Explain the characteristics and benefits of various WAN technologies:	
1. Fiber <ul style="list-style-type: none"> <li>i. SONET</li> <li>ii. DWDM</li> <li>iii. CWDM</li> </ul> 2. Frame Relay           3. Satellite           4. Broadband cable           5. DSL/ADSL           6. ISDN           7. ATM           8. PPP/Multilink PPP           9. MPLS           10. GSM/CDMA <ul style="list-style-type: none"> <li>i. LTE/4G</li> <li>ii. HSPA+</li> <li>iii. 3G</li> <li>iv. Edge</li> </ul> 11. Dialup           12. WiMAX           13. Metro-Ethernet           14. Leased lines <ul style="list-style-type: none"> <li>i. T-1</li> <li>ii. T-3</li> <li>iii. E-1</li> <li>iv. E-3</li> <li>v. OC3</li> <li>vi. OC12</li> </ul> 15. Circuit switch vs packet switch	<b>SE/TE:</b> 16-17, 28-29, 134-139, 140-150, 181-189, 225-229, 463-468, 476-479, 495-500, 590-600



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e. Install and properly terminate various cable types and connectors using appropriate tools:	
1. Copper connectors <ul style="list-style-type: none"> <li>i. RJ-11</li> <li>ii. RJ-45</li> <li>iii. RJ-48C</li> <li>iv. DB-9/RS-232</li> <li>v. DB-25</li> <li>vi. UTP coupler</li> <li>vii. BNC coupler</li> <li>viii. BNC</li> <li>ix. F-connector</li> <li>x. 110 block</li> <li>xi. 66 block</li> </ul> 2. Copper cables <ul style="list-style-type: none"> <li>i. Shielded vs unshielded</li> <li>ii. CAT3, CAT5, CAT5e, CAT6, CAT6a</li> <li>iii. PVC vs plenum</li> <li>iv. RG-59</li> <li>v. RG-6</li> <li>vi. Straight-through vs crossover vs rollover</li> </ul> 3. Fiber connectors <ul style="list-style-type: none"> <li>i. ST</li> <li>ii. SC</li> <li>iii. LC</li> <li>iv. MTRJ</li> <li>v. FC</li> <li>vi. Fiber coupler</li> </ul> 4. Fiber cables <ul style="list-style-type: none"> <li>i. Single mode</li> <li>ii. Multimode</li> <li>iii. APC vs UPC</li> </ul> 5. Media converters <ul style="list-style-type: none"> <li>i. Single mode fiber to Ethernet</li> <li>ii. Multimode fiber to Ethernet</li> <li>iii. Fiber to coaxial</li> <li>iv. Single mode to multimode fiber</li> </ul> 6. Tools <ul style="list-style-type: none"> <li>i. Cable crimpers</li> <li>ii. Punch down tool</li> <li>iii. Wire strippers</li> <li>iv. Snips</li> <li>v. OTDR</li> <li>vi. Cable certifier</li> </ul>	<b>SE/TE:</b> 62-70, 71-75, 76-87, 123-129, 134-139, 238-244, 512

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f. Differentiate between common network topologies:	
1. Mesh <ul style="list-style-type: none"> <li>i. Partial</li> <li>ii. Full</li> </ul> 2. Bus           3. Ring           4. Star           5. Hybrid           6. Point-to-point           7. Point-to-multipoint           8. Client-server           9. Peer-to-peer.	<b>SE/TE:</b> 5-11, 38-43, 94-97, 468-475
g. Differentiate between network infrastructure implementations:	
1. WAN           2. MAN           3. LAN           4. WLAN <ul style="list-style-type: none"> <li>i. Hotspot</li> </ul> 5. PAN <ul style="list-style-type: none"> <li>i. Bluetooth</li> <li>ii. IR</li> <li>iii. NFC</li> </ul> 6. SCADA/ICS <ul style="list-style-type: none"> <li>i. ICS Server</li> <li>ii. DCS/closed network</li> <li>iii. Remote terminal unit</li> <li>iv. Programmable logic controller</li> <li>v. Medianets:               <ul style="list-style-type: none"> <li>a. VTC: ISDN, IP/SIP</li> </ul> </li> </ul>	<b>SE/TE:</b> 5, 16-23, 24-37, 170-180, 181-189, 468-475, 492-495

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h. Implement and configure the appropriate addressing schema given a scenario:	
1. IPv6 <ul style="list-style-type: none"> <li>i. Auto-configuration               <ul style="list-style-type: none"> <li>a. EUI64</li> </ul> </li> <li>ii. DHCP6</li> <li>iii. Link local</li> <li>iv. Address Structure</li> <li>v. Address compression</li> <li>vi. Tunneling 6 to 4, 4 to 6               <ul style="list-style-type: none"> <li>a. Teredo/Miredo</li> </ul> </li> </ul> 2. IPv4 <ul style="list-style-type: none"> <li>i. Address structure</li> <li>ii. subnetting</li> <li>iii. APIPA</li> <li>iv. Classful A, B, C, D</li> <li>v. Classless</li> <li>vi. Private vs Public</li> <li>vii. NAT/PAT</li> <li>viii. MAC addressing</li> <li>ix. Multicast</li> <li>x. Unicast</li> <li>xi. Broadcast</li> <li>xii. Broadcast domains vs collision domains.</li> </ul>	<b>SE/TE:</b> 33-37, 207-213, 218-225, 264-268, 277-278, 286-289, 290-295, 355-362, 410-420, 480-484

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i. Explain the basics of routing concepts and protocols:	
1. Loopback interface 2. Routing loops 3. Routing tables 4. Static vs dynamic routes 5. Default route 6. Distance vector routing 7. Protocols (RIP v2) 8. Hybrid routing protocols i. BGP 9. Link state routing protocols i. OSPF ii. IS-IS 10. Interior vs exterior gateway routing protocols 11. Autonomous system numbers 12. Route redistribution 13. High availability i. VRRP ii. Virtual IP iii. HSRP 14. Route aggregation 15. Routing metrics i. Hop counts ii. MTU, bandwidth iii. Costs iv. Latency v. Administrative distance vi. SPB	<b>SE/TE:</b> 290-295, 355-362, 393-404, 407-410, 411-419, 420-424, 425-429, 492-495, 492-495
j. Identify the basic elements of unified communication technologies:	
1. VoIP 2. Video 3. Real time services i. Presence ii. Multicast vs unicast 4. QoS i. DSCP ii. COS 5. Devices i. UC servers ii. UC devices iii. UC gateways	<b>SE/TE:</b> 225-230, 233-234, 264-267, 290-295, 355-362

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k. Compare and contrast technologies that support cloud and virtualization:	
1. Virtualization <ul style="list-style-type: none"> <li>i. Virtual switches</li> <li>ii. Virtual routers</li> <li>iii. Virtual firewall</li> <li>iv. Virtual vs physical NICs</li> <li>v. Software defined networking</li> </ul> 2. Storage area network <ul style="list-style-type: none"> <li>i. iSCSI</li> <li>ii. Jumbo frame</li> <li>iii. Fibre Channel</li> <li>iv. Network attached storage</li> </ul> 3. Cloud concepts <ul style="list-style-type: none"> <li>i. Public IaaS, SaaS, PaaS</li> <li>ii. Private IaaS, SaaS, PaaS</li> <li>iii. Hybrid IaaS, SaaS, PaaS</li> <li>iv. Community IaaS, SaaS, PaaS</li> </ul>	<b>SE/TE:</b> 316-319, 537-541, 575-587, 617-628, 629-633, 634-636
l. Implement a basic network given a set of requirements:	
1. List of requirements 2. Device types/requirements 3. Environment limitations 4. Equipment limitations 5. Compatibility requirements 6. Wired/wireless considerations 7. Security considerations.	<b>SE/TE:</b> 24-37, 38-43, 55-59, 161-169, 170-180, 181-189

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<b>2. NETWORK OPERATIONS</b>	
a. Use appropriate monitoring tools given a scenario:	
1. Packet/network analyzer 2. Interface monitoring tools 3. Port scanner 4. Top talkers/listeners 5. SNMP management software <ul style="list-style-type: none"> <li>i. Trap</li> <li>ii. Get</li> <li>iii. Walk</li> <li>iv. MIBS</li> </ul> 6. Alerts <ul style="list-style-type: none"> <li>i. Email</li> <li>ii. SMS</li> </ul> 7. Packet flow monitoring 8. SYSLOG 9. SIEM 10. Environmental monitoring tools <ul style="list-style-type: none"> <li>i. Temperature</li> <li>ii. Humidity</li> </ul> 11. Power monitoring tools 12. Wireless survey tools 13. Wireless analyzers	<b>SE/TE:</b> 327-331, 332-335, 514-518, 519-520, 521-524, 538-540, 541-547, 575-586
b. Analyze metrics and reports from monitoring and tracking performance tools given a scenario:	
1. Baseline, Bottleneck 2. Log management 3. Graphing 4. Utilization <ul style="list-style-type: none"> <li>i. Bandwidth</li> <li>ii. Storage</li> <li>iii. Network device CPU</li> <li>iv. Network device memory</li> <li>v. Wireless channel utilization</li> </ul> 5. Link status 6. Interface monitoring <ul style="list-style-type: none"> <li>i. Errors</li> <li>ii. Utilization</li> <li>iii. Discards</li> <li>iv. Packet drops</li> <li>v. Interface resets</li> <li>vi. Speed and duplex</li> </ul>	<b>SE/TE:</b> 71-75, 405-407, 420-423, 495-500, 617-629

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c. Use appropriate resources to support configuration management given a scenario:	
1. Archives/backups 2. Baselines 3. On-boarding and off-boarding of mobile devices 4. NAC 5. Documentation <ul style="list-style-type: none"> <li>i. Network diagrams (logical/physical)</li> <li>ii. Asset management</li> <li>iii. IP address utilization</li> <li>iv. Vendor documentation</li> <li>v. Internal operating procedures/policies/standards)</li> </ul>	<b>SE/TE:</b> 67-71, 188-189, 480-491, 661-662, 663-665
d. Explain the importance of implementing network segmentation:	
1. SCADA systems/Industrial control systems 2. Legacy systems 3. Separate private/public networks 4. Honey-pot/honeynet, Testing lab 5. Load balancing 6. Performance optimization 7. Security 8. Compliance	<b>SE/TE:</b> 24-37, 170-181, 207-213, 405-410, 571-575
e. Install and apply patches and updates given a scenario:	
1. OS updates 2. Firmware updates 3. Driver updates 4. Feature changes/updates 5. Major vs minor updates 6. Vulnerability patches 7. Upgrading vs downgrading (Configuration backup)	<b>SE/TE:</b> 316-324, 369-379, 430-438, 657-662, 663-665

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f. Configure a switch using proper features given a scenario:	
1. VLAN <ul style="list-style-type: none"> <li>i. Native VLAN/Default VLAN</li> <li>ii. VTP</li> </ul> 2. Spanning tree (802.1d)/rapid spanning tree (802.1w) <ul style="list-style-type: none"> <li>i. Flooding</li> <li>ii. Forwarding/blocking</li> <li>iii. Filtering</li> </ul> 3. Interface configuration <ul style="list-style-type: none"> <li>i. Trunking/802.1q</li> <li>ii. Tag vs untag VLANs</li> <li>iii. Port bonding (LACP)</li> <li>iv. Port mirroring (local vs remote)</li> <li>v. Speed and duplexing</li> <li>vi. IP address assignment</li> <li>vii. VLAN assignment</li> </ul> 4. Default gateway           5. PoE and PoE+ (802.3af, 802.3at)           6. Switch management <ul style="list-style-type: none"> <li>i. User/passwords</li> <li>ii. AAA configuration</li> <li>iii. Console</li> <li>iv. Virtual terminals</li> <li>v. In-band/Out-of-band management</li> </ul> 7. Managed vs unmanaged.	<b>SE/TE:</b> 20-23, 140-150, 213-225, 313-315, 316-324, 325-326, 327-331, 332-335, 355-362, 468-475, 476-480



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<p align="center"><b>South Carolina Information Technology Standards</b></p>	<p align="center"><b>Networking Essentials: A CompTIA Network+ N10-007 Textbook ©2018</b></p>
<p>g. Install and configure wireless LAN infrastructure and implement the appropriate technologies in support of wireless capable devices:</p>	
<ol style="list-style-type: none"> <li>1. Small office/home office wireless router</li> <li>2. Wireless access points               <ol style="list-style-type: none"> <li>i. Device density</li> <li>ii. Roaming</li> <li>iii. Wireless controllers                   <ol style="list-style-type: none"> <li>a. VLAN pooling</li> <li>b. LWAPP</li> </ol> </li> <li>iv. Wireless bridge</li> <li>v. Site surveys (Heat maps)</li> <li>vi. Frequencies (2.4 Ghz, 5.0 Ghz)</li> <li>vii. Channels</li> <li>viii. Goodput</li> <li>ix. Connection types                   <ol style="list-style-type: none"> <li>a. 802.11a-ht</li> <li>b. 802.11g-ht</li> </ol> </li> <li>x. Antenna placement</li> <li>xi. Antenna types                   <ol style="list-style-type: none"> <li>a. Omnidirectional</li> <li>b. Unidirectional</li> </ol> </li> <li>xii. MIMO/MUMIMO</li> <li>xiii. Signal strength                   <ol style="list-style-type: none"> <li>a. Coverage</li> <li>b. Differences between device antennas</li> </ol> </li> <li>xiv. SSID broadcast</li> <li>xv. Topologies                   <ol style="list-style-type: none"> <li>a. Adhoc</li> <li>b. Mesh</li> <li>c. Infrastructure</li> </ol> </li> <li>xvi. Mobile devices                   <ol style="list-style-type: none"> <li>a. Cell phones</li> <li>b. Laptops</li> <li>c. Tablets</li> <li>d. Gaming devices</li> <li>e. Media devices</li> </ol> </li> </ol> </li> </ol>	<p><b>SE/TE:</b> 5-11, 24-37, 38-43, 161-169, 170-180, 190-195, 257-267, 537-540, 600-604</p>

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<b>3. NETWORK SECURITY</b>	
a. Compare and contrast risk related concepts:	
1. Disaster recovery 2. Business continuity 3. Battery backups/UPS 4. First responders 5. Data breach 6. End user awareness and training 7. Single point of failure <ul style="list-style-type: none"> <li>i. Critical nodes</li> <li>ii. Critical assets</li> <li>iii. Redundancy</li> </ul> 8. Adherence to standards and policies 9. Vulnerability scanning 10. Penetration testing	<b>SE/TE:</b> 324-326, 562-571, 663-665

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b. Compare and contrast common network vulnerabilities and threats such as:	
1. Attacks/threats <ul style="list-style-type: none"> <li>i. Denial of service               <ul style="list-style-type: none"> <li>a. Distributed DoS                   <ul style="list-style-type: none"> <li>1. Botnet</li> <li>2. Traffic spike</li> <li>3. Coordinated attack</li> </ul> </li> <li>b. Reflective/amplified                   <ul style="list-style-type: none"> <li>1. DNS</li> <li>2. NTP</li> <li>3. Smurfing</li> </ul> </li> <li>c. Friendly/unintentional DoS</li> <li>d. Physical attack                   <ul style="list-style-type: none"> <li>1. Permanent DoS</li> </ul> </li> </ul> </li> <li>ii. ARP cache poisoning</li> <li>iii. Packet/protocol abuse</li> <li>iv. Spoofing</li> <li>v. Wireless               <ul style="list-style-type: none"> <li>a. Evil twin</li> <li>b. Rogue AP</li> <li>c. War driving</li> <li>d. War chalking</li> <li>e. Bluejacking</li> <li>f. Bluesnarfing</li> <li>g. WPA/WEP/WPS attacks</li> </ul> </li> <li>vi. Brute force</li> <li>vii. Session hijacking</li> <li>viii. Social engineering</li> <li>ix. Man-in-the-middle</li> <li>x. VLAN hopping</li> <li>xi. Compromised system</li> <li>xii. Effect of malware on the network</li> <li>xiii. Insider threat/malicious employee</li> <li>xiv. Zero day attacks</li> </ul>	<b>SE/TE:</b> 525-529, 560-571, 572-574, 575-587, 600-604

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<p align="center"><b>South Carolina Information Technology Standards</b></p>	<p align="center"><b>Networking Essentials: A CompTIA Network+ N10-007 Textbook ©2018</b></p>
<p><b>(Continued)</b>            2. Vulnerabilities                i. Unnecessary running services                ii. Open ports                iii. Unpatched/legacy systems                iv. Unencrypted channels                v. Clear text credentials                vi. Unsecure protocols                    a. TELNET                    b. HTTP                    c. SLIP                    d. FTP                    e. TFTP                    f. SNMPv1 and SNMPv2                vii. TEMPEST/RF emanation</p>	

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c. Implement network hardening techniques given a scenario:	
<ol style="list-style-type: none"> <li>1. Anti-malware software               <ol style="list-style-type: none"> <li>i. Host-based</li> <li>ii. Cloud/server-based</li> <li>iii. Network-based</li> </ol> </li> <li>2. Switch port security               <ol style="list-style-type: none"> <li>i. DHCP snooping</li> <li>ii. ARP inspection</li> <li>iii. MAC address filtering</li> <li>iv. VLAN assignments                   <ol style="list-style-type: none"> <li>a. Network segmentation</li> </ol> </li> </ol> </li> <li>3. Security policies</li> <li>4. Disable unneeded network services</li> <li>5. Use secure protocols such as:               <ol style="list-style-type: none"> <li>i. SSH</li> <li>ii. SNMPv3</li> <li>iii. TLS/SSL</li> <li>iv. SFTP</li> <li>v. HTTPS</li> <li>vi. IPsec</li> </ol> </li> <li>6. Access lists such as:               <ol style="list-style-type: none"> <li>i. Web/content filtering</li> <li>ii. Port filtering</li> <li>iii. IP filtering</li> <li>iv. Implicit deny</li> </ol> </li> <li>7. Wireless security such as:               <ol style="list-style-type: none"> <li>i. WEP</li> <li>ii. WPA/WPA2                   <ol style="list-style-type: none"> <li>a. Enterprise</li> <li>b. Personal</li> </ol> </li> <li>iii. TKIP/AES</li> <li>iv. 802.1x</li> <li>v. TLS/TTLS</li> <li>vi. MAC filtering</li> </ol> </li> <li>8. User authentication such as:               <ol style="list-style-type: none"> <li>i. CHAP/MSCHAP</li> <li>ii. PAP</li> <li>iii. EAP</li> <li>iv. Kerberos</li> <li>v. Multifactor authentication</li> <li>vi. Two-factor authentication</li> <li>vii. Single sign-on</li> </ol> </li> <li>9. Hashes such as MD5 and SHA.</li> </ol>	<p><b>SE/TE:</b> 213-225, 257-267, 327-331, 335-340, 562-571, 572-573, 574-587, 588-589, 600-604</p>

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d. Compare and contrast physical security controls such as:	
1. Mantraps 2. Network closets 3. Video monitoring i. IP cameras/CCTVs 4. Door access controls 5. Proximity readers/key fob 6. Biometrics 7. Keypad/cipher locks 8. Security guard.	<b>SE/TE:</b> 67, 575-586, 587-589, 600-604, 652
e. Install and configure a basic firewall given a scenario.	
1. Types of firewalls i. Host-based ii. Network-based iii. Software vs hardware iv. Application aware/context aware v. Small office/home office firewall vi. Stateful vs stateless inspection vii. UTM 2. Settings/techniques i. ACL ii. Virtual wire vs routed iii. DMZ iv. Implicit deny v. Block/allow a. Outbound traffic b. Inbound traffic vi. Firewall placement a. Internal/external	<b>SE/TE:</b> 33-37, 325-327, 495-500, 545-546, 575-587, 588-589
f. Explain the purpose of various network access control models such as:	
1. 802.1x 2. Posture assessment 3. Guest network 4. Persistent vs non-persistent agents 5. Quarantine network 6. Edge vs access control	<b>SE/TE:</b> 181-189, 335-340, 617-628

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g. Summarize basic forensic concepts such as:	
<ol style="list-style-type: none"> <li>1. First responder</li> <li>2. Secure the area.               <ol style="list-style-type: none"> <li>i. Escalate when necessary.</li> </ol> </li> <li>3. Document the scene.</li> <li>4. eDiscovery</li> <li>5. Evidence/data collection</li> <li>6. Chain of custody</li> <li>7. Data transport</li> <li>8. Forensics report</li> <li>9. Legal hold</li> </ol>	<b>SE/TE: 575-587</b>
<b>4. TROUBLESHOOTING</b>	
a. Implement the following network troubleshooting methodology given a scenario.	
<ol style="list-style-type: none"> <li>1. Identify the problem.               <ol style="list-style-type: none"> <li>i. Gather information</li> <li>ii. Duplicate the problem, if possible.</li> <li>iii. Question users.</li> <li>iv. Identify symptoms.</li> <li>v. Determine if anything has changed.</li> <li>vi. Approach multiple problems individually.</li> </ol> </li> <li>2. Establish a theory of probable cause.               <ol style="list-style-type: none"> <li>i. Question the obvious.</li> <li>ii. Consider multiple approaches (Top-to-bottom/bottom-to-top OSI model, or divide and conquer).</li> </ol> </li> <li>3. Test the theory to determine cause.               <ol style="list-style-type: none"> <li>i. Once theory is confirmed, determine next steps to resolve problem; if theory is not confirmed, re-establish new theory or escalate.</li> </ol> </li> <li>4. Establish a plan of action to resolve the problem and identify potential effects.</li> <li>5. Implement the solution or escalate as necessary.</li> <li>6. Verify full system functionality and if applicable implement preventative measures.</li> <li>7. Document findings, actions, and outcomes.</li> </ol>	<b>SE/TE: 541-547</b>

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b. Analyze and interpret the output of troubleshooting tools given a scenario using the following:	
1. Command line tools such as: <ul style="list-style-type: none"> <li>i. ipconfig0</li> <li>ii. Netstat</li> <li>iii. ifconfig</li> <li>iv. Ping/ping6/ping -6</li> <li>v. Tracert/tracert -6/traceroute6/traceroute -6</li> <li>vi. nbtstat, nslookup</li> <li>vii. arp</li> <li>viii. mac address lookup</li> <li>ix. table</li> <li>x. Pathping</li> </ul> 2. Line testers 3. Certifiers 4. Multimeter 5. Cable tester 6. Light meter 7. Toner probe 8. Speed test sites 9. Looking glass sites 10. WiFi analyzer 11. Protocol analyzer	<b>SE/TE:</b> 16-23, 33-37, 38-43, 44-47, 98-106, 257-267, 393-404, 514-518, 519-520, 521-524, 541-547, 562-571



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c. Troubleshoot and resolve common wireless issues given a scenario such as:	
<ol style="list-style-type: none"> <li>1. Signal loss</li> <li>2. Interference</li> <li>3. Overlapping channels</li> <li>4. Mismatched channels</li> <li>5. Signal-to-noise ratio</li> <li>6. Device saturation</li> <li>7. Bandwidth saturation</li> <li>8. Untested updates</li> <li>9. Wrong SSID</li> <li>10. Power levels</li> <li>11. Open networks</li> <li>12. Rogue access point</li> <li>13. Wrong antenna type</li> <li>14. Incompatibilities</li> <li>15. Wrong encryption</li> <li>16. Bounce</li> <li>17. MIMO</li> <li>18. AP placement</li> <li>19. AP configurations               <ol style="list-style-type: none"> <li>i. LWAPP</li> <li>ii. Thin vs thick</li> </ol> </li> <li>20. Environmental factors               <ol style="list-style-type: none"> <li>i. Concrete walls</li> <li>ii. Window film</li> <li>iii. Metal studs</li> </ol> </li> <li>21. Wireless standard related issues               <ol style="list-style-type: none"> <li>i. Throughput</li> <li>ii. Frequency</li> <li>iii. Distance</li> <li>iv Channels</li> </ol> </li> </ol>	<p><b>SE/TE:</b> 514-518, 519-520, 521-524, 525-529, 530-534, 535-536, 537-540</p>

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d. Troubleshoot and resolve common copper cable issues given a scenario such as:	
<ol style="list-style-type: none"> <li>1. Shorts</li> <li>2. Opens</li> <li>3. Incorrect termination (mismatched standards)               <ol style="list-style-type: none"> <li>i. Straight-through</li> <li>ii. Crossover</li> </ol> </li> <li>4. Cross-talk               <ol style="list-style-type: none"> <li>i. Near end</li> <li>ii. Far end</li> </ol> </li> <li>5. EMI/RFI</li> <li>6. Distance limitations</li> <li>7. Attenuation/Db loss</li> <li>8. Bad connector</li> <li>9. Bad wiring</li> <li>10. Split pairs</li> <li>11. Tx/Rx reverse</li> <li>12. Cable placement</li> <li>13. Bad SFP/GBIC - cable or transceiver.</li> </ol>	<b>SE/TE:</b> 38-43, 64-71, 72-75, 76-88, 89-93, 120-122, 134-140, 407-410
e. Troubleshoot and resolve common fiber cable issues given a scenario such as:	
<ol style="list-style-type: none"> <li>1. Attenuation/Db loss</li> <li>2. SFP/GBIC - cable mismatch</li> <li>3. Bad SFP/GBIC - cable or transceiver</li> <li>4. Wavelength mismatch</li> <li>5. Fiber type mismatch</li> <li>6. Dirty connectors</li> <li>7. Connector mismatch</li> <li>8. Bend radius limitations</li> <li>9. Distance limitations</li> </ol>	<b>SE/TE:</b> 98-106, 134-140, 537-541

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f. Troubleshoot and resolve common network issues given a scenario such as:	
1. Incorrect IP configuration/default gateway 2. Broadcast storms/switching loop 3. Duplicate IP 4. Speed and duplex mismatch 5. End-to-end connectivity 6. Incorrect VLAN assignment 7. Hardware failure 8. Misconfigured DHCP 9. Misconfigured DNS 10. Incorrect interface/interface 11. Misconfiguration 12. Cable placement 13. Interface errors 14. Simultaneous wired/wireless connections 15. Discovering neighboring devices/nodes 16. Power failure/power anomalies 17. MTU/MTU black hole 18. Missing IP routes 19. NIC teaming misconfiguration <ul style="list-style-type: none"> <li>i. Active-active vs active-passive</li> <li>ii. Multicast vs broadcast</li> </ul>	<b>SE/TE:</b> 16-23, 24-37, 181-189, 213-224, 225-229, 257-267, 274-278, 290-295, 332-335, 541-547

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g. Troubleshoot and resolve common security issues given a scenario such:	
<ol style="list-style-type: none"> <li>1. Misconfigured firewall</li> <li>2. Misconfigured ACLs/applications</li> <li>3. Malware</li> <li>4. Denial of service</li> <li>5. Open/closed ports</li> <li>6. ICMP related issues               <ol style="list-style-type: none"> <li>i. Ping of death</li> <li>ii. Unreachable default gateway</li> </ol> </li> <li>7. Unpatched firmware/Oss</li> <li>8. Malicious users               <ol style="list-style-type: none"> <li>i. Trusted</li> <li>ii. Untrusted users</li> <li>iii. Packet sniffing</li> </ol> </li> <li>9. Authentication issues               <ol style="list-style-type: none"> <li>i. TACACS/RADIUS misconfigurations</li> <li>ii. Default passwords/settings</li> </ol> </li> <li>10. Improper access/backdoor access</li> <li>11. ARP issues</li> <li>12. Banner grabbing/OUI</li> <li>13. Domain/local group configurations</li> <li>14. Jamming</li> </ol>	<b>SE/TE:</b> 207-213, 316-324, 486-491, 514-519, 562-571, 572-574, 575-587, 588-589, 600-604
h. Troubleshoot and resolve common WAN issues given a scenario for the following:	
<ol style="list-style-type: none"> <li>1. Loss of internet connectivity</li> <li>2. Interface errors</li> <li>3. Split horizon</li> <li>4. DNS issues</li> <li>5. Interference</li> <li>6. Router configurations</li> <li>7. Customer premise equipment</li> <li>8. Smart jack/NIU</li> <li>9. Demark</li> <li>10. Loopback</li> <li>11. CSU/DSU               <ol style="list-style-type: none"> <li>i. copper line drivers/repeaters</li> </ol> </li> <li>12. Company security policy               <ol style="list-style-type: none"> <li>i. Throttling</li> <li>ii. Blocking</li> <li>iii. Fair access policy/utilization limits</li> </ol> </li> <li>13. Satellite issues               <ol style="list-style-type: none"> <li>i. Latency</li> </ol> </li> </ol>	<b>SE/TE:</b> 218-225, 226-230, 324-327, 393-404, 405-407, 463-468, 480-492, 493-495, 541-547

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<b>5. INDUSTRY STANDARDS, PRACTICES, AND NETWORK THEORY</b>	
a. Analyze a scenario and determine the corresponding OSI layer for the following layers:	
1. Layer 1 – Physical 2. Layer 2 – Data link 3. Layer 3 – Network 4. Layer 4 – Transport 5. Layer 5 – Session 6. Layer 6 – Presentation 7. Layer 7 – Application	<b>SE/TE:</b> 12-16
b. Explain the basics of network theory and concepts:	
1. Encapsulation/de-encapsulation 2. Modulation techniques <ul style="list-style-type: none"> <li>i. Multiplexing</li> <li>ii. De-multiplexing</li> <li>iii. Analog and digital techniques</li> <li>iv. TDM</li> </ul> 3. Numbering systems <ul style="list-style-type: none"> <li>i. Binary</li> <li>ii. Hexadecimal</li> <li>iii. Octal</li> </ul> 4. Broadband/base band 5. Bit rates vs baud rate 6. Sampling size 7. CDMA/CD and CSMA/CA 8. Carrier detect/sense 9. Wavelength 10. TCP/IP suite <ul style="list-style-type: none"> <li>i. ICMP</li> <li>ii. UDP</li> <li>iii. TCP</li> </ul> 11. Collision	<b>SE/TE:</b> 136-140, 161-170, 181-189, 207-213, 214-225, 257-267, 268-274, 290-295, 463-467, 468-475, 476-479
c. Deploy the appropriate wireless standard given a scenario:	
1. 802.11a 2. 802.11b 3. 802.11g 4. 802.11n 5. 802.11ac	<b>SE/TE:</b> 24-37 161-170

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d. Deploy the appropriate wired connectivity standard given a scenario for the following:	
1. Ethernet standards <ul style="list-style-type: none"> <li>i. 10BaseT</li> <li>ii. 100BaseT</li> <li>iii. 1000BaseT</li> <li>iv. 1000BaseTX</li> <li>v. 10GBaseT</li> <li>vi. 100BaseFX</li> <li>vii. 10Base2</li> <li>viii. 10GBaseSR</li> <li>ix. 10GBaseER</li> <li>x. 10GBaseSW</li> <li>xi. IEEE 1905.1-2013               <ul style="list-style-type: none"> <li>a. Ethernet over HDMI</li> <li>b. Ethernet over power line</li> </ul> </li> </ul> 2. Wiring standards <ul style="list-style-type: none"> <li>i. EIA/TIA 568A/568B</li> </ul> 3. Broadband standards <ul style="list-style-type: none"> <li>i. DOCSIS</li> </ul>	<b>SE/TE:</b> 63-71, 72-75, 89-93, 94-97, 468-475, 476-479
e. Implement the appropriate policies or procedures given a scenario for the following:	
1. Security policies <ul style="list-style-type: none"> <li>i. Consent to monitoring</li> </ul> 2. Network policies           3. Acceptable use policy           4. Standard business documents <ul style="list-style-type: none"> <li>i. SLA</li> <li>ii. MOU</li> <li>iii. MSA</li> <li>iv. SOW</li> </ul>	<b>SE/TE:</b> 629-633, 657-662

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f. Summarize safety practices.	
1. Electrical safety <ul style="list-style-type: none"> <li>i. Grounding</li> </ul> 2. ESD <ul style="list-style-type: none"> <li>i. Static</li> </ul> 3. Installation safety <ul style="list-style-type: none"> <li>i. Lifting equipment</li> <li>ii. Rack installation</li> <li>iii. Placement</li> <li>iv. Tool safety</li> </ul> 4. MSDS           5. Emergency procedures <ul style="list-style-type: none"> <li>i. Building layout</li> <li>ii. Fire escape plan</li> <li>iii. Safety/emergency exits</li> <li>iv. Fail open/fail close</li> <li>v. Emergency alert system</li> </ul> 6. Fire suppression systems           7. HVAC	<b>SE/TE:</b> 98-106, 645-653

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g. Install and configure equipment in the appropriate location using best practices given a scenario for the following:	
<ol style="list-style-type: none"> <li>1. Intermediate distribution frame</li> <li>2. Main distribution frame</li> <li>3. Cable management               <ol style="list-style-type: none"> <li>i. Patch panels</li> </ol> </li> <li>3. Power management               <ol style="list-style-type: none"> <li>i. Power converters</li> <li>ii. Circuits</li> <li>iii. UPS</li> <li>iv. Inverters</li> <li>v. Power redundancy</li> </ol> </li> <li>4. Device placement</li> <li>5. Air flow</li> <li>6. Cable trays</li> <li>7. Rack systems               <ol style="list-style-type: none"> <li>i. Server rail racks</li> <li>ii. Two-post racks</li> <li>iii. Four-post racks</li> <li>iv. Free-standing racks</li> </ol> </li> <li>8. Labeling               <ol style="list-style-type: none"> <li>i. Port labeling</li> <li>ii. System labeling</li> <li>iii. Circuit labeling</li> <li>iv. Naming conventions</li> <li>v. Patch panel labeling</li> </ol> </li> <li>9. Rack monitoring</li> <li>10. Rack security</li> </ol>	<b>SE/TE:</b> 16-23, 64-71, 76-88, 98-106, 140-150, 332-335, 492-500



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h. Explain the basics of change management procedures for the following:	
1. Documenting reason for a change 2. Change request <ul style="list-style-type: none"> <li>i. Configuration procedures</li> <li>ii. Rollback process</li> <li>iii. Potential impact</li> <li>iv. Notification</li> </ul> 3. Approval process 4. Maintenance window <ul style="list-style-type: none"> <li>i. Authorized downtime</li> </ul> 5. Notification of change 6. Documentation <ul style="list-style-type: none"> <li>i. Network configurations</li> <li>ii. Additions to network</li> <li>iii. Physical location changes</li> </ul>	<b>SE/TE:</b> 541-547
i. Compare and contrast the following ports and protocols.	
1. 80 HTTP 2. 443 HTTPS 3. 137-139 NetBIOS 4. 110 POP 5. 143 IMAP 6. 25 SMTP 7. 5060/5061 SIP 8. 2427/2727 MGCP 9. 5004/5005 RTP 10. 1720 H.323 11. TCP <ul style="list-style-type: none"> <li>i. Connection-oriented</li> </ul> 12. UDP <ul style="list-style-type: none"> <li>i. Connectionless</li> </ul>	<b>SE/TE:</b> 256-267
j. Configure and apply the appropriate ports and protocols given a scenario.	
1. 20,21 FTP 2. 161 SNMP 3. 22 SSH 4. 23 Telnet 5. 53 DNS 6. 67,68 DHCP 7. 69 TFTP 8. 445 SMB 9. 3389 RDP	<b>SE/TE:</b> 519-521