Arkansas Computer Science and Computing Standards

High School Networking

2020

Arkansas Computer Science and Computing Standards for High School Networking

Introduction

The Arkansas Computer Science and Computing Initiative standards for high school courses are designed to provide understandings of concepts in computer science that are necessary for students to function in an ever-changing technological world. Through these standards, students will explore, apply, and move toward mastery in skills and concepts related to Computational Thinking and Problem Solving; Data, Information, and Security; Algorithms and Programs; Computers and Communications; and Professionalism and Impacts of Computing. These standards help students learn to accomplish tasks and solve problems independently and collaboratively. These standards give students the tools and skills needed to be successful in college and careers including computer science, computing, and other fields.

State developed pathways within the Arkansas Computer Science and Computing Initiative all begin with common year-one standards which allow for consistency across the state and all schools. These common standards address the basic knowledge and skills needed for any student entering a technology-based field.

The course standards have been grouped into one-credit (typically yearly) standards to afford the classroom educator additional flexibility in their curriculum choices; however, the course codes remain based on one-half credit (typically semester). Each state-developed pathway will have three credits (six pathway specific course codes) worth of Computer Science Flex Credit (465XXX) course codes.

The Arkansas State Board of Education (SBE) does not place any prerequisites on the Arkansas Computer Science and Computing Initiative high school courses, but allows for schools to place students in any of the courses based on ability and desire. The Arkansas Department of Education (ADE) recommends that districts develop and formally adopt a written policy outlining placement protocols. Evaluation tools and placement criteria will be the responsibility of the local districts.

The SBE and ADE authorize schools to enroll students across levels in the same sections of the master schedule (a.k.a. stacking) as long as the number of students does not exceed Standards of Accreditation maximums and/or ratios and the school can reasonably assure a high-quality educational experience for all students within that section.

Implementation of the Arkansas Computer Science Standards for High School Networking begins during the 2021-2022 school year.

Course Title: Networking
Course/Unit Credit: 0.5 credit per listed course code

	Networking Year 1 - Level 1 / Level 2	**Networking Year 2 - Level 3 / Level 4**	**Networking Year 3 - Advanced**
Networking	465110 / 465120	465130 / 465140	465150 / 465160

Teacher Licensure: Please refer to the Course Code Management System (https://adedata.arkansas.gov/ccms/) for the most current licensure codes.
Grades: 9-12
Prerequisites: There are no ADE established course prerequisites for any of the Arkansas Computer Science and Computing Initiative high school courses; it is up to the local district to determine placement based on student ability.

Computer Science and Computing Practices

Students exhibit proficiency in computer science and computing through:

Communication - Students effectively communicate, using accurate and appropriate terminology, when explaining the task completion or problem solving strategies used. They recognize that creating good documentation is an ongoing and important part of the communication process.

Collaboration - Students productively work with others while ensuring multiple voices are heard and considered. They understand that diverse thoughts may lead to creative solutions and that some problems may be best solved collaboratively.

Storytelling - Students creatively combine multimedia tools, such as graphics, animations, and videos with research, writing, and oral presentations to create ethical, data-driven stories.

Professionalism - Students embrace professionalism by demonstrating skills and behaviors necessary for success in technical careers.

Ethics and Impact - Students comprehend the ramifications of actions prior to taking them. They are aware of their own digital and cyber presence and its impact on other individuals and society.

Inclusion - Students encourage diversity in the field of computer science and computing regardless of race, ethnicity, gender, or other differences.

Learning by Failure - Students reflect upon and critique their work while embracing a willingness to seek feedback and constructive instruction from teachers and peers. They utilize the feedback to continually improve current projects, educational experiences, knowledge, and confidence.

Perseverance - Students expect difficulties and persist in overcoming challenges that occur when completing tasks. They recognize making and correcting mistakes is necessary for the learning process while problem solving.

Understanding - Students recognize patterns, utilize tools, and apply problem solving strategies to build understanding, find solutions, and successfully deliver high-quality work.

Patterns - Students understand and utilize the logical structure of information through identifying patterns and creating conceptual models. They decompose complex problems into simpler modules and patterns.

Problem Solving - Students exhibit proficiency through the process of identifying and systematically solving problems. They recognize problem solving is an ongoing process.

Research - Students purposefully gather information and seek to expand their knowledge through various methods and mediums. They embrace the practice of gaining knowledge to develop novel approaches for solving problems and addressing issues they have not previously encountered, in addition to merely searching for answers.

Tools - Students evaluate and select tools to be used when completing tasks and solving problems. They understand that appropriate tools may include, but are not limited to, their mind, pencil and paper, manipulatives, software applications, programming languages, or appropriate computing devices.

Arkansas Computer Science and Computing Standards for High School Networking

Strand	Content Cluster
Computational Thinking and Problem Solving	
	1. Students will analyze and utilize problem-solving strategies.
	2. Students will analyze and utilize connections between concepts of mathematics and computer science.
Data, Information, and Security	
	3. Students will analyze and utilize data through the use of computing devices.
	4. Students will analyze and utilize concepts of cybersecurity.
Algorithms and Programs	
	5. Students will create, evaluate, and modify algorithms.
	6. Students will create programs to solve problems.
Computers and Communications	
	7. Students will analyze the utilization of computers within industry.
	8. Students will analyze communication methods and systems used to transmit information among computing devices.
	9. Students will utilize appropriate hardware and software.
Professionalism and Impacts of Computing	
	10. Students will analyze the impacts of technology and professionalism within the computing community.
	11. Students will demonstrate understanding of storytelling with data and appropriately communicate about technical information.

Understanding the Arkansas Computer Science and Computing Standards Documents:

- This Arkansas Department of Education curriculum standards document is intended to assist in district curriculum development, unit design, and to provide a uniform, comprehensive guide for instruction.
- The goal for each student is proficiency in all academic standards for the course/year in which the student is enrolled.
- The Practice Standards are intended to be habits of mind for all students and were written broadly in order to apply to all grades/levels. The Practice Standards are not content standards and are not intended to be formally assessed.
- Notes (NOTE:) and examples given (e.g.,) found within the document are not mandated by the Arkansas State Board of Education, but are provided for clarification of the standards by the Arkansas Department of Education and/or the standards drafting committee. The notes and examples given are subject to change as understandings of the standards evolve.
- Within the high school documents, the numbering for standards is read as: Course Abbreviation - Year - Content Cluster - Standard. Example: "CSPG.Y1.2.3" would be Computer Science Programming - Year 1 - Content Cluster 2 - Standard 3.
- Within the Coding Block document, the numbering for standards is read as: Course Abbreviation - Content Cluster - Standard. Example: "CSCB.1.2" would be Coding Block, Content Cluster 1, Standard 2.
- Within the K-8 Computer Science Standards documents, the numbering for standards is read as: Course Abbreviation - Grade - Content Cluster - Standard. Example: "CSK8.G1.2.3" would be K-8, Grade 1, Content Cluster 2, Standard 3
- Ancillary documents and supporting information may be released to assist in further understanding of the standards with possible classroom implementation strategies included.

"Research" and Learning

The Arkansas Department of Education Office of Computer Science recognizes that the use of the term "research" as an action verb within academic standards is not mainstream, though not unheard of, and exists as a measurable objective within other Arkansas K-12 academic standards. The members of the internal team, composed of the State Director of Computer Science and nine state-wide Computer Science Specialists, discussed this at length amongst ourselves and with many committee members. While there existed varying opinions for various reasons, the internal team opted to keep "research" as an action verb within the standards for the following reasons:

1. The internal team believes that this use of "research" and the skill-building activities students will undertake while performing said research will produce students that have a skillset which industry representatives have identified as missing from workers entering technical job fields.
2. As the field of Computer Science and Computing is ever changing and growing, professionals and students within this field must conduct informal research on an almost daily basis to maintain relevant knowledge and skills.
3. The use of "research" within this document does not determine classroom implementation; however, it is used to indicate that the student should take individual and active efforts to seek out knowledge to develop novel approaches for solving problems and addressing issues they have not previously encountered, in addition to merely searching for answers.
4. The use of "research" should not infer that a student should be required to do an extensive qualitative or quantitative research project from the use of "research" anywhere in this document; however, a more formal research project is not prohibited if the teacher feels it is appropriate.

Strand: Computational Thinking and Problem Solving

Content Cluster 1: Students will analyze and utilize problem-solving strategies.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSNT.Y1.1.1 Leverage problem-solving strategies to solve problems of level-appropriate complexity	CSNT.Y2.1.1 Leverage problem-solving strategies to solve problems of level-appropriate complexity	CSNT.Y3.1.1 Leverage problem-solving strategies to solve problems of level-appropriate complexity
NOTE: Problem-solving strategies that encompass computational thinking include, but are not limited to, abstraction, algorithm development, decomposition, and pattern recognition.		
CSNT.Y1.1.2 Analyze and utilize multiple representations of problem-solving logic used to solve problems of appropriate complexity	CSNT.Y2.1.2 Analyze and utilize multiple representations of problem-solving logic used to solve problems of appropriate complexity	CSNT.Y3.1.2 Analyze and utilize multiple representations of problem-solving logic used to solve problems of appropriate complexity
NOTE: Representations may include, but are not limited to, backlog, decision matrix, design brief, documentation, fault tree analysis, flowchart, pseudocode, and sprints		
CSNT.Y1.1.3 Analyze and utilize collaborative methods in problem solving of level-appropriate complexity	CSNT.Y2.1.3 Analyze and utilize collaborative methods in problem solving of level-appropriate complexity	CSNT.Y3.1.3 Analyze and utilize collaborative methods in problem solving of level-appropriate complexity
NOTE: Collaborative methods may include, but are not limited to, distributive (divide and conquer), paired programming, and redundant parallel.		
CSNT.Y1.1.4 Analyze and utilize level-appropriate troubleshooting strategies for hardware and software	CSNT.Y2.1.4 Analyze and utilize level-appropriate troubleshooting strategies for hardware and software CSNT Y2: Hardware includes networking devices and servers	CSNT.Y3.1.4 Analyze and utilize level-appropriate troubleshooting strategies for hardware and software, including networking devices and servers

Strand: Computational Thinking and Problem Solving

Content Cluster 2: Students will analyze and utilize connections between concepts of mathematics and computer science.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSNT.Y1.2.1 Interpret relational and logical expressions of level-appropriate complexity using comparison and Boolean operators	CSNT.Y2.2.1 Construct and evaluate expressions using relational and logical operators of level-appropriate complexity via command line, packet filters, protocol analyzers, or scripts	CSNT.Y3.2.1 Construct and evaluate expressions of level-appropriate complexity using relational and logical operators via command line, packet filters, protocol analyzers, or scripts
NOTE: Boolean operators include AND, OR, NOT, and XOR. Comparison operators may include, but are not limited to, <, >, and !=.		
CSNT.Y1.2.2 Classify the types of information that can be stored as variables and analyze the appropriateness of each (e.g., Booleans, characters, integers, floating points, strings)	CSNT.Y2.2.2 Summarize how data is stored and passed through a network (e.g., alternate data streams, data frames, data packets) and identify common issues and vulnerabilities (e.g., ping of death)	CSNT.Y3.2.2 Analyze how data is stored and passed through a network (e.g., alternate data streams, data frames, data packets) and identify common issues and vulnerabilities (e.g., ping of death)
CSNT.Y1.2.3 Analyze how computer science concepts relate to the field of mathematics	CSNT.Y2.2.3 Analyze and utilize level-appropriate pathfinding algorithms and apply graph theory to network routing	CSNT.Y3.2.3 Analyze and utilize pathfinding algorithms and apply graph theory to network routing
NOTE: Concepts may include, but are not limited to, different division methods (e.g., integer, long, modular), random number generation, domain, maximum, mean, minimum, mode, and range.		
CSNT.Y1.2.4 Discuss and apply concepts of abstraction	CSNT.Y2.2.4 Analyze and utilize concepts of abstraction as modeling and abstraction as encapsulation CSNT Y2: Analyze and utilize concepts of abstraction as modeling and abstraction as encapsulation using Network Address Translation (NAT)	CSNT.Y3.2.4 Utilize the concepts of abstraction as modeling and encapsulation
NOTE: Abstraction is the process of reducing information and detail to facilitate focus on relevant concepts and functionality (displaying only essential information while hiding the details).		

<table>
<tr><td colspan="3">NOTE CSNT Y2-Y3:
Virtualization may include, but is not limited to, network functions virtualization (NFV), network virtualization, software-defined networking (SDN), virtual desktop infrastructure (VDI), and virtual private networks (VPN).
Abstraction may include, but is not limited to, cloud, hierarchies and gateways, Open Systems Interconnection (OSI) and Transmission Control Protocol (TCP) networking models, Port Address Translation (PAT), spanning tree, static and dynamic NAT, and virtualization technologies.</td></tr>
<tr><td>CSNT.Y1.2.5
Perform operations of level-appropriate complexity with binary, decimal, and hexadecimal numbers</td><td>CSNT.Y2.2.5
Perform operations of level-appropriate complexity with binary, octal, decimal, and hexadecimal numbers

CSNT Y2:
Perform operations of level-appropriate complexity with subnetting and Classless Inter-Domain Routing (CIDR) notation, Internet Protocol version 4 (IPv4) and Internet Protocol version 6 (IPv6) addressing</td><td>CSNT.Y3.2.5
Perform operations of level-appropriate complexity with binary, octal, decimal, and hexadecimal numbers (e.g., data packets, payloads, subnet masking)</td></tr>
<tr><td colspan="3">NOTE:
Operations may include, but are not limited to, addition, subtraction, multiplication, division, and conversion.</td></tr>
<tr><td>CSNT.Y1.2.6
Demonstrate operator precedence in expressions and statements</td><td>CSNT.Y2.2.6
Demonstrate operator precedence in expressions and statements</td><td>CSNT.Y3.2.6
Demonstrate operator precedence in expressions and statements (e.g., Access Control List (ACL), execution stack, firewall rules, network policies)</td></tr>
<tr><td colspan="3">NOTE:
Operators include, but are not limited to, addition, subtraction, division, modulus division, concatenation, square root, and exponentiation.
Operator precedence may include, but is not limited to, inside-out, order of operations, and the understanding that the assignment statement of “x = 1” is not the same as “1 = x.”</td></tr>
</table>

Strand: Data, Information, and Security

Content Cluster 3: Students will analyze and utilize data through the use of computing devices.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSNT.Y1.3.1 Define, store, access, and manipulate level-appropriate data (e.g., primitive, linear)	CSNT.Y2.3.1 Create programs to store, access, and manipulate level-appropriate data (e.g., structured data, objects) CSNT Y2: Identify how data moves throughout a network and analyze network traffic and track packets	CSNT.Y3.3.1 Create programs to collect and analyze data by combining multiple collection and analysis tools
NOTE: Primitive data may include, but is not limited to, Boolean, character, double, float, and integer. Linear data may include, but is not limited to, arrays, lists, strings, and vectors. Structured data may include, but is not limited to, arrays, classes, linked lists, maps, multidimensional arrays, and structs. Objects may include, but are not limited to, constructors, data members, and methods. Defining, storing, and accessing may include, but are not limited to, type declaration, variables, and modifiers (e.g., final, pass-by-value, pass-by-reference parameters, private, protected, public). Manipulating data may include, but is not limited to, arranging (e.g., queuing, stacking), bit manipulation, casting, rearranging, and sorting.		
CSNT.Y1.3.2 Define and discuss different examples of level-appropriate quantitative and qualitative data	CSNT.Y2.3.2 Define and discuss different examples of level-appropriate quantitative and qualitative data	*Continuation of this standard is not specifically included or excluded*
This standard is not specifically required until Year 2	CSNT.Y2.3.3 Research, discuss, and create level-appropriate programs to model and simulate probabilistic and real-world scenarios	CSNT.Y3.3.3 Predict the minimum specifications for a future network using models and simulations
NOTE: Probabilistic scenarios may include, but are not limited to, flipping a coin, random walkers, and rolling dice. Real-world scenarios may include, but are not limited to, city population and predator-prey. NOTE CSNT Y2-Y3: Networking programs may include, but are not limited to, network protocol analyzer (e.g., Wireshark), packet analyzer (e.g., tcpdump), packet capture (PCAP), packet tracer, virtualization (e.g., virtual local area network (VLAN) to simulate real-world network operations and malfunction).		

CSNT.Y1.3.4 Analyze, utilize, and visually represent level-appropriate data	CSNT.Y2.3.4 Analyze, utilize, and visually represent level-appropriate static and dynamic data CSNT Y2: Create visual representations of past and present network conditions using data collection tools and utilities	CSNT.Y3.3.4 Analyze network performance and reliability using student-created visual representations of past and present data
NOTE: Visual representation tools may include, but are not limited to, analytics reports, graphical representations, programming language libraries, and spreadsheets. Dynamic data may include, but is not limited to, network traffic, real-time weather data, sensor statuses, stock market valuations, and system status. NOTE CSNT Y2-Y3: Networking data collection tools may include, but are not limited to, network mappers (e.g., Nmap, Zenmap), network protocol analyzers (e.g., Wireshark, SolarWinds), and packet analyzers (e.g., tcpdump).		
CSNT.Y1.3.5 Perform level-appropriate data analysis using computing tools	CSNT.Y2.3.5 Perform level-appropriate data analysis using computing tools	CSNT.Y3.3.5 Analyze level-appropriate data to predict behaviors and patterns using computing tools
NOTE: Analysis may include, but is not limited to, maximum values, mean values, minimum values, ranges, and string comparisons. NOTE CSNT Y2-Y3: Identification of data includes, but is not limited to, attributes, cluster algorithms, exfiltration, intrusion detection systems (IDS) and intrusion prevention systems (IPS) logs, outliers, and statistical algorithms.		
This standard is not specifically required until Year 2	CSNT.Y2.3.6 Describe the types of metrics used to evaluate network performance (e.g., bandwidth, congestion, latency)	CSNT.Y3.3.6 Identify network performance issues and justify recommendations for resolutions

Strand: Data, Information, and Security

Content Cluster 4: Students will analyze and utilize concepts of cybersecurity.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSNT.Y1.4.1 Identify the five pillars of cybersecurity and evaluate the relevance of each pillar to computer science concepts	CSNT.Y2.4.1 Apply the five pillars of cybersecurity as applicable to level-appropriate computer science concepts CSNT Y2: Discuss implications of unauthorized access and apply network-related digital and physical methods to ensure consistent, reliable, and secure data	CSNT.Y3.4.1 Design a network that incorporates the five pillars of cybersecurity and justify methods used in implementation (e.g., network device hardening)
NOTE: Additional concepts and key terms of the five pillars of cybersecurity (confidentiality, integrity, availability, non-repudiation, and authentication) may include, but are not limited to, access control paradigms, accountability, authorization, least-privilege, and need-to-know.		
CSNT.Y1.4.2 Research and describe different roles within the hacking community (e.g., white hat, black hat, gray hat hacking), including positive and negative motivations, significant impacts, and social stereotypes	CSNT.Y2.4.2 Explore ethical and legal implications of using digital, physical, or social tools and techniques to access or manipulate a computer network (e.g., multi-factor authentication, physical security devices, physical token, Telecommunications Electronics Materials Protected from Emanating Spurious Transmissions (TEMPEST) standards)	CSNT.Y3.4.2 Perform and present a network vulnerabilities assessment
NOTE: White hat hacking may include, but is not limited to, bug bounty programs and contracted penetration testing. A significant impact example may include, but is not limited to, Charlie Miller's compromisation of Fiat Chrysler vehicles. Black hat hacking may include, but is not limited to, the unauthorized processes of accessing systems to destroy, compromise, or steal data and deny access to services or systems. A significant impact example may include, but is not limited to, Behzad Mesri's alleged theft of data from Home Box Office (HBO) and subsequent ransom demands. Gray hat hacking may include, but is not limited to, unauthorized processes of accessing systems to report, correct, and draw attention to security vulnerabilities. A significant example of gray hat hacking is intentionally not included; students and teachers are encouraged to explore and discuss the nuances of "right versus wrong" and motivations within this community, including nation-state actions.		
CSNT.Y1.4.3 Research and describe the impacts of ransomware, trojans, viruses, and other malware	CSNT.Y2.4.3 Research and describe common attacks on hardware, software, and networks	CSNT.Y3.4.3 Orchestrate an attack against a controlled network/network environment and provide a findings assessment

NOTE: Common hardware attacks may include, but are not limited to, clones, hardware trojans, and side-channel attacks. Common software attacks may include, but are not limited to, buffer overflows, deployment errors, software bugs, and Structured Query Language (SQL) and command injection. Common network attacks may include, but are not limited to, man-in-the-middle attacks, packet sniffing, protocol abuse, and spoofing of media access control (MAC) or internet protocol (IP) addresses. NOTE CSNT Y2-Y3: Environments may include, but are not limited to, capture the flag events and activities, red and blue team challenges, and self-hosted networks or dedicated, educational network labs (e.g., University of Arkansas at Little Rock (UALR) CyberGym, University of Central Arkansas (UCA) Cyber Range). Common network attacks may also include, but are not limited to, snooping, social engineering, and weak or nonexistent network passwords for wifi.		
CSNT.Y1.4.4 Explain implications related to identification and responsible reporting of a vulnerability versus exploitation	CSNT.Y2.4.4 Analyze and manipulate cybersecurity controls within a simulated network	CSNT.Y3.4.4 Justify the use of cybersecurity controls within a network
NOTE CSNT Y2-Y3: Cybersecurity controls include, but are not limited to, hardware and software firewalls, interdependency, multiple backups, operations, policy, security, segregation, and servers.		

Strand: Algorithms and Programs

Content Cluster 5: Students will create, evaluate, and modify algorithms.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSNT.Y1.5.1 Design and implement level-appropriate algorithms that use iteration, selection, and sequence	CSNT.Y2.5.1 Design and implement level-appropriate algorithms that use iteration, recursion, selection, and sequence	CSNT.Y3.5.1 Design and implement algorithms for automation of level-appropriate tasks (e.g., adding hosts to a network/domain, setting switch/router configurations, utilizing DevOps)
NOTE CSNT Y2-Y3: Algorithms include, but are not limited to, configuring Domain Name Service (DNS) for iterative and recursive queries, packet sequencing, pathfinding, and routing protocols.		
CSNT.Y1.5.2 Illustrate the flow of execution of algorithms in level-appropriate programs including branching and looping	CSNT.Y2.5.2 Illustrate the flow of execution of level-appropriate network algorithms (e.g., network mapping, packet tracing) including branching and looping	CSNT.Y3.5.2 Illustrate the flow of execution of level-appropriate network algorithms (e.g., network mapping, packet tracing) including branching and looping
NOTE: Illustrations may include, but are not limited to, flowcharts and pseudocode.		
CSNT.Y1.5.3 Evaluate the qualities of level-appropriate student-created and non-student-created algorithms	CSNT.Y2.5.3 Evaluate the qualities of level-appropriate student-created and non-student-created algorithms including classic search and sort algorithms	*Continuation of this standard is not specifically included or excluded*
NOTE: Evaluation tools may include, but are not limited to, code review and test cases. Qualities may include, but are not limited to, correctness, efficiency, exception handling, input/data/model validation, portability, readability, scalability, and usability. NOTE CSNT Y2-Y3: Searching algorithms include, but are not limited to, breadth versus depth searches, Dijkstra's algorithm, and routing indices.		
CSNT.Y1.5.4 Use a systematic approach to detect and resolve errors in a given algorithm	CSNT.Y2.5.4 Use a systematic approach to detect and resolve errors in a given algorithm	*Continuation of this standard is not specifically included or excluded*

Strand: Algorithms and Programs

Content Cluster 6: Students will create programs to solve problems.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSNT.Y1.6.1 Create programs using procedures to solve problems of level-appropriate complexity	CSNT.Y2.6.1 Create programs to solve problems of level-appropriate complexity	CSNT.Y3.6.1 Create scripts to solve problems and troubleshoot network issues of level-appropriate complexity
NOTE: “Procedures” is considered interchangeable with “functions” for meeting this standard. Problems may include, but are not limited to, encoding, encryption, finding minimum/maximum values, identifying prime numbers, searching and sorting, and solving classic computer science tasks such as The Towers of Hanoi problem. NOTE CSNT Y2-Y3: Scripting languages include, but are not limited to, Bash, Perl, PowerShell, Python, or Ruby.		
CSNT.Y1.6.2 Discuss and apply best practices of program design and format (e.g., descriptive names, documentation, indentation, user experience design, whitespace)	CSNT.Y2.6.2 Discuss and apply best practices of program design and format (e.g., descriptive names, documentation, indentation, user experience design, whitespace)	*Continuation of this standard is not specifically included or excluded*
CSNT.Y1.6.3 Determine the scope and state of variables declared in procedures and control structures over time	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
NOTE: “Procedures” is considered interchangeable with “functions” for meeting this standard.		
CSNT.Y1.6.4 Create programs of level-appropriate complexity that read from standard input, write to standard output, read from a file, write to a file, and append to a file	CSNT.Y2.6.4 Create programs that read from, write to, and append to a file of level-appropriate complexity that includes structured data	CSNT.Y3.6.4 Create scripts that generate, capture, and analyze network traffic
NOTE: Standard input and output is platform-specific. Standard input and output on personal computers may include, but are not limited to, a keyboard and terminal. Standard input and output on mobile application devices may include, but are not limited to, speakers and touchscreen. Standard input and output on robots may include, but are not limited to, sensors and servos. Structured data refers to any representation of data which can be interpreted by an external or separate computing system including, but not limited to, comma-separated values (CSV), JavaScript Object Notation (JSON), Extensible Markup Language (XML), and other line-based text documents.		

CSNT.Y1.6.5 Use a systematic approach to detect logic, runtime, and syntax errors within a program	CSNT.Y2.6.5 Use a systematic approach to detect logic, runtime, and syntax errors within a program	CSNT.Y3.6.5 Use a systematic approach to detect logic, runtime, and syntax errors within a program

Strand: Computers and Communications

Content Cluster 7: Students will analyze the utilization of computers within industry.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSNT.Y1.7.1 Identify hardware and software specific to carrying out the mission of regional industries	CSNT.Y2.7.1 Utilize hardware and/or software to solve level-appropriate industry-based problems	*Continuation of this standard is not specifically included or excluded*
CSNT.Y1.7.2 Research advancing and emerging technologies (e.g., artificially intelligent agents, blockchain, extended reality, Internet of Things (IoT), machine learning, robotics)	CSNT.Y2.7.2 Discuss impacts of incorporating advancing and emerging technologies (e.g., artificially intelligent agents, blockchain, extended reality, IoT, machine learning, robotics) into a network or network schematic, including proper configuration	CSNT.Y3.7.2 Incorporate advancing and emerging technologies into a network or network schematic
NOTE CSNT Y2-Y3: Cloud-based services may include, but are not limited to, infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS).		

Strand: Computers and Communications

Content Cluster 8: Students will analyze communication methods and systems used to transmit information among computing devices.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSNT.Y1.8.1 Utilize the command line to accomplish common network troubleshooting tasks at an introductory level	CSNT.Y2.8.1 Utilize the command line to accomplish level-appropriate network troubleshooting tasks (e.g., Address Resolution Protocol (ARP), DNS cache flush, nslookup)	CSNT.Y3.8.1 Determine the appropriate command or tool to troubleshoot complex network issues (e.g., bottlenecks, conflicting policies, firewall rules, quality of service)
NOTE: Common network troubleshooting tasks may include, but are not limited to, viewing internal IP address information (e.g., ipconfig /all); viewing external IP address information using an external service (e.g., ifconfig.me, myip.com, whatsmyip.com); validating communication with a remote system (e.g., ping); tracing path of communication to a remote system (e.g., traceroute); and releasing and renewing IP addresses (e.g., ipconfig /renew).		
CSNT.Y1.8.2 Research and describe common networking concepts at an introductory level	CSNT.Y2.8.2 Discuss networking concepts of level-appropriate complexity	CSNT.Y3.8.2 Implement networking concepts of level-appropriate complexity
NOTE: Networking concepts may include, but are not limited to, different types of networks (e.g., local area network (LAN), wide area network (WAN)); various common topologies; the role of a MAC address; local versus public IP and how they are assigned; Internet Protocol version 4 (IPv4) and Internet Protocol version 6 (IPv6) addressing schemes; role of Domain Name System (DNS); the hierarchical nature of networks; purpose of virtual private networks (VPN); signal carriers for networks (e.g., copper, fiber optic, radio); purpose of firewalls; network access roles (e.g., employee versus guest, staff versus student); role of internet service providers (ISP); wireless connectivity; client-server relationship versus peer-to-peer (P2P); role of common internet protocols; and secure versus insecure protocols.		
CSNT.Y1.8.3 Research and describe modems, network interface cards, routers (e.g., consumer, industrial), switches, and wireless access points, and identify their purposes within a network	CSNT.Y2.8.3 Design and implement a physical or virtual network of level-appropriate complexity	CSNT.Y3.8.3 Design and implement a physical or virtual network of level-appropriate complexity, integrating multiple networks of varying size and topologies
CSNT.Y1.8.4 Describe the importance of creating and using common rules for communication and the utilization of common network protocols including the relationship between client and server	CSNT.Y2.8.4 Examine network protocols and communication concepts of level-appropriate complexity (e.g., frames, OSI model, ports, protocols, TCP versus User Datagram Protocol (UDP))	CSNT.Y3.8.4 Interpret network protocols used for data transmission in a simulated network
NOTE: Discussions of common rules for communications may include, but are not limited to, the Open Systems Interconnection (OSI) Model and packet communication. Common network protocols may include, but are not limited to, DNS, Hypertext Transfer Protocol (HTTP)/ Secure Hypertext Transfer Protocol (HTTPS), Simple Mail Transfer Protocol (SMTP)/Post Office Protocol (POP)/Internet Message Access Protocol (IMAP), and Telnet/Secure Shell (SSH).		

Strand: Computers and Communications

Content Cluster 9: Students will utilize appropriate hardware and software.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSNT.Y1.9.1 Compare and contrast computer programming paradigms (e.g., functional, imperative, object-oriented)	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
CSNT.Y1.9.2 Research, describe, and utilize at an appropriate level: ● debugging strategies ● integrated development environments (IDE) ● source-code editors ● version control strategies	CSNT.Y2.9.2 Use collaboration tools and version control systems in a group software project of appropriate complexity	*Continuation of this standard is not specifically included or excluded*
CSNT.Y1.9.3 Classify layers of software (e.g., applications, drivers, firmware, operating systems) utilized within various platforms (e.g., Android, ChromeOS, iOS, Linux, macOS, Windows)	CSNT.Y2.9.3 Identify networking devices and server software, including configuration tools	CSNT.Y3.9.3 Utilize networking devices and server software, including configuration tools
CSNT.Y1.9.4 Identify and describe the purpose of hardware components within various personal computing platforms	CSNT.Y2.9.4 Identify networking devices and server hardware components	CSNT.Y3.9.4 Utilize networking devices and server hardware components
NOTE: Hardware components include, but are not limited to, central processing units (CPU), chassis, cooling components, graphics cards, input/output devices, memory, motherboards, power supplies, and storage devices.		

Strand: Professionalism and Impacts of Computing

Content Cluster 10: Students will analyze the impacts of technology and professionalism within the computing community.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSNT.Y1.10.1 Research and describe the risks and risk mitigation strategies associated with the utilization and implementation of social media and other digital technology implications	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
NOTE: Risks include, but are not limited to, cyberbullying, identity theft, impersonation, and social engineering attacks. Implications may include, but are not limited to, employability, legal, physical, psychological, and social access.		
This standard is not specifically required until Year 2	CSNT.Y2.10.2 Research and describe issues related to creating and enforcing cyber-related laws and regulations (e.g., ethical challenges, policy vacuum, privacy versus security, unintended consequences)	*Continuation of this standard is not specifically included or excluded*
CSNT.Y1.10.3 Research and describe the potential benefits associated with the utilization and implementation of social media and other digital technologies	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
NOTE: Potential benefits may include, but are not limited to, brand building, crowdsourcing, personal promotion awareness, and project funding.		
CSNT.Y1.10.4 Research and describe the relationship between access and security (e.g., active and passive data, convenience, data mining, digital marketing, online wallets, privacy, theft of personal information)	CSNT.Y2.10.4 Identify the ethical implications encountered in the management, curation, and monetization of data (e.g., harvesting, information overload, knowledge management repositories, sharing, summarizing)	*Continuation of this standard is not specifically included or excluded*
This standard is not specifically required until Year 2	CSNT.Y2.10.5 Explain advantages and disadvantages of various software life cycle processes (e.g., Agile, spiral, waterfall) CSNT Y2: Discuss networking life cycles and the role and responsibilities of the network engineer	*Continuation of this standard is not specifically included or excluded*

CSNT.Y1.10.6 Research the history of computing devices and their impact on society	CSNT.Y2.10.6 Research the history of networking	CSNT.Y3.10.6 Identify advancing and emerging technologies network technologies (e.g., micro subnetting, Recursive InterNetwork Architecture)
CSNT.Y1.10.7 Research and identify diverse careers and career opportunities (e.g., accessibility, availability, demand) that are influenced by computer science and the technical and soft skills needed for each	CSNT.Y2.10.7 Demonstrate industry-relevant technical and soft skills	CSNT.Y3.10.7 Demonstrate industry-relevant technical and soft skills
NOTE CSNT Y2-Y3: Networking-related soft skills include, but are not limited to, collaboration, communication, flexibility, problem solving, respect, responsiveness, teamwork, and time management. Networking-related technical skills include, but are not limited to, familiarity with aspects of architecture and management, hardware functionality, scripting and automation, system/architecture evaluation and design, and tools for analysis and tracking.		

Strand: Professionalism and Impacts of Computing

Content Cluster 11: Students will demonstrate understanding of storytelling with data and appropriately communicate about technical information.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSNT.Y1.11.1 Communicate basic technical information effectively to diverse audiences including, but not limited to, non-technical audience members	CSNT.Y2.11.1 Communicate level-appropriate technical information effectively to diverse audiences including, but not limited to, non-technical audience members	CSNT.Y3.11.1 Communicate level-appropriate technical information effectively to diverse audiences including, but not limited to, non-technical audience members
NOTE: Technical information may include, but is not limited to, collecting or collected data, computing hardware, cyber hygiene, networking concepts, programming paradigms, and troubleshooting concepts.		
CSNT.Y1.11.2 Describe and utilize the concepts of storytelling with data	CSNT.Y2.11.2 Describe and utilize the concepts of storytelling with data	CSNT.Y3.11.2 Describe and utilize the concepts of storytelling with data
NOTE: Storytelling concepts may include, but are not limited to, identifying the knowledge level of the intended audience; developing a compelling narrative; creating appealing visualizations appropriate for the intended audience and that enhance the narrative; remaining objective and avoiding biases; and avoiding the censoring of data.		
CSNT.Y1.11.3 Describe the following common types of data bias: ● confirmation bias ● confounding variables ● outliers ● overfitting/underfitting ● selection bias	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
CSNT.Y1.11.4 Compare and contrast causation and correlation	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
CSNT.Y1.11.5 Compare and contrast interpreting data, inferring using data, and implicating with data	CSNT.Y2.11.5 Compare and contrast interpreting data, inferring using data, and implicating with data	CSNT.Y3.11.5 Compare and contrast interpreting data, inferring using data, and implicating with data

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