Maryland
STATE DEPARTMENT OF EDUCATION

Program of Study Guide: Networking Systems - DRAFT

Comprehensive guidelines and course standards for the Network Systems pathway

Office of College and Career Pathways

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MARYLAND STATE DEPARTMENT OF EDUCATION

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Table of Contents

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Purpose

The purpose of this document is to communicate the required Career and Technical Education (CTE) academic standards for the Networking Program of Study. The academic standards in this document are theoretical and performance based. The standards contain content from multiple state departments of education, the College Board, and the Computer Science Teachers Association (CSTA) and have been reviewed and vetted by members of the Maryland business and industry community.

In addition to academic standards, the Maryland State Department of Education (MSDE) has incorporated into this document Labor Market Information (LMI) definitions and explanations for the Program of Study; program aligned Industry Recognized Credentials; and Work-Based Learning resources and requirements by course level.

This document is intended for use by educational administrators and practitioners. A similar document is available for each state-approved CTE Program of Study.

Standards Sources

The following sources collectively support a progression of standards from foundational to advanced networking concepts in a high school context, preparing students for industry-aligned certifications like CompTIA Network+ and providing them with the necessary knowledge and skills for career readiness in networking fields.

1. **CompTIA Network+ Certification Exam Objectives**
   A. **Description:** The CompTIA Network+ objectives provide a detailed breakdown of required knowledge and skills for entry-level network professionals, covering networking fundamentals, infrastructure, security, and troubleshooting.
   B. **Use:** These objectives form the basis for both foundational (Network I) and advanced (Network II) networking standards, guiding skills progression.
   C. **Source:** CompTIA Network+ Exam Objectives

2. **NICE (National Initiative for Cybersecurity Education) Cybersecurity Workforce Framework**
   A. **Description:** The NICE Framework outlines cybersecurity roles, knowledge, and skills necessary for a variety of career paths, with specific areas like Network Services and Infrastructure and Interconnection relevant to networking courses.
   B. **Use:** Provides a national standard for networking and security skills, helpful for aligning high school networking courses with cybersecurity career pathways.
   C. **Source:** NICE Cybersecurity Workforce Framework

3. **ISTE (International Society for Technology in Education) Standards for Students**
   A. **Description:** ISTE standards focus on digital skills, including computational thinking and digital citizenship, which are relevant to the knowledge and ethical use of networks.
   B. **Use:** These standards emphasize student skills in problem-solving, computational thinking, and responsible technology use, supporting a foundational understanding of networking concepts in education.
   C. **Source:** ISTE Standards for Students

4. **Cisco Networking Academy Course Materials**
   A. **Description:** Cisco Networking Academy's curriculum offers robust materials that cover a range of networking topics from introductory to advanced levels, including hands-on labs, assessments, and simulations.
   B. **Use:** Cisco's introductory courses align well with Networking I, while advanced topics in routing, switching, and security are applicable for Networking II.
   C. **Source:** Cisco Networking Academy

5. **TestOut Network Pro Course**
   A. **Description:** TestOut's Network Pro course covers foundational and advanced networking skills, designed to align with the CompTIA Network+ objectives and incorporating hands-on labs.
   B. **Use:** TestOut provides an interactive curriculum that supports learning objectives for both Networking I and II, with advanced labs focused on security, access control, and troubleshooting for Networking II.
   C. **Source:** TestOut Network Pro

6. **Open Networking Foundation (ONF) Resources**
   A. **Description:** ONF offers resources on emerging networking technologies like Software Defined Networking (SDN) and network virtualization, topics relevant to more advanced networking courses.
   B. **Use:** These resources support advanced concepts in Networking II, particularly in virtualization, cloud networking, and SDN.
   C. **Source:** Open Networking Foundation

7. **AWS Academy and Google Cloud Training**
   A. **Description:** Both AWS and Google Cloud provide introductory cloud networking and infrastructure courses that include virtual network setup, VPCs, and cloud security.
   B. **Use:** Cloud networking is crucial in Networking II as it helps students understand virtual and hybrid networks, especially in cloud-integrated environments.
   C. **Source:** AWS Academy and Google Cloud Training

Course Descriptions

Course Level	Course Information	Description
Required Core: Course 1	Networking I SCED: <XX> Grades: 9-12 Prerequisite: None Credit: 1	Networking I introduces students to the fundamentals of computer networks, covering LAN/WAN operation, IP addressing, switching, routing, and network security. The course emphasizes hands-on skills with modern technologies, including Ethernet, VLANs, IPv6, and cybersecurity practices. Students will also explore career pathways in IT, develop employability skills, and integrate academic concepts into practical networking scenarios, preparing for certifications like CompTIA A+.
Required Core: Course 2	Networking II SCED: <XX> Grades: 10-12 Prerequisite: Networking I Credit: 1	Networking II builds upon foundational networking skills by introducing students to intermediate-level concepts essential for managing and troubleshooting networks in business environments. This course focuses on advanced IP addressing, routing protocols, network security, and troubleshooting techniques and equips students with skills to pursue certifications like CompTIA Network+
Optional Flex: Course 1	Networking III SCED: <XX> Grades: 11-12 Prerequisite: Networking I and II Credit: 1	Networking III is designed to expand students' understanding of advanced network security, wireless technologies, and emerging networking trends. Building on the knowledge from Networking I and II, students will learn to implement advanced security protocols, secure wireless networks, and work with cutting-edge technologies such as IoT and SDN (Software-Defined Networking).
Optional Flex: Course 2	Career Connected Learning I SCED: <XX> Grades: 11-12 Prerequisite: Computer Programming II Credit: 1	This flexible, work-based learning course introduces students to real-world applications of classroom knowledge and technical skills through on-the-job experiences and reflective practice. Students engage in career exploration, skill development, and professional networking by participating in youth apprenticeships, registered apprenticeships, pre-apprenticeships, internships, capstone projects, or

		other approved career-connected opportunities. Variable credit (1–3) accommodates the required on-the-job training hours and related instruction. By integrating industry standards, employability skills, and personalized learning goals, Career Connected Learning I equips students to make informed career decisions, develop a professional portfolio, and build a strong foundation for success in postsecondary education, training, or the workforce.
Optional Flex: Course 3	Career Connected Learning II SCED: <XX> Grades: 11-12 Prerequisite: Career Connected Learning I Credit: 1	Building on the foundational experiences of Career Connected Learning I, this advanced work-based learning course provides students with deeper on-the-job practice, leadership opportunities, and refined career exploration. Students continue to enhance their technical and professional skills, expanding their industry networks and aligning personal goals with evolving career interests. Variable credit (1–3) remains aligned with the required training hours and related instruction. Through elevated responsibilities and skill application, Career Connected Learning II prepares students to confidently transition into higher-level postsecondary programs, apprenticeships, or the workforce.

Dual Enrollment and Career Connected Learning Experiences Must be Aligned to the CTE Core.

Industry-Recognized Credentials and Work-Based Learning

Industry-Recognized Credentials – The standards in this document are aligned to the following certifications:		
By the end of Networking I: CompTIA A+ **By the end of Networking II:** CompTIA Network + **Optional Credentials (via the Flex Course options):** CompTIA Security +, Cisco 100-490 RSTECH Supporting Cisco Routing and Switching Network Devices, Cisco CCNA 200-301 Implementing and Administering Cisco Solutions		
Work-Based Learning Examples and Resources		
Networking I: **Career Awareness**	**Networking II:** **Career Preparation**	**Flex Courses:** **Career Preparation**
• Industry Visits • Guest Speakers • Participation in Career and Technical Student Organizations • Postsecondary Visits – Program Specific Site Tours • Mock Interviews	• All of Career Awareness plus the following: • Job Shadow • Paid and Unpaid Internships	• Paid and Unpaid Internships • Apprenticeships

Labor Market Information: Definitions and Data

Labor market information (LMI) plays a crucial role in shaping Career and Technical Education (CTE) programs by providing insights into industry demands, employment trends, and skills gaps. This data helps education leaders assess the viability of existing programs and identify opportunities for new offerings. By aligning CTE programs with real-time labor market needs, schools can better prepare students for in-demand careers and ensure that resources are effectively utilized to support pathways that lead to high-quality, sustainable employment.

Standard Occupational Code (SOC) and Aligned Industry:

Indicator	Definition	Pathway Labor Market Data
High Wage[1]	Those occupations that have a 25th percentile wage equal to or greater than the most recent MIT Living Wage Index for one adult in the state of Maryland, and/or leads to a position that pays at least the median hourly or annual wage for the DC-VA-MD-WV Metropolitan Statistical Area (MSA). *Note: A 25th percentile hourly wage of $24.74 or greater is required to meet this definition.*	**Standard Occupational Code:** 15-1244: Network and Computer Systems Administrators **Hourly Wage/Annual Salary:** 25th Percentile: $25.89 / $53,851.00 50th Percentile: $51.78 / $107,702.00 75th Percentile: $77.67 / $161,554.00
High Skill	Those occupations located within the DC-VA-MD-WV Metropolitan Statistical Area (MSA) with the following education or training requirements: completion of an apprenticeship program; completion of an industry-recognized certification or credential; associate's degree, bachelor's degree, or higher.	**Typical Entry-Level Education:** Some employers require a post-secondary certificate or an associate's degree. However, network and computer systems administrators typically need bachelor's degree in computer and information technology or a related field, such as engineering.
In-Demand	Annual growth plus replacement, across all Maryland occupations, is 405 openings between 2024-2029.	**Annual Openings:**

[1] Living Wage Calculator: https://livingwage.mit.edu/states/24

Labor Market Information Data Source

Lightcast Q4 2024 Data Set. Lightcast occupation employment data are based on final Lightcast industry data and final Lightcast staffing patterns. Wage estimates are based on Occupational Employment Statistics (QCEW and Non-QCEW Employees classes of worker) and the American Community Survey (Self-Employed and Extended Proprietors). Occupational wage estimates are also affected by county-level Lightcast earnings by industry. Foundational data for the state of Maryland is collected and reported by the Maryland Department of Labor.

Methodology for High Wage Calculations

To combine labor market data across multiple Standard Occupational Classifications (SOCs), a weighted average approach was used to ensure accurate representation of the marketplace. Median wages for each SOC were weighted based on their respective employment levels, reflecting the relative demand for each occupation. This method ensures that occupations with higher employment contribute proportionately to the overall wage calculation. Additionally, job openings from all relevant SOCs were summed to determine the total projected demand. For example, if Mechanical Engineers account for 67% of total employment and Electrical Engineers for 33%, their respective wages are weighted accordingly, and job openings are aggregated to provide a comprehensive view of labor market opportunities. This approach delivers a balanced and accurate representation of both wages and employment demand for the program.

Methodology for In-Demand Calculations

The baseline for annual job openings, taking into account new positions and replacement positions, was determined by taking the average of all annual job openings between 2024 and 2029 across all 797 career sectors at the 5-digit SOC code level. For the 2024-2029 period, average job openings (growth + replacement) is 405.

Course Standards: Networking I

1. **GENERAL REQUIREMENTS.** This course is recommended for students in Grades 9-12, and there are no prerequisites for this course.

2. **INTRODUCTION**
   A. Career and Technical Education (CTE) instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
   B. The Digital Technology Career Cluster focuses on building linkages in IT occupations for entry level, technical, and professional careers related to the design, development, support, and management of hardware, software, multimedia, and systems integration services.
   C. The Networking Systems program of study emphasizes careers and educational pathways related to the design and implementation of computer and information networks, including local area networks (LAN), wide area networks (WAN), intranets, extranets, and other data communication systems. It covers the analysis of data processing challenges involved in developing and enhancing computer network systems.
   D. Networking I introduces students to the fundamentals of computer networks, covering LAN/WAN operation, IP addressing, switching, routing, and network security. The course emphasizes hands-on skills with modern technologies, including Ethernet, VLANs, IPv6, and cybersecurity practices. Students will also explore career pathways in IT, develop employability skills, and integrate academic concepts into practical networking scenarios, preparing for certifications like CompTIA A+.
   E. Students will participate in at least two Career-Connected Education and Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.
   F. Students are encouraged to participate in extended learning experiences through aligned Career and Technical Student Organizations (CTSOs). CTSOs are a cocurricular requirement in the Carl D. Perkins Act, and alignment to CTSO activities is an expectation for CTE programs in the state of Maryland.

3. **KNOWLEDGE AND SKILLS**
   A. The student demonstrates the necessary skills for career development, maintenance of employability, and successful completion of course outcomes. The student is expected to:
      1. Identify and demonstrate positive work behaviors that enhance employability and job advancement, such as regular attendance, promptness, proper attire, maintenance of a clean and safe work environment, and pride in work.
      2. Demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, active listening, and a willingness to learn.
      3. Employ effective reading, writing, and technical documentation skills.
      4. Solve problems using critical thinking techniques and structured troubleshooting methodologies.
      5. Demonstrate leadership skills and collaborate effectively as a team member.
      6. Implement safety procedures, including proper handling of hardware and following cybersecurity guidelines.
      7. Exhibit an understanding of legal and ethical responsibilities in the IT field, following data privacy laws and best practices for security.

8. Demonstrate time-management skills and the ability to prioritize tasks in a technical setting.

B. The student identifies various career pathways in the information technology field. The student is expected to:

1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles in IT networking.
2. Create a professional resume and portfolio that reflect skills, projects, certifications, and recommendations.
3. Demonstrate effective interview skills for roles in IT and networking.

C. The student develops technology and digital literacy skills. The student is expected to:

1. Use technology as a tool for research, organization, communication, and problem-solving.
2. Use digital tools, including computers, mobile devices, collaboration platforms, and cloud services, to access, manage, and create information.
3. Demonstrate proficiency in using emerging and industry-standard technologies, including virtualization tools, network management software, and cybersecurity applications.
4. Understand ethical and legal considerations for technology use, including the principles of data protection, copyright, and responsible technology use.

D. The student integrates core academic skills into networking practices. The student is expected to:

1. Demonstrate the use of clear communication techniques, both written and verbal, that are consistent with industry standards.
2. Apply mathematical concepts such as binary conversion, subnetting, and data rate calculations in network configuration and troubleshooting.
3. Use scientific principles, such as signal properties and electromagnetic interference, in network design and troubleshooting.

E. The student understands and operates data networks. The student is expected to:

1. Describe the functions and characteristics of various network devices, including routers, switches, firewalls, access points, and network interface cards (NICs).
2. Identify components required for modern network and Internet communication, including cables, connectors, and transceivers for both wired and wireless networks.
3. Select the correct network components based on performance requirements, scalability, and cost considerations.
4. Explain the operation of the OSI and TCP/IP models and associated protocols, including HTTP/HTTPS, DNS, DHCP, and SNMP.
5. Discuss the impact of evolving networking applications, such as cloud computing, Voice over IP (VoIP), streaming services, and Internet of Things (IoT), on network infrastructure.
6. Interpret network diagrams and documentation to understand network layout and connectivity.
7. Analyze the routing path between hosts and identify potential network issues using tools like traceroute and packet sniffers.
8. Differentiate between Local Area Networks (LANs), Wide Area Networks (WANs), Metropolitan Area Networks (MANs), and Software-Defined Networks (SDNs).

F. The student configures, verifies, and troubleshoots network switching. The student is expected to:

1. Select appropriate cabling and connectors for different network scenarios, including fiber optics, twisted pair (Cat 5e, Cat 6, Cat 6a), and coaxial cables.
2. Explain Ethernet standards, network topologies, and switching concepts such as VLANs, spanning tree protocol (STP), and MAC address table.
3. Configure switches to segment networks, manage traffic, and ensure redundancy.
4. Perform switch configuration tasks, including setting up Virtual Local Area Networks (VLANs), trunking, and port security.
5. Use network monitoring tools to verify switch operation and status, troubleshoot connectivity, and diagnose faults.
6. Implement security measures on switches, such as access control lists (ACLs), port-based security, and 802.1X authentication.
7. Diagnose and resolve switch-related issues such as incorrect VLAN assignments, misconfigured trunk links, and spanning tree problems.

G. The student implements Internet Protocol (IP) addressing schemes and services for networks. The student is expected to:

1. Explain the purpose and structure of IP addressing, including IPv4, IPv6, and subnetting.
2. Compare IPv4 and IPv6, including differences in address structure, configuration, and migration considerations.
3. Design and apply IP addressing schemes that include subnetting, variable-length subnet masks (VLSM), and address allocation.
4. Configure and verify IP addresses for hosts, servers, and networking devices in both IPv4 and IPv6 environments.
5. Explain the functions of Network Address Translation (NAT), Port Address Translation (PAT), and IPsec.
6. Configure Domain Name System (DNS) and Dynamic Host Configuration Protocol (DHCP) for dynamic IP management.
7. Explain public and private IP address usage, and describe strategies for IPv4 address exhaustion mitigation, such as IPv6 transition.
8. Troubleshoot IP addressing issues using tools like ipconfig, ping, and Wireshark.

H. The student configures, verifies, and troubleshoots routing. The student is expected to:

1. Describe routing principles, including static and dynamic routing, distance-vector, and link-state protocols.
2. Explain the role of routing protocols such as OSPF, EIGRP, RIP, and BGP in network communication.
3. Configure routers for inter-VLAN routing, network segmentation, and remote access.
4. Verify network configuration using command-line tools (ping, traceroute, SSH) and network diagnostic software.
5. Implement secure router configurations, including firewall rules, VPNs, and encryption.
6. Manage router firmware and configuration files, including updates, backups, and restores.
7. Implement routing security features such as route filtering, authentication, and access lists.
8. Troubleshoot routing issues related to network misconfiguration, hardware failures, and incorrect access controls.

I. The student understands and implements network security measures. The student is expected to:

1. Apply network security principles, including firewalls, intrusion prevention systems (IPS), and encryption.
2. Configure wireless network security protocols, such as WPA3, and implement secure wireless settings.
3. Identify and mitigate common security threats, including malware, phishing, DDoS attacks, and social engineering.
4. Conduct vulnerability assessments and implement appropriate security measures.
5. Understand compliance standards such as GDPR, HIPAA, and PCI-DSS, and their impact on network security.
6. Use logging and monitoring tools to detect and respond to security incidents.
7. Implement data loss prevention (DLP) strategies to protect sensitive information.

Course Standards: Networking II

1. **GENERAL REQUIREMENTS.** This course is recommended for students in Grades 10-12, and Networking I is the prerequisite.

2. **INTRODUCTION**
   A. Career and Technical Education (CTE) instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
   B. The Digital Technology Career Cluster focuses on building linkages in IT occupations for entry level, technical, and professional careers related to the design, development, support, and management of hardware, software, multimedia, and systems integration services.
   C. The Networking Systems program of study emphasizes careers and educational pathways related to the design and implementation of computer and information networks, including local area networks (LAN), wide area networks (WAN), intranets, extranets, and other data communication systems. It covers the analysis of data processing challenges involved in developing and enhancing computer network systems.
   D. Networking II focuses on deeper networking concepts, advanced configurations, security configuration, and troubleshooting skills. introduces students to advanced networking concepts, IP routing, cloud networking, and troubleshooting in diverse network environments.
   E. Students will participate in at least two Career-Connected Education and Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.
   F. Students are encouraged to participate in extended learning experiences through aligned Career and Technical Student Organizations (CTSOs). CTSOs are a cocurricular requirement in the Carl D. Perkins Act, and alignment to CTSO activities is an expectation for CTE programs in the state of Maryland.

3. **KNOWLEDGE AND SKILLS**
   A. The student demonstrates the necessary skills for career development, maintenance of employability, and successful completion of course outcomes. The student is expected to:
      1. Identify and demonstrate positive work behaviors that enhance employability and job advancement, such as regular attendance, promptness, proper attire, maintenance of a clean and safe work environment, and pride in work.
      2. Demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, active listening, and a willingness to learn.
      3. Employ effective reading, writing, and technical documentation skills.
      4. Solve problems using critical thinking techniques and structured troubleshooting methodologies.
      5. Demonstrate leadership skills and collaborate effectively as a team member.
      6. Implement safety procedures, including proper handling of hardware and following cybersecurity guidelines.
      7. Exhibit an understanding of legal and ethical responsibilities in the IT field, following data privacy laws and best practices for security.
      8. Demonstrate time-management skills and the ability to prioritize tasks in a technical setting.

B. The student identifies various career pathways in the information technology field. The student is expected to:

1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles in IT networking.
2. Create a professional resume and portfolio that reflect skills, projects, certifications, and recommendations.
3. Demonstrate effective interview skills for roles in IT and networking.

C. The student develops technology and digital literacy skills. The student is expected to:

1. Use technology as a tool for research, organization, communication, and problem-solving.
2. Utilize digital tools, including computers, mobile devices, collaboration platforms, and cloud services, to access, manage, and create information.
3. Demonstrate proficiency in using emerging and industry-standard technologies, including virtualization tools, network management software, and cybersecurity applications.
4. Understand ethical and legal considerations for technology use, including the principles of data protection, copyright, and responsible technology use.

D. The student integrates core academic skills into networking practices. The student is expected to:

1. Demonstrate the use of clear communication techniques, both written and verbal, that are consistent with industry standards.
2. Apply mathematical concepts such as binary conversion, subnetting, and data rate calculations in network configuration and troubleshooting.
3. Use scientific principles, such as signal properties and electromagnetic interference, in network design and troubleshooting.

E. Students will develop skills to design and implement advanced network architectures, including hybrid and enterprise networks. The student is expected to:

1. Explain and design network segmentation (VLANs, subnets) and use cases for network scalability.
2. Differentiate and configure WAN and remote access technologies (MPLS, VPNs, leased lines).
3. Create network diagrams that include hybrid and cloud-based network components, considering redundancy and load balancing.

F. Students will understand and apply advanced IP addressing schemes and routing protocols to support complex network infrastructure. The student is expected to:

1. Implement IPv6 addressing, subnetting, and address management in a dual-stack environment.
2. Configure and analyze dynamic routing protocols (RIP, OSPF, EIGRP) and understand their differences.
3. Troubleshoot advanced routing issues using routing tables and diagnostic tools.

G. Students will apply security principles to protect networks, emphasizing access control and encryption. The student is expected to:

1. Configure and manage firewall settings, ACLs (Access Control Lists), and VPNs for secure remote access.

2. Understand and apply security protocols like IPSec and SSL/TLS in network communications.
3. Identify and mitigate network security risks, including those associated with IoT and cloud networks.

H. Students will perform advanced network management, including monitoring and maintaining network performance using network management protocols and tools. The student is expected to:

1. Use SNMP (Simple Network Management Protocol) and NetFlow for network performance monitoring and data collection.
2. Implement network baselining and alerting to identify and resolve performance issues.
3. Apply change management protocols and document network configurations and incidents for continuity.

I. Students will understand and configure virtual network infrastructure and explain how cloud networking principles integrate with traditional networks. The student is expected to:

1. Configure virtual LANs (VLANs) and understand virtual private networks (VPNs) and SD-WAN (Software-Defined Wide Area Networking).
2. Describe the principles of cloud service models (IaaS, PaaS, SaaS) and their network requirements.
3. Explain and demonstrate the configuration of virtualized network components in a lab setting.

J. Students will refine their troubleshooting skills to address complex networking issues across multi-layer network architectures. The student is expected to:

1. Use advanced diagnostic tools and commands (traceroute, netstat, Wireshark) to analyze network issues.
2. Develop and follow a systematic approach for resolving connectivity and performance issues in complex network environments.
3. Troubleshoot common issues in cloud-based, hybrid, and virtual networks.

Course Standards: Networking III

1. **GENERAL REQUIREMENTS.** This course is recommended for students in Grades 11-12, and Networking I and II are the prerequisites.

2. **INTRODUCTION**
   A. Career and Technical Education (CTE) instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
   B. The Digital Technology Career Cluster focuses on building linkages in IT occupations for entry level, technical, and professional careers related to the design, development, support, and management of hardware, software, multimedia, and systems integration services.
   C. The Networking Systems program of study emphasizes careers and educational pathways related to the design and implementation of computer and information networks, including local area networks (LAN), wide area networks (WAN), intranets, extranets, and other data communication systems. It covers the analysis of data processing challenges involved in developing and enhancing computer network systems.
   D. Networking III advances students' knowledge of network infrastructure by focusing on secure network design, advanced routing and switching, and hybrid network models. Students will gain hands-on experience with virtualized networking, cloud integration, and advanced security protocols, preparing them to manage and secure complex networks in business and enterprise environments.
   E. Students will participate in at least two Career-Connected Education and Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.
   F. Students are encouraged to participate in extended learning experiences through aligned Career and Technical Student Organizations (CTSOs). CTSOs are a cocurricular requirement in the Carl D. Perkins Act, and alignment to CTSO activities is an expectation for CTE programs in the state of Maryland.

3. **KNOWLEDGE AND SKILLS**
   A. The student demonstrates the necessary skills for career development, maintenance of employability, and successful completion of course outcomes. The student is expected to:
      1. Identify and demonstrate positive work behaviors that enhance employability and job advancement, such as regular attendance, promptness, proper attire, maintenance of a clean and safe work environment, and pride in work.
      2. Demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, active listening, and a willingness to learn.
      3. Employ effective reading, writing, and technical documentation skills.
      4. Solve problems using critical thinking techniques and structured troubleshooting methodologies.
      5. Demonstrate leadership skills and collaborate effectively as a team member.
      6. Implement safety procedures, including proper handling of hardware and following cybersecurity guidelines.
      7. Exhibit an understanding of legal and ethical responsibilities in the IT field, following data privacy laws and best practices for security.

8. Demonstrate time-management skills and the ability to prioritize tasks in a technical setting.

B. The student identifies various career pathways in the information technology field. The student is expected to:

1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles in IT networking.
2. Create a professional resume and portfolio that reflect skills, projects, certifications, and recommendations.
3. Demonstrate effective interview skills for roles in IT and networking.

C. The student develops technology and digital literacy skills. The student is expected to:

1. Use technology as a tool for research, organization, communication, and problem-solving.
2. Use digital tools, including computers, mobile devices, collaboration platforms, and cloud services, to access, manage, and create information.
3. Demonstrate proficiency in using emerging and industry-standard technologies, including virtualization tools, network management software, and cybersecurity applications.
4. Understand ethical and legal considerations for technology use, including the principles of data protection, copyright, and responsible technology use.

D. The student integrates core academic skills into networking practices. The student is expected to:

1. Demonstrate the use of clear communication techniques, both written and verbal, that are consistent with industry standards.
2. Apply mathematical concepts such as binary conversion, subnetting, and data rate calculations in network configuration and troubleshooting.
3. Use scientific principles, such as signal properties and electromagnetic interference, in network design and troubleshooting.

E. The student applies advanced security principles to network design and operation, preparing for the CompTIA Security+ certification. The student is expected to:

1. Identify and configure secure network access policies, such as multi-factor authentication (MFA) and role-based access controls (RBAC).
2. Implement and manage security features on network devices, including firewalls, intrusion detection systems (IDS), and intrusion prevention systems (IPS).
3. Conduct risk assessments and develop mitigation strategies for common threats like malware, ransomware, and unauthorized access.
4. Explain and apply cryptographic protocols (e.g., TLS, SSL, IPsec) and encryption standards for data protection.
5. Identify compliance requirements for network security, including GDPR, HIPAA, and PCI-DSS, and apply best practices for maintaining compliance.
6. Use security information and event management (SIEM) tools for proactive threat monitoring and response.

F. The student demonstrates advanced routing and switching techniques suitable for complex network infrastructures, aligning with the Cisco 100-490 RSTECH and CCNA certifications. The student is expected to:

1. Implement and troubleshoot inter-VLAN routing and VLAN trunking protocols for segmented networks.
2. Describe and configure advanced dynamic routing protocols (e.g., EIGRP, OSPF) for efficient data flow across networks.
3. Configure high-availability solutions, such as load balancing and failover, to ensure network redundancy and reliability.
4. Use advanced Layer 2 protocols, including spanning tree protocol (STP) variations (e.g., RSTP) and VLAN tagging.
5. Perform network diagnostics and troubleshooting using Cisco-specific tools (e.g., Cisco Packet Tracer).

G. The student develops network architectures that integrate virtualized environments, cloud services, and hybrid network solutions. The student is expected to:

1. Describe and configure hybrid network models, integrating both on-premise and cloud-based components.
2. Implement virtual networking concepts, such as virtual LANs (VLANs), SD-WAN, and VPNs, for secure and flexible network access.
3. Use cloud-based services (e.g., IaaS, SaaS, PaaS) in network design, understanding their security implications and requirements.
4. Explain the role of software-defined networking (SDN) and network functions virtualization (NFV) in modern network architectures.

Course Standards: Career Connected Learning I and II

Career connected learning is an educational approach that integrates classroom instruction with real-world experiences, enabling high school students to explore potential careers and develop relevant skills before graduation. By participating in work-based learning opportunities—such as apprenticeships, internships, capstone projects, and school-based enterprises—students apply academic concepts in authentic settings, gain practical industry knowledge, and build professional networks. This hands-on engagement helps students connect their studies to future career paths, strengthens their problem-solving and communication skills, and supports a smoother transition into college, vocational programs, or the workforce.

All Career and Technical Education Programs of Study include aspects of work-based learning, and almost all of the programs include two Career Connected Learning (CCL) courses. Below are the course descriptions for CCL I and CCL II. The CCL standards can be found via this link: