Networking

Primary Career Cluster:	Information Technology (IT)
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C10H13
Prerequisite(s):	*Computer Systems* (C10H10), *Algebra I* (G02X02, G02H00)
Credit:	1
Grade Level:	11-12
Focus Elective Graduation Requirement:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other *IT* courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition, when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the third course in the *Networking Systems* program of study.
Aligned Student Organization(s)	SkillsUSA: http://www.skillsusatn.org/ Technology Student Association (TSA): http://www.tntsa.org
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
Promoted Student Industry Credentials	Credentials are aligned with post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	152, 153, 173, 311, 435, 436, 470, 474, 475, 476, 477, 582, 595, 740, 953
Required Teacher Certifications/Training:	All endorsements except for 173 will require either the Individuals teaching this course will require either the NOCTI test code 5910: Computer Networking Fundamentals Certification, **or** the A+, Net+, CIW, or CISCO Industry Certifications.
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-information-technology.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st century skills necessary to be successful in career and in life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards which feed into intentionally designed programs of study.

Students engage in industry relevant content through general education integration and experiences such as career and technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry specific, informational texts.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to put classroom learning into real-life experiences for your students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course, note this is not an exhaustive list.

- Participate in CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry specific skills that involve teamwork and project management.
- Participate in contests that highlight job skill demonstration, interviewing skills, community service activities, extemporaneous speaking, and job interview.
- Participate in leadership activities such as Student2Student Mentoring, National Week of Service, Officer Training, and Community Action Project.

For more ideas and information, visit Tennessee SkillsUSA at http://www.skillsusatn.org/.

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standards 1.1-2.2** | Invite an industry to discuss career options and safety protocols.
- **Standards 3.1-3.2** | Informational interview with an industry partner.
- **Standards 4.1-6.2** | Have students do a project that is useful to a local employer for evaluation.
- **Standards 7.1-7.2** | Invite an industry expert to discuss topologies.
- **Standards 8.1-11.1** | Visit an industry partner with this equipment and have the students see it in operation.
- **Standards 12.1-12.4** | Discuss security with the employee responsible for networking security for a local business.
- **Standards 13.1-13.2** | Discuss troubleshooting with an employee responsible for troubleshooting for a local business.

For more ideas and information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.

Course Description

Networking is an advanced course designed to emphasize the conceptual and practical skills necessary to design, manage, and diagnose network hardware and software. Upon completion of this course, proficient students will identify types of networks, understand the layers of the open systems interconnection (OSI) model, prevent security risks, and apply troubleshooting theory to the successful execution of networking tasks. Course content covers transmission control protocol, internet protocol, wired and wireless topologies, switching and routing, network hardware, wireless networking, and network operating systems (NOS). Upon completion of this course, proficient students will be prepared to sit for the CompTIA Network+ exam.

Course Standards

1. Safety

1.1 <u>Safety Rules</u>: Accurately **read, interpret, and demonstrate adherence to safety rules**, including but not limited to rules published by the National Science Teachers Association (NSTA), rules pertaining to electrical safety, Internet safety, Occupational Safety and Health Administration (OSHA) guidelines, and state and national code requirements. Be able to distinguish between rules and explain why certain rules apply. Complete safety test with 100 percent accuracy.

1.2 <u>Use of Safety Equipment</u>: **Identify and explain the intended use of safety equipment available in the classroom**. For example, demonstrate how to properly inspect, use, and maintain safe operating procedures with tools and equipment.

2. Career Exploration

2.1 <u>Computer Technology Industry Association</u>: **Locate and access the Computer Technology Industry Association** (CompTIA) website and **analyze its structure, policies, and requirements for CompTIA Network+ certification**. Explain what steps are required to obtain the certification, methods to prepare for the examination, and how it can be a stepping stone to more advanced certifications.

2.2 <u>Networking Standards Organizations</u>: **Research the** following **networking standards organizations** and write an informative paper **explaining the industry standards that are managed by each**. Describe why these standards are important and how they influence the work of a network administrator or other IT professional.
    a. American National Standards Institute
    b. Electronic Industries Alliance and Telecommunications Industry Association
    c. Institute of Electrical and Electronics Engineers
    d. International Organization for Standardization
    e. International Telecommunication Union
    f. Internet Society
    g. Internet Assigned Numbers Authority
    h. Internet Corporation for Assigned Names and Numbers

3. **Types of Networks**

    3.1 <u>Network Features and Components</u>: **Define the term "network," define and describe the necessary features and components of a network, and differentiate between different network types**. Using graphic illustrations, or other diagrams, identify and describe the following types of networks, outlining the features that distinguish each network from the others and effectively diagraming the flow of information in each.
    - a. Peer-to-peer networks
    - b. Client/server networks
    - c. Local area networks (LAN)
    - d. Metropolitan area networks (MAN)
    - e. Wide area networks (WAN)

    3.2 <u>Network Functions</u>: Describe the following **functions provided by a network**. Distinguish between these network services in a large office versus an office with few users, providing specific examples.
    - a. File and print services
    - b. Access services
    - c. Communication services
    - d. Internet services
    - e. Management services

4. **Open Systems Interconnection Model (OSI) Model**

    4.1 <u>Open System Interconnection (OSI) Model</u>: Create and use diagrams to **explain the Open Systems Interconnection (OSI) Model and the flow of data through it**. Define the functions and identify the associated hardware components of the OSI Model's following seven layers. For example, explain how each layer interacts to ensure that data arrives in the correct place without errors.
    - a. Application
    - b. Presentation
    - c. Session
    - d. Transport
    - e. Network
    - f. Data Link
    - g. Physical

5. **Data Transmission**

    5.1 <u>Standard Cable Types</u>: **Identify and describe a range of standard cable types** (e.g., coaxial cable, shielded twisted pair, unshielded twisted pair, single-mode fiber, multimode fiber, serial, plenum, and non-plenum), comparing and contrasting their characteristics and properties, and differentiating between them accurately. Explain why it is necessary to consider the following properties when selecting and installing the appropriate cables for a networking task, and why these decisions must conform to industry standards. For a given task and environment, make a recommendation about an appropriate cable type and defend the recommendation with specific evidence and reasoning.
    - a. Transmission speeds

b. Distance
c. Duplex
d. Noise immunity (e.g., security, electromagnetic interference (EMI))
e. Frequency

6. Transmission Control Protocol (TCP)/Internet Protocol (IP)

6.1 <u>Subprotocols</u>: Research and **identify the common subprotocols associated with transmission control protocol (TCP) and internet protocol**. Using a combination of text and graphic illustrations, explain their functions and how they correlate to the layers of the open systems connection (OSI) model. Examples of subprotocols include but are not limited to: hypertext transfer protocol (HTTP), user diagram protocol (UDP), internet control message protocol (ICMP), internet group management protocol (IGMP), address resolution protocol (ARP), domain name system (DNS), network time protocol (NTP), file transfer protocol (FTP), and trivial file transfer protocol (TFTP).

6.2 <u>Address Formats</u>: **Describe** the following **address formats**: IPv6, IPv4, and MAC. **Using the advantages and disadvantages as supporting evidence, identify and explain the application of each format**.

7. Topologies

7.1 <u>Physical Network Topologies</u>: **Define each** of the following **physical network topologies, and draw diagrams to distinguish among the layouts**. Include examples of the most effective applications, as well as identify the advantages and disadvantages of each topology.
   a. Star
   b. Mesh
   c. Bus
   d. Ring
   e. Point to point
   f. Point to multipoint
   g. Hybrid

7.2 <u>Types of Topologies</u>: **Compare and contrast logical network topologies to physical network topologies**. Explain how these two types of topologies differ. Identify the common logical network topologies and describe their characteristics. Provide examples demonstrating how logical network topologies are useful in troubleshooting.

8. Switching and Routing

8.1 <u>Switching</u>: Define **switching and** detail **the role that it occupies in a logical network topology**. Describe the three types of switching (circuit, message, and packet) and identify the specific details that distinguish how each method establishes paths between nodes.

8.2 <u>Routing</u>: Define routing and **explain why a router is protocol dependent**. Identify and list the properties of a router and describe its basic functions, citing examples found in informational texts.

8.3 <u>Data Flow</u>: Write descriptive **text that outlines the process used to determine the most efficient path** (e.g., route) **for data to flow across a network**. Identify and describe that variables influence the best path, including the following most common routing protocols.
   a. Link-state: open shortest path first (OSPF), intermediate system to intermediate system (IS-IS)
   b. Distance-vector: routing information protocol (RIP), routing information protocol version 2 (RIPv2), border gateway protocol (BGP)
   c. Hybrid: enhanced interior gateway routing protocol (EIGRP)

9. Network Hardware

9.1 <u>Network Interface Cards (NICS)</u>: Research the **following types of network interface cards (NICs)**. Create a table or other graphic organizer that lists **examples and characteristics of NICs, as well as steps to selecting the appropriate NIC**. Demonstrate proper installation and configuration of each device, attending to appropriate measurements and units. Summarize the multistep procedure to install and configure the various NICs.
   a. Internally attached (internal bus standards)
   b. Externally attached (peripheral bus standards)
   c. On-board
   d. Wireless

9.2 <u>Repeaters</u>: **Define a repeater and explain its limitations**. Describe the characteristics of a hub; explain how it is a type of repeater, yet it still differs from the repeater. Install and configure the following types of hubs and identify their distinguishing characteristics.
   a. Passive
   b. Intelligent
   c. Managed
   d. Stand-alone
   e. Workgroup

9.3 <u>Bridges, Repeaters, Hubs</u>: **Compare and contrast bridges with repeaters and hubs**, identifying examples of **advantages that bridges have over these devices**. Provide supporting evidence to justify each example.

9.4 <u>Node Installation</u>: Create and execute a plan to first **install multiple nodes to a small switch, and then to connect the switch to another connectivity device**. Verbally describe the steps of the procedure as they are being demonstrated.

9.5 <u>Gateway Devices</u>: Identify **common gateway devices** and explain **how they are different from connectivity devices**. Further, explain why the gateways must operate on multiple layers of the open systems interconnection (OSI) model.

10. Wireless Networking

10.1 <u>Wireless Transmission Technology</u>: Demonstrate **understanding of wireless transmission technology**. Use a combination of graphic illustrations and text to describe how a wireless signal originates from an electrical current and travels along a conductor. Include definitions and functions of the following concepts.
- a. Antenna
- b. Signal propagation
- c. Signal degradation
- d. Frequency ranges
- e. Narrowband, broadband, and spread spectrum signals
- f. Fixed vs. mobile

10.2 <u>Wireless Local Area Networks</u>: **Compare and contrast wireless local area network (WLAN) infrastructure to that of wired network topologies**. Identify and explain the differences between the two layout types.

10.3 <u>Wireless Fidelity Standards</u>: Locate and **access the 802.11 standards** (wireless fidelity or Wi-Fi) developed by the Institute for Electrical and Electronics Engineers (IEEE). Explain the **purpose of these standards, as well as how IT professionals should apply them to networking systems**.

10.4 <u>Bluetooth Technology</u>: Explore **Bluetooth technology, differentiating between purposes of, and standards that govern, Bluetooth and other technologies** (such as those governed by IEEE 802.111).

10.5 <u>Basic Wireless Network</u>: Given specifications to **install and configure a basic wireless network in a home or small office**, write and execute a plan that includes, but is not limited to, the following:
- a. install the client,
- b. locate and place the access point,
- c. install the access point, and
- d. verify installation.

Provide details of the multistep procedure and justify the recommendations in the plan by providing supporting evidence that conforms to industry standards (e.g., Institute for Electrical and Electronics Engineers (IEEE) 802.11, Bluetooth).

10.6 <u>Wireless Network Installation Large Office</u>: Given specifications to **install and configure a wireless network in a large office**, conduct a site survey to **assess requirements of the clients, facility characteristics, and coverage area**. Using the survey results, write and execute a plan that includes, but is not limited to, the following:
- a. wireless access point placement,
- b. antenna types,
- c. interference,
- d. frequencies,
- e. channels,
- f. wireless standards, and
- g. service set identifier (SSID) (e.g., enable/disable).

Provide details of the multistep procedure and justify the plan by providing supporting evidence that conforms to the Institute for Electrical and Electronics Engineers (IEEE) 802.11 standards.

11. Network Operating Systems

11.1 <u>Network Operating Systems</u>: In teams, **research** various **types of network operating systems** (NOS) (e.g., Microsoft Windows server, Linux enterprise server, UNIX, etc.). Identify the basic functions of a NOS, and synthesize the findings to write an explanatory text that includes, but is not limited to, the following:
   a.   guiding questions to determine the optimal software requirements;
   b.   client support features;
   c.   organization of network elements;
   d.   sharing applications;
   e.   managing system resources (e.g., memory, multitasking, multiprocessing); and
   f.   why it is important to consider future needs.
Present the paper to other teams and revise it based on constructive feedback from peers.

12. Security

12.1 <u>Scheduled Audit</u>: Develop a **plan for a regularly scheduled audit to examine a network's security risks.** The plan should include, but is not limited to, the following:
   a.   how often and when the audit will be conducted,
   b.   security threats to be examined,
   c.   rating system to assess the security threats,
   d.   security policy goals and content, and
   e.   how security breaches will be addressed.
Implement the security plan for the duration of the course, revising as necessary.

12.2 <u>Security Risks</u>: Research and describe the **most common security risks associated with people; data transmission and hardware; protocols and software; and internet access**. Investigate and distinguish among the following common prevention methods to secure a network system.
   a.   Physical security
   b.   Security in network design
   c.   Network operating system security
   d.   Encryption
   e.   Authentication protocols
   f.   Wireless network security
Given various scenarios, identify the most applicable best practices to secure a network. Implement these practices and write a justification for each scenario solution. Provide supporting evidence drawing on industry standards.

12.3 <u>Firewalls</u>: Explore the **application of firewalls to secure networks**. Describe their features and functions while distinguishing between the types (e.g., software and hardware). Install and configure a basic firewall. Verbally explain each step of the implementation process as it is executed. Cite any applicable industry standards.

12.4 Fault Tolerance: **Define fault tolerance**, **distinguishing between failures and faults in a network**. Write a paper describing the following aspects that should be monitored and managed to sustain fault tolerance.
- a. Environment
- b. Power
- c. Topology and connectivity
- d. Servers
- e. Storage

Identify those aspects that are most influential on fault tolerance and justify the claim with supporting evidence. Demonstrate the application of these practices and compare the changes (if any) in the tolerance to results generated by other classmates.

13. Troubleshooting

13.1 Troubleshooting Theory: **For each network system problem** given, **apply the** following **general troubleshooting theory**.
- a. Gather information from users or the system, back up data, and document findings.
- b. Verify the problem exists and how many users are affected.
- c. Isolate the cause of the problem and generate alternative solutions.
- d. Determine whether escalation is necessary.
- e. Plan a solution and resolve the problem.
- f. Verify that the problem was resolved and prevent a future occurrence.
- g. Document findings, resolution, and preventative maintenance plan.

Following the steps of the general troubleshooting theory, select a problem to present to classmates as a case study.

13.2 Applying Troubleshooting Theory: For a given assignment related to the following common problems, **follow the troubleshooting theory using appropriate hardware and software tools** (e.g., cable tester, butt set, multimeter, protocol analyzer, throughput testers, connectivity software, etc.).
- a. Wireless problems (e.g., interference, signal strength, configurations, latency)
- b. Router and switch problems (e.g., switching loop, bad cables, port configuration)
- c. Physical connectivity problems (e.g., connectors, wiring, split cables, cable placement)

Identify the problem(s) and document the findings and resolution. Include an explanation of the common symptoms, diagnostic procedures, and specific tools used that led to the problem resolution.

Standards Alignment Notes

*References to other standards include:
- P21: Partnership for 21st Century Skills [Framework for 21st Century Learning](#)
  - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.