



Program of Study Justifications for Information Technology

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Coding

Information Technology

2017-2018 Program of Study	Level 1	Level 2	Level 3	Level 4
Coding	Computer Science Foundations (6905)	Coding I (6098)	Coding II (6099) -or- Mobile App Development -or- Dual Enrollment Coding (4113)	Coding Practicum (5908) -and/or- AP Computer Science (3634) -and/or- AP Computer Science Principles (3635) -or- Dual Enrollment Coding (4113)
	Industry Certification: CompTIA IT Fundamentals		Industry Certification: Comp TIA A+	

Description

The Coding program is study (POS) is designed for students interested in computer programming. Computer programming is either a stand-alone career or it can be used with other computer applications as a major aspect of broader computer science occupations. Students will develop standard programming techniques and learn the logic tools and methods typically used by programmers to create simple computer applications. Proficient students will be able to solve problems by planning multistep procedures; write, analyze, review, and revise programs, converting detailed information from workflow charts and diagrams into coded instructions in a computer language; and will be able to troubleshoot/debug programs and software applications to correct malfunctions and ensure their proper execution. This POS also challenges students to develop advanced skills in problem analysis, construction of algorithms, and computer implementation of algorithms as they work on programming projects of increased complexity. In so doing, they develop key skills of discernment and judgment as they must choose from among many languages, development environments, and strategies for the program life cycle. Course content is reinforced through numerous short- and long-term programming projects, accomplished both individually and in small groups. These projects are meant to hone the discipline and logical thinking skills necessary to craft error-free syntax for the writing and testing of programs.

Mobile App Development is a course found as an optional Level 3 course in the Coding POS. It is intended to teach students the basic concepts and skills of mobile app design. The course places an emphasis on the history of mobile technologies, design and development methodologies, code for mobile applications, application lifecycles, APIs, mobile device controls, user interfaces, deployment, publishing for mobile devices, developer tools, and career development. Upon completion of this course, proficient students will demonstrate an understanding of mobile app development concepts.

Upon completion of this POS, proficient students will demonstrate an understanding of object-oriented programming language using high-level languages such as FOCUS, Python, or SAS.

Job Outlook

The Tennessee Department of Labor and Workforce Development listed five information technology jobs on the list of *Hot Careers to 2022*. Among these careers were Computer Programmers and Computer Systems Analysts.¹ According to O'Net OnLine, the rate of employment is expected to grow in these occupations (See Figure 1 for details). Computer Programmers will grow at a slower rate (15 percent) compared to Software Developers (28 percent). However, related occupations as Computer Systems Analysts (31 percent) will increase well above average growth.²

Although these occupations are all related to Coding, they each have different roles and responsibilities. Software developers provide the conceptual design that is the foundation for a computer program. There are two types of software developers—the type that develops applications to do specific tasks on a computer or other device and the type that develops systems that run devices or control networks.³ Computer programmers use program designs that are developed by engineers and software developers to write instructions for computers to follow. This is also referred to as coding.⁴ Computer Systems Analysts evaluate an organization's computer systems and procedures and provide design solutions that will improve operations.⁵

¹ Tennessee Department of Labor and Workforce Development. (2014). *Tennessee's Hot Careers to 2022* on the Internet at http://www.tn.gov/assets/entities/labor/attachments/statewide_2020outlooks.pdf (visited June 6, 2017).

² Jobs4Tn online at www.jobs4tn.gov (visited June 6, 2017).

³ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2016-17 Edition*, Software Developers, <http://www.bls.gov/ooh/computer-and-information-technology/software-developers.htm> (visited June 6, 2017).

⁴ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2016-17 Edition*, Computer Programmers, <http://www.bls.gov/ooh/computer-and-information-technology/computer-programmers.htm> (visited June 6, 2017).

⁵ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2016-17 Edition*, Computer Systems Analysts, <http://www.bls.gov/ooh/computer-and-information-technology/computer-systems-analysts.htm> (visited June 6, 2017).

Occupations in this program of study have bright outlooks nationally and statewide. **Figure 1 and Figure 2** outline the related career opportunities in Tennessee.

Figure 1. Tennessee long term employment projections for coding-related occupations in Tennessee for the 2014-2024 projection period.⁶⁷

Occupation	2014 Estimated Employment	2024 Projected Employment	Total 2014- 2024 Employment Change	Total Percent Change	Median Salary
Computer Programmers	5,320	6,120	220	15.00%	\$70,050
Software Developers (Systems)	2,610	3,320	110	28.00%	\$83,130
Computer and Information Systems Managers	5,460	6,710	200	23.00%	\$101,200

Figure 2. State and national trends for coding-related occupations with positive projections 2014-24⁸⁹¹⁰

United States	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Computer Programmers	328,600	302,200	-8%	8,100
Tennessee	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Computer Programmers	5,320	6,120	+15%	220

⁶ Tennessee Department of Labor and Workforce Development, Job4TN Online. (2017). *Occupational Projections (Long-term)*. Retrieved from <https://www.jobs4tn.gov/vosnet/analyzer/results.aspx?session=occpj>.

⁷ Tennessee Department of Labor and Workforce Development, Job4TN Online. (2017). *Occupational Employment and Wage Rates (OES)*. Retrieved from <https://www.jobs4tn.gov/vosnet/analyzer/results.aspx?session=occpj>.

⁸ Career One Stop. (2017). *Occupation Profile, State and National Trends*. Retrieved from <http://www.onetonline.org/link/summary/15-1131.00>.

⁹ Career One Stop. (2017). *Occupation Profile, State and National Trends*. Retrieved from <https://www.onetonline.org/link/summary/15-1133.00>.

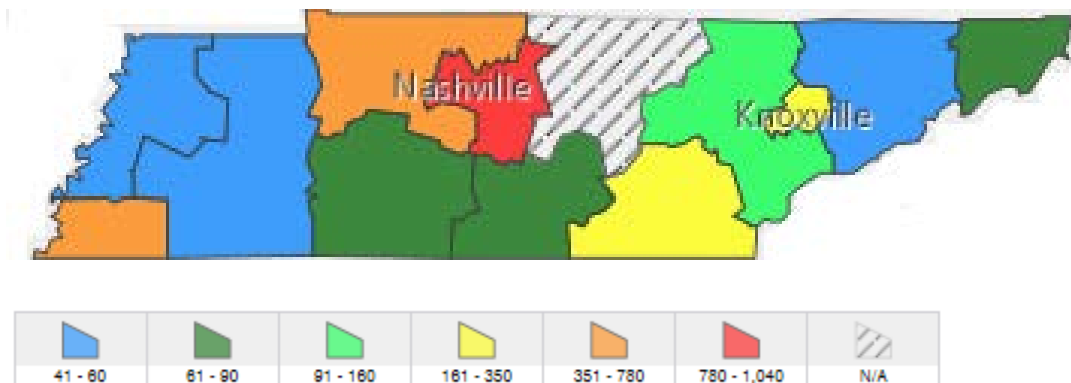
¹⁰ Career One Stop. (2017). *Occupation Profile, State and National Trends*. Retrieved from <https://www.onetonline.org/link/summary/11-3021.00>.

United States	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Software Developers (Systems)	395,600	447,000	+13%	10,790
Tennessee	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Software Developers (Systems)	2,610	3,320	+28%	110

United States	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Computer and Information Systems Manager	348,500	402,200	+15%	9,480
Tennessee	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Computer and Information Systems Manager	5,460	6,710	+23%	200

Job opportunities for computer programmer occupations are strongest in urban and surrounding areas in Tennessee. **Figure 3** shows that more coding occupations in Tennessee are employed and needed in the Memphis, Nashville, and Chattanooga areas than in surrounding areas.

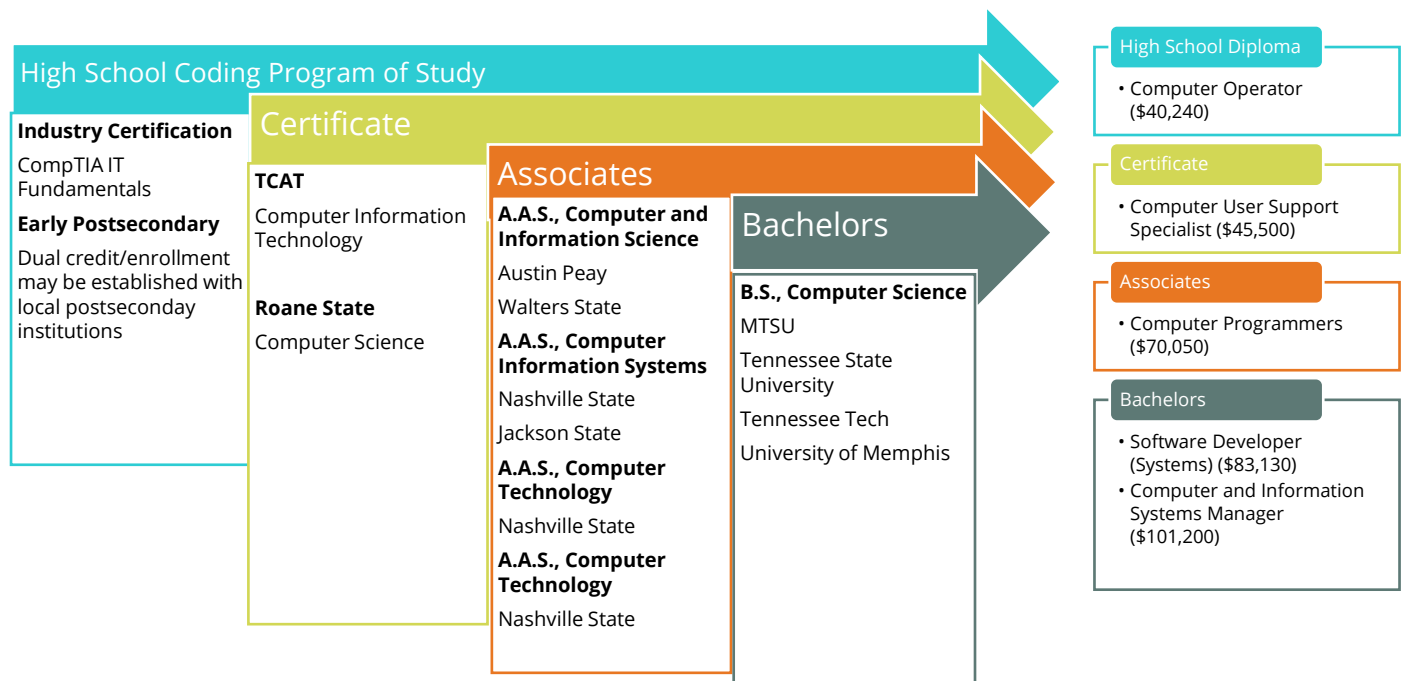
Figure 3. 2014 Estimated Employment¹¹



¹¹ Tennessee Department of Labor and Workforce Development, Job4TN Online. (2017). *Occupational Projections (Long-term)*. Retrieved from <https://www.jobs4tn.gov/vosnet/analyzer/results.aspx?session=occproj>.

Postsecondary Pathways

Coding occupations requires students who are interested in developing specific skill sets. Students who are interested in an occupation as a software developer should develop skills in critical thinking, operation analysis, systems analysis, systems evaluation, complex problem-solving and programming. More specifically, they should demonstrate proficiency using software such as Microsoft SQL Server (database management), Microsoft Visual Basic (development environment software), C++ (object or component oriented development software), Python (object or component oriented development software), program testing software, and Hypertext markup language (HTML) (web platform development software), and JavaScript (web platform development software). Students should also be proficient in using tools such as computer servers, mainframe computers, and integrated circuit testers.¹²



Upon completing a postsecondary education, students will find that the top industries seeking software developers are computer systems design services, software publishers, management of companies and enterprises, insurance carriers, and management, scientific, and technical consulting services.¹³ Although education for computer programmers and software developers varies by employer, most students will be able to enter the occupation with an associate's degree. However, for students who want to advance in their careers and earn higher salaries, a bachelor's degree in computer science should be attained. Upon completing a postsecondary education, students will

¹²O*Net Online on the Internet at <http://www.onetonline.org/> (visited June 6, 2017).

¹³O*Net Online on the Internet at <http://www.onetonline.org/> (visited June 6, 2017).



find that occupations in various companies can include: software engineer, IT director, and computer and information systems managers.¹⁴

Current Secondary Landscape

In the 2016-2017 school year, 60 schools in Tennessee responded to the demand to grow local talent in emerging information technology fields and instituted special programs of study in coding. District data from SY 17-18 suggest that 86 schools will implement Coding at the beginning of the SY.¹⁵ These figures demonstrate that there is an appetite among schools—and students—to explore information technology at the high school level, which bodes well for the growing number of postsecondary institutions to offer technology related programs.

Figure 5. Open Enrollment Analysis¹⁶

Coding	
2014-15	29
2015-16	28
2016-17	60
2017-18	86

Student Enrollment¹⁷

SY	Computer Science Foundations	Coding I	Coding II	Coding Practicum
2013-14	1380	154	35	0
2014-15	1586	993	361	394
2015-16	3139	1207	383	255

Coding Concentrators¹⁸

Coding	
2013-14	64
2014-15	22
2015-16	58

¹⁴ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2016-17 Edition*, <http://www.bls.gov/oes/> (visited June 6, 2017).

¹⁵ Tennessee Department of Education. (2017). Student Enrollment Data. Retrieved from Author’s calculation of student enrollment data.

¹⁶Tennessee Department of Education. (2017). Student Enrollment Data. Retrieved from Author’s calculation of student enrollment data.

¹⁷ Tennessee Department of Education. (2017). *Student Enrollment Data*. Retrieved from Author’s calculation of student enrollment data.

¹⁸ Tennessee Department of Education. (2017). Student Enrollment Data. Retrieved from Author’s calculation of student enrollment data.

Recommendation

Through advisory council meetings and discussions with industry and postsecondary partners, it is the recommendation to add cloud technology, Internet of Things (IoT), and data analytics standards to the Level 1: Computer Science Foundations course as an introduction to emerging technologies. These recommendations will add rigor and relevancy to the established courses already in place.

2018-2019 Program of Study	Level 1	Level 2	Level 3	Level 4
Coding	Computer Science Foundations (6905)	Coding I (6098)	Coding II (6099) -or- Mobile App Development -or- Dual Enrollment Coding (4113)	Coding Practicum (5908) -and/or- AP Computer Science (3634) -and/or- Dual Enrollment Coding (4113)
		AP Computer Science Principles (3635)		
	Industry Certification: CompTIA IT Fundamentals		Industry Certification: MTA Software Development Fundamentals	



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Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2016-17 Edition*, Computer Programmers, <http://www.bls.gov/ooh/computer-and-information-technology/computer-programmers.htm>

Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2016-17 Edition*, Computer Systems Analysts, <http://www.bls.gov/ooh/computer-and-information-technology/computer-systems-analysts.htm>

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Tennessee Department of Labor and Workforce Development, Job4TN Online. (2017). *Occupational Employment and Wage Rates (OES)*. Retrieved from <https://www.jobs4tn.gov/vosnet/analyzer/results.aspx?session=occproj>

Networking Systems

Information Technology

2017-2018 Program of Study	Level 1	Level 2	Level 3	Level 4
Networking Systems	Computer Science Foundations (6905)	Computer Systems (6094)	Networking (6097) -or- Dual Enrollment Networking Systems (4114)	Cabling and Internetworking (6093) -and/or- IT Clinical Internship (6096) -or- Dual Enrollment Networking Systems (4114)
	Industry Certification: CompTIA IT Fundamentals	Industry Certification: Comp TIA A+ Cisco Certified Entry Network Tech (CCENT)	Industry Certification: CompTIA Network + Cisco Certified Network Associate (CCNA)	

Description

The Networking program is study is designed for students interested in occupations including: computer support specialists, network and computer systems administrators, computer hardware engineers, and computer network architects. Networking systems is either a stand-alone career or it can be used with other computer applications as a major aspect of broader computer science occupations. This program of study provides students the opportunity to acquire knowledge in both theory and practical applications pertaining to hardware, operating systems, safe mode, command prompt, security, networking, printers, peripheral devices, laptops, mobile devices, troubleshooting, and customer service management. Upon completion of the course, proficient students will have acquired skills and knowledge to install, configure, and maintain computer systems. Students will also identify types of networks, understand the layers of the open systems interconnection (OSI) model, 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 program of study, proficient students will be prepared to sit for the CompTIA Network+ exam and will be eligible to pursue the IT industry-standard credential, CompTIA's A+ certification.

Job Outlook

The Tennessee Department of Labor and Workforce Development listed five information technology jobs on the list of *Hot Careers to 2022*. Among these careers were Network and Computer Systems Administrators, Computer and Information Systems Managers, and Computer User Support Specialists.¹⁹ According to O*Net, the rate of employment is expected to grow in these occupations (See figure 1 for details). Computer Support Specialists will grow at a faster rate of (26 percent) compared to Network and Computer Systems Administrators (19 percent) or Computer and Information Systems Managers (23 percent), all at above average growth.²⁰

Although these occupations are all related to Networking Systems, they each have different roles and responsibilities. Network Architects are different in that they design and build data communication networks such as LANs, WANs, and intranets.²¹ Database Administrators use specific software to store, organize, and secure data from unauthorized access.²² Computer and Information Systems Managers plan, direct, or coordinate activities in such fields as electronic data processing, information systems, systems analysis, and computer programming.²³ Network and Computer Systems Administrators are responsible for the daily operation of network systems. For example, administrators organize, install, and support systems such as local area networks (LANs), wide area networks (WANs), network segments, intranets, and other communication data systems.²⁴ Finally, Computer Support Specialists Analyze, test, troubleshoot, and evaluate existing network systems, such as local area network (LAN), wide area network (WAN), and Internet systems or a segment of a network system. Perform network maintenance to ensure networks operate correctly with minimal interruption.²⁵

Occupations in this program of study have bright outlooks nationally and statewide. **Figure 1 and Figure 2** outline the related career opportunities in Tennessee.

¹⁹ Tennessee Department of Labor and Workforce Development. (2014). *Tennessee's Hot Careers to 2022* on the Internet at http://www.tn.gov/assets/entities/labor/attachments/statewide_2020outlooks.pdf (visited June 7, 2017).

²⁰ O*Net Online on the Internet at <http://www.onetonline.org/> (visited June 7, 2017).

²¹ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2016-17 Edition*, Computer Network Architects, <http://www.bls.gov/ooh/computer-and-information-technology/computer-network-architects.htm> (visited June 7, 2017).

²² Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2016-17 Edition*, Database Administrators, <http://www.bls.gov/ooh/computer-and-information-technology/database-administrators.htm> (visited June 7, 2017).

²³ Bureau of Labor Statistics, U.S. Department of Labor on the internet at: <http://www.bls.gov/oes/current/oes113021.htm> (visited June 7, 2017).

²⁴ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2015-16 Edition*, Network and Computer Systems Administrators, <http://www.bls.gov/ooh/computer-and-information-technology/network-and-computer-systems-administrators.htm#tab-2> (visited June 7, 2017).

²⁵ Bureau of Labor Statistics, U.S. Department of Labor on the internet at: <http://www.bls.gov/soc/2010/soc151152.htm> (visited June 7, 2017).

Figure 1. Tennessee long term employment projections for networking-related occupations in Tennessee for the 2014-2024 projection period.²⁶²⁷

Occupation	2014 Estimated Employment	2024 Projected Employment	Total 2014- 2024 Employment Change	Total Percent Change	Median Salary
Network and Computer Systems Administrator	6,090	7,240	210	19.00%	\$74,300
Computer and Information Systems Manager	5,460	6,710	200	23.00%	\$101,200
Computer Network User Support Specialist	2,670	3,100	310	16.00%	\$57,990

Figure 2. State and national trends for networking-related occupations with positive projections 2014-24²⁸²⁹³⁰

United States	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Network and Computer Systems Administrator	382,600	412,800	+8%	7,940
Tennessee	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Network and Computer Systems Administrator	6,090	7,240	+19%	210

²⁶ Tennessee Department of Labor and Workforce Development, Job4TN Online. (2017). *Occupational Projections (Long-term)*. Retrieved from <https://www.jobs4tn.gov/vosnet/analyzer/results.aspx?session=occproj>

²⁷ Tennessee Department of Labor and Workforce Development, Job4TN Online. (2017). *Occupational Employment and Wage Rates (OES)*. Retrieved from <https://www.jobs4tn.gov/vosnet/analyzer/results.aspx?session=occproj>

²⁸ Career One Stop. (2017). *Occupation Profile, State and National Trends*. Retrieved from <http://www.onetonline.org/link/summary/15-1142.00>

²⁹ Career One Stop. (2017). *Occupation Profile, State and National Trends*. Retrieved from <https://www.onetonline.org/link/summary/11-3021.00>

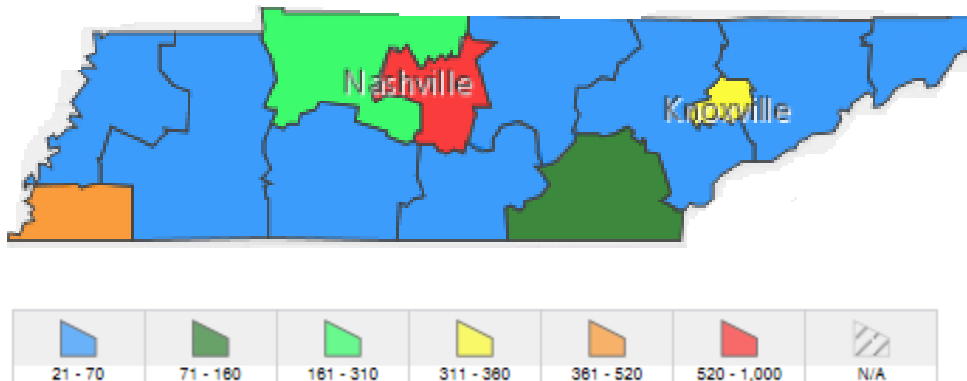
³⁰ Career One Stop. (2017). *Occupation Profile, State and National Trends*. Retrieved from <https://www.onetonline.org/link/summary/15-1152.00>

United States	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Computer and Information Systems Manager	348,500	402,200	+15%	9,480
Tennessee	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Computer and Information Systems Manager	5,460	6,710	+23%	200

United States	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Computer Network User Support Specialist	181,000	194,600	+8%	3,690
Tennessee	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Computer Network User Support Specialist	2,670	3,100	+16%	90

Job opportunities for Network and Computer Systems Administrator occupations are strongest in urban and surrounding areas in Tennessee. **Figure 3** shows that more occupations in Tennessee are employed and needed in the Memphis and Nashville areas than in surrounding areas.

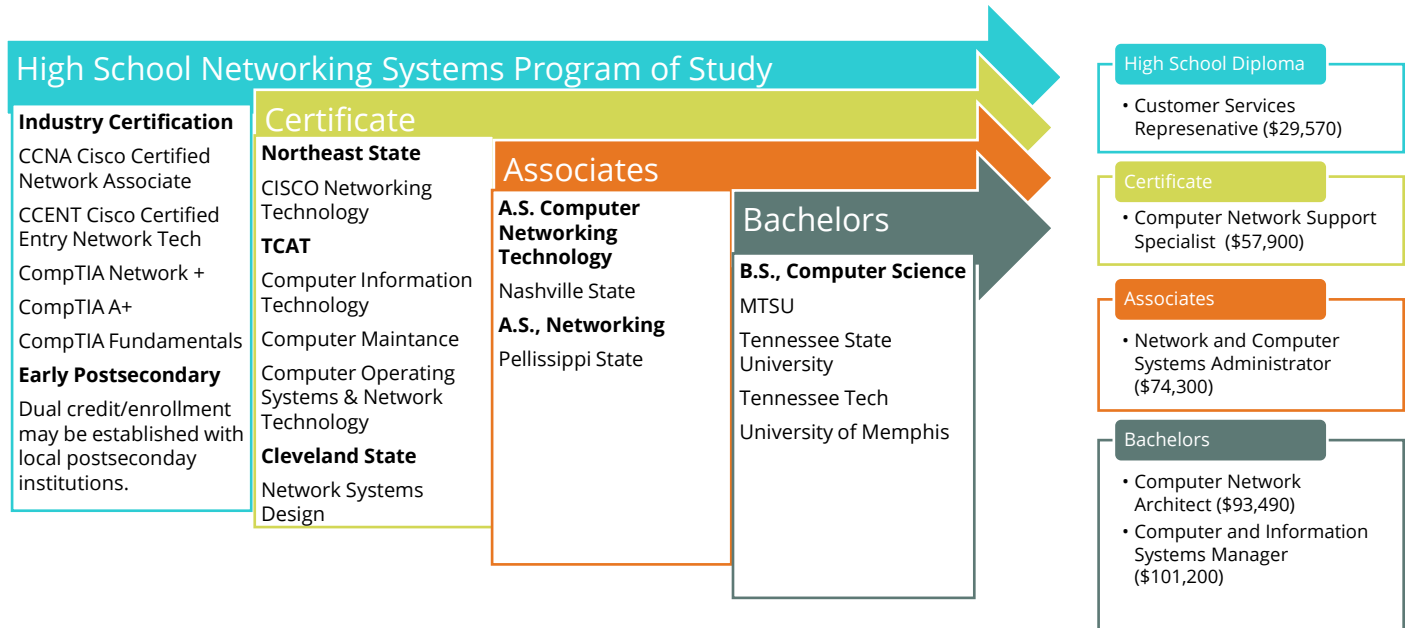
Figure 3. 2014 Estimated Employment³¹



³¹ Tennessee Department of Labor and Workforce Development, Job4TN Online. (2017). *Occupational Projections (Long-term)*. Retrieved from <https://www.jobs4tn.gov/vosnet/analyzer/results.aspx?session=occproj>

Postsecondary Pathways

Students who are interested in Network and Computer Systems Administrator occupations should develop skills in critical thinking, systems analysis, complex problem solving, systems evaluation, operation monitoring, and programming. In addition, students should be proficient in using tools such as Cisco Systems, network management software, patch and update software, intrusion prevention system (IPS) software, network and system vulnerability assessment software, and encryption software.³²



Upon completing a postsecondary education, students will find that the top industries seeking Network and Computer Systems Administrators are computer systems design services, educational services (state, local, and private), information, finance and insurance, and manufacturing.³³ Although students can obtain Network Systems jobs with a bachelor's degree, obtaining an industry certification, such as CompTIA Fundamentals, CompTIA A+, and CompTIA Network+ will increase the number of job opportunities.³⁴

³² O*Net Online, Network and Computer Systems Administrators, on the Internet at <http://www.onetonline.org/link/summary/15-1142.00> (visited June 7, 2017).

³³ Bureau of Labor Statistics, U.S. Department of Labor, *Work Environment*, 2016. Online at <http://www.bls.gov/ooh/> (visited June 7, 2017).

³⁴ Network and Computer Systems Administrators, on the Internet at <http://www.bls.gov/ooh/computer-and-information-technology/network-and-computer-systems-administrators.htm#tab-3> (visited June 7, 2017).



Current Secondary Landscape

In the 2016-2017 school year, 37 schools in Tennessee responded to the demand to grow local talent in emerging information technology fields and instituted special programs of study in networking. District data from SY 17-18 suggest that 48 schools will implement Networking at the beginning of the SY.³⁵ These figures demonstrate that there is an appetite among schools—and students—to explore networking at the high school level, which bodes well for the growing number of postsecondary institutions to offer networking related programs.

Figure 5. Open Enrollment Analysis³⁶

Networking	
2014-15	34
2015-16	37
2016-17	37
2017-18	48

Student Enrollment³⁷

SY	Computer Science Foundations	Computer Systems	Networking	Cabling and Internetworking	IT Clinical Internship
2013-14	1380	567	346	86	36
2014-15	1586	589	349	132	60
2015-16	3139	671	289	144	64

Networking Concentrators³⁸

Networking	
2013-14	202
2014-15	257
2015-16	301

³⁵ Tennessee Department of Education. (2017). Student Enrollment Data. Retrieved from Author’s calculation of student enrollment data.

³⁶Tennessee Department of Education. (2017). Student Enrollment Data. Retrieved from Author’s calculation of student enrollment data.

³⁷ Tennessee Department of Education. (2017). *Student Enrollment Data*. Retrieved from Author’s calculation of student enrollment data.

³⁸ Tennessee Department of Education. (2017). Student Enrollment Data. Retrieved from Author’s calculation of student enrollment data.

Recommendation

Through advisory council meetings and discussions with industry and postsecondary partners, it is the recommendation to add cloud technology, Internet of Things (IoT), and data analytics standards to the Level 1: Computer Science Foundations course as an introduction to emerging technologies. These recommendations will add rigor and relevancy to the established courses already in place.

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References

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- Tennessee Department of Labor and Workforce Development, Job4TN Online. (2017). *Occupational Projections (Long-term)*. Retrieved from <https://www.jobs4tn.gov/vosnet/analyzer/results.aspx?session=occproj>
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Information Technology

2017-2018 Program of Study	Level 1	Level 2	Level 3	Level 4
Web Design	Computer Science Foundations (6095)	Web Design Foundations (6100)	Web Site Development (6102) -or- Dual Enrollment Web Design (4115)	Web Design Practicum (6171) -and/or- AP Computer Science Principles (3634) -or- Dual Enrollment Web Design (4115)
	Industry Certification: Comp TIA Fundamentals		Industry Certification: CIW Web Design Specialist	

Description

The Web Design program of study is designed for students interested in designing and creating websites. Web Design is either a stand-alone career or it can be used with other computer applications as a major aspect of broader computer science occupations. Students will develop fundamental skills in both theory and practical application of the basic web design and development process, project management and teamwork, troubleshooting and problem solving, and interpersonal skill development. Laboratory facilities and experiences simulate those found in the web design and development industry; where interaction with a “client” is indicated in the standards, it is expected that students’ peers or the instructor may serve as mock clients in lieu of an actual relationship with an industry partner. Emphasis is also placed on applying the design process toward projects of increasing sophistication, culminating in the production of a functional, static website. As students work toward this goal, they will acquire key skills in coding, project management, basic troubleshooting and validation, and content development and analysis. Upon completion of this course, proficient students will be prepared for more advanced coursework in the Web Design program of study.

Job Outlook

United States jobs related to computers and mathematics are expected to increase at a rate of 27 percent through the year 2024. During this time, about 39,500 new jobs will need to be filled in an industry that already has roughly 148,500 positions. The expansion of e-commerce is expected to be the main driver of Web developer job growth in the next decade.³⁹ As more companies expand their online retail presence, more Web developers will be needed to build the websites visited by consumers. Increased reliance on mobile search is another reason the industry's employment growth should remain strong. Further, individuals in these occupations often times move to other information technology occupations. For example, Jobs4TN.gov reported that over the past five years 26.77 percent of software developers (applications) and 12.12 percent of computer programmers moved to the occupation of web developer.⁴⁰

Occupations in this program of study have bright outlooks nationally and statewide. **Figure 1 and Figure 2** outline the related career opportunities in Tennessee.

Figure 1. Tennessee long term employment projections for web design-related occupations in Tennessee for the 2014-2024 projection period.^{41,42}

Occupation	2014 Estimated Employment	2024 Projected Employment	Total 2014- 2024 Employment Change	Total Percent Change	Median Salary
Web Developers	1,690	2,010	60	+19%	\$55,800
Web Administrators	2,130	2,160	40	+2%	\$72,220
Computer Programmers	5,320	6,120	220	+15%	\$70,050

³⁹ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2016-17 Edition*, Web Developers, on the Internet at <http://www.bls.gov/ooh/computer-and-information-technology/web-developers.htm> (visited June 8, 2017).

⁴⁰ Tennessee Department of Labor and Workforce Development. (2017). *Occupation Profile: Occupational Details: Career Ladder*, on the Internet at www.jobs4tn.gov (visited June 8, 2017).

⁴¹ Tennessee Department of Labor and Workforce Development, Job4TN Online. (2017). *Occupational Projections (Long-term)*. Retrieved from <https://www.jobs4tn.gov/vosnet/analyzer/results.aspx?session=occproj>

⁴² Tennessee Department of Labor and Workforce Development, Job4TN Online. (2017). *Occupational Employment and Wage Rates (OES)*. Retrieved from <https://www.jobs4tn.gov/vosnet/analyzer/results.aspx?session=occproj>



Figure 2. State and national trends for web design-related occupations with positive projections 2014-24⁴³⁴⁴⁴⁵

United States	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Web Developers	148,500	188,000	+27%	5,860
Tennessee	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Web Developers	1,690	2,010	+19%	60

United States	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Web Administrators	233,000	240,800	+3%	3,770
Tennessee	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Web Administrators	2,130	2,160	+2%	40

United States	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Computer Programmers	328,600	302,200	-8%	8,100
Tennessee	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Computer Programmers	5,320	6,120	+15%	220

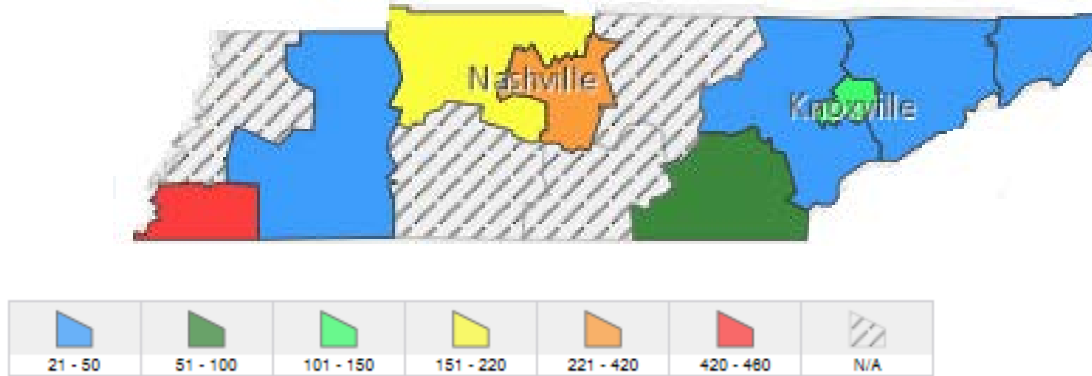
⁴³ Career One Stop. (2017). *Occupation Profile, State and National Trends*. Retrieved from <http://www.onetonline.org/link/summary/15-1134.00>

⁴⁴ Career One Stop. (2017). *Occupation Profile, State and National Trends*. Retrieved from <https://www.onetonline.org/link/summary/15-1199.03>

⁴⁵ Career One Stop. (2017). *Occupation Profile, State and National Trends*. Retrieved from <https://www.onetonline.org/link/summary/15-1131.00>

Job opportunities for web design occupations are strongest in urban and surrounding areas in Tennessee. **Figure 3** shows that more coding occupations in Tennessee are employed and needed in the Memphis and Nashville areas than in surrounding areas.

Figure 3. 2014 Estimated Employment⁴⁶



Postsecondary Pathways

Web developers design, build, and maintain web sites using authoring and scripting languages. As a result, they must have knowledge of programming and graphics design.⁴⁷ Although an associate's degree is the typical education level needed to enter the web developer occupation, 43 percent of adults attained a bachelor's degree. In addition, national growth in the web developer occupation is expected to be faster than the average at 27 percent through year 2024.⁴⁸ This growth is a direct correlation to the growth in use of mobile devices and e-Commerce. As a result of growth in job openings, some states may see a demand in web developers. For example, Jobs4TN.gov reported that there were .45 potential candidates for every web developer job opening in Tennessee.⁴⁹ In 2016, the national median annual wage for web developers was \$66,130, and in 2016, Tennessee's annual mean wage for web developers was \$55,800.⁵⁰

As shown in the graphic below, web design pathways offer students who are interested in an occupation as a web developer should develop skills in critical thinking, operation analysis, complex problem-solving and programming. More specifically, they should demonstrate proficiency using software such as C, Microsoft Visual Basic, HTML, Java Script, C++, Microsoft Active X, and multimedia publishing tools like Flash.

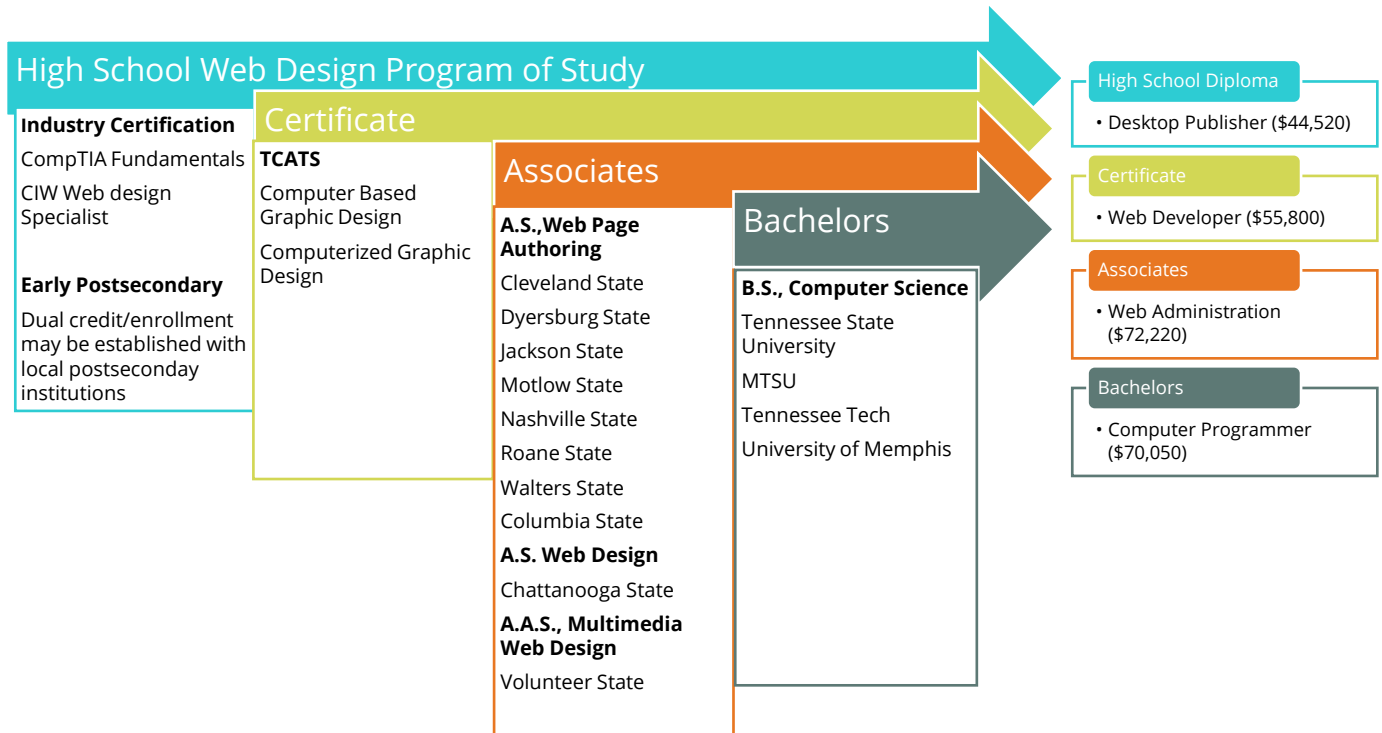
⁴⁶ Tennessee Department of Labor and Workforce Development, Job4TN Online. (2017). *Occupational Projections (Long-term)*. Retrieved from <https://www.jobs4tn.gov/vosnet/analyzer/results.aspx?session=occproj>

⁴⁷ O*Net Online, *Web Developers*, on the Internet at <http://www.onetonline.org/link/summary/15-1134.00> (visited June 8, 2017).

⁴⁸ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2015-16 Edition*, Web Developers, on the Internet at <http://www.bls.gov/ooh/computer-and-information-technology/web-developers.htm> (visited June 8, 2017).

⁴⁹ Tennessee Department of Labor and Workforce Development. (2017). *Occupation Details: Supply and Demand Data*, Web Developers, on the Internet at <https://www.jobs4tn.gov> (visited June 8, 2017).

⁵⁰ O*Net Online, *Web Developers*, on the Internet at <http://www.onetonline.org/link/summary/15-1134.00> (visited June 8, 2017).



Although education for web developers varies by employer, most students will be able to enter the occupation with an associate's degree in web page design. However, for students who want to advance in their careers and earn higher salaries, a bachelor's degree in computer science or management information systems should be attained.⁵¹ Upon completing a postsecondary education, students will find that the top industries seeking web developers are Data Processing and Hosting services; Computer Systems Design services; Advertising and Public Relations services; and Management, Scientific and Technical Consultation services.⁵²

⁵¹ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2016-17 Edition*, How to Become a Web Developer, on the Internet at <http://www.bls.gov/ooh/computer-and-information-technology/web-developers.htm#tab-4> (June 8, 2017).

⁵² Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Employment and Wages, 2016*, Web Developers, on the Internet at <http://www.bls.gov/OES/current/oes151134.htm> (visited June 8, 2017).

Current Secondary Landscape

In the 2016-2017 school year, 48 schools in Tennessee responded to the demand to grow local talent in emerging information technology fields and instituted special programs of study in web design. District data from SY 17-18 suggest that 62 schools will implement Web Design at the beginning of the SY.⁵³ These figures demonstrate that there is an appetite among schools—and students—to explore networking at the high school level, which bodes well for the growing number of postsecondary institutions to offer web design related programs.

Figure 5. Open Enrollment Analysis⁵⁴

Web Design	
2014-15	34
2015-16	37
2016-17	48
2017-18	62

Student Enrollment⁵⁵

SY	Computer Science Foundations	Web Design Foundations	Website Development	Web Design Practicum
2013-14	1380	546	175	0
2014-15	1586	2731	614	0
2015-16	3139	2151	619	81

Web Design Concentrators⁵⁶

Networking	
2013-14	28
2014-15	290
2015-16	373

⁵³ Tennessee Department of Education. (2017). Student Enrollment Data. Retrieved from Author's calculation of student enrollment data.

⁵⁴Tennessee Department of Education. (2017). Student Enrollment Data. Retrieved from Author's calculation of student enrollment data.

⁵⁵ Tennessee Department of Education. (2017). *Student Enrollment Data*. Retrieved from Author's calculation of student enrollment data.

⁵⁶ Tennessee Department of Education. (2017). Student Enrollment Data. Retrieved from Author's calculation of student enrollment data.

Recommendation

Through advisory council meetings and discussions with industry and postsecondary partners, it is the recommendation to add cloud technology, Internet of Things (IoT), and data analytics standards to the Level 1: Computer Science Foundations course as an introduction to emerging technologies. These recommendations will add rigor and relevancy to the established courses already in place.

2018-2019 Program of Study	Level 1	Level 2	Level 3	Level 4
Web Design	Computer Science Foundations (6095)	Web Design Foundations (6100)	Web Site Development (6102) -or- Dual Enrollment Web Design (4115)	Web Design Practicum (6171) -and/or- AP Computer Science (3635) -or- Dual Enrollment Web Design (4115)
		AP Computer Science Principles (3634)		
	Industry Certification: Comp TIA Fundamentals		Industry Certification: CIW Web Design Specialist	

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- Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Employment and Wages, 2016*, Web Developers. Retrieved from: <http://www.bls.gov/OES/current/oes151134.htm>
- Career One Stop. (2017). *Occupation Profile, State and National Trends*. Retrieved from <http://www.onetonline.org/link/summary/15-1134.00>
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- Tennessee Department of Labor and Workforce Development. (2017). *Occupation Details: Supply and Demand Data*, Web Developers. Retrieved from: <https://www.jobs4tn.gov>
- Tennessee Department of Education. (2017). Student Enrollment Data. Retrieved from Author's calculation of student enrollment data.

Cybersecurity

Information Technology

2017-2018 Program of Study	Level 1	Level 2	Level 3	Level 4
Cybersecurity	Computer Science Foundations (6095)	Cybersecurity I (6175)	Cybersecurity II (6176) -or- Dual Enrollment Cybersecurity (6191)	Cybersecurity Practicum (6177) -and/or- AP Computer Science Principles (3634) -or- Dual Enrollment Cybersecurity (6191)
	Industry Certification: CompTIA IT Fundamentals		Industry Certification: CompTIA Security +	

Description

The cybersecurity program of study is designed for students interested in protecting computers, networks, programs and data from unintended or unauthorized access, change or destruction. Cybersecurity is either a stand-alone career or it can be used with other computer applications as a major aspect of broader computer science occupations. This program offers a sequence of courses that provides coherent and rigorous content aligned with challenging academic standards and relevant technical knowledge and skills needed to prepare for further education and cybersecurity-related careers in the Information Technology career cluster; provides technical skill proficiency, and includes competency-based applied learning that contributes to the academic knowledge, higher-order reasoning and problem-solving skills, work attitudes, general employability skills, technical skills, and occupation-specific skills, and knowledge of all aspects of cybersecurity. The content includes but is not limited to foundational knowledge and skills in computer and network security, security vulnerabilities, attack mechanisms and techniques, intrusion detection and prevention, cryptographic systems, system hardening, risk identification, incidence response, penetration testing, key management, access control, and recovery. Specialized courses focus on database security, planning and analysis, software, and web security.

Job Outlook

Network outages, data compromised by hackers, computer viruses and other incidents affect our lives in ways that range from inconvenient to life-threatening. As the number of mobile users, digital applications and data networks increase, so do the opportunities for exploitation. Governments, military, corporations, financial institutions, hospitals and other businesses collect, process and store a great deal of confidential information on computers and transmit that data across networks to other computers. With the growing volume and sophistication of cyber attacks, ongoing attention is required to protect sensitive business and personal information, as well as safeguard national security. During a Senate hearing in March 2013, the nation's top intelligence officials warned that cyber attacks and digital spying are the top threat to national security, eclipsing terrorism.

According to the US News and World Report on education, cybersecurity is ranked #5 out of 11 hot college majors.⁵⁷ Companies and government agencies are moving aggressively to protect their computer systems. Cyber-attacks have grown in frequency, and analysts will be needed to come up with innovative solutions to avert hackers from taking critical information or creating issues for computer networks. Between 2014 and 2016, the Pentagon is planning to add more than 4,000 experts at its Cyber Command. Specialists in cybersecurity can also expect to find openings in health care, energy and at security services firms.⁵⁸

The need for this pathway to be included in our Information Technology cluster is supported by the projected robust job growth both in Tennessee and nationally. ⁵⁹ ⁶⁰ The change of employment from 2014-2024 is expected to grow 18 percent nationally and 35 percent in Tennessee which is much faster than average. ⁶¹

Occupations in this program of study have bright outlooks nationally and statewide. **Figure 1 and Figure 2** outline the related career opportunities in Tennessee.

⁵⁷ US News and World Report, *Discover 11 Hot College Majors That Lead to Jobs*. Online at: <http://www.usnews.com/education/best-colleges/articles/2013/09/10/discover-11-hot-college-majors-that-lead-to-jobs> (Visited on June 8, 2017)

⁵⁸ US News and World Report, *Discover 11 Hot College Majors That Lead to Jobs*. Online at: <http://www.usnews.com/education/best-colleges/articles/2013/09/10/discover-11-hot-college-majors-that-lead-to-jobs> (Visited on June 8, 2017)

⁵⁹ O*Net Online on the Internet at <http://www.onetonline.org>, (visited June 8, 2017).

⁶⁰ Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, 2016-2017 Edition, <http://www.bls.gov/oes/>, (visited June 8, 2017)

⁶¹ Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, 2016-17 Edition, <http://www.bls.gov/ooh/computer-and-information-technology/information-security-analysts.htm#tab-1> (visited on June 8, 2017)

Figure 1. Tennessee long term employment projections for cybersecurity-related occupations in Tennessee for the 2014-2024 projection period.^{62,63}

Occupation	2014 Estimated Employment	2024 Projected Employment	Total 2014- 2024 Employment Change	Total Percent Change	Median Salary
Information Security Analyst	840	1,140	40	+36%	\$76,250
Computer Systems Analyst	9,440	12,370	440	+31%	\$72,220
Computer Network Architect	1,530	1,900	60	+25%	\$93,490

Figure 2. State and national trends for cybersecurity-related occupations with positive projections 2014-24^{64,65,66}

United States	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Information Security Analyst	82,900	97,700	+18%	2,550
Tennessee	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Information Security Analyst	840	1,140	+36%	40

⁶² Tennessee Department of Labor and Workforce Development, Job4TN Online. (2017). *Occupational Projections (Long-term)*. Retrieved from <https://www.jobs4tn.gov/vosnet/analyzer/results.aspx?session=occproj>

⁶³ Tennessee Department of Labor and Workforce Development, Job4TN Online. (2017). *Occupational Employment and Wage Rates (OES)*. Retrieved from <https://www.jobs4tn.gov/vosnet/analyzer/results.aspx?session=occproj>

⁶⁴ Career One Stop. (2017). *Occupation Profile, State and National Trends*. Retrieved from <http://www.onetonline.org/link/summary/15-1122.00>

⁶⁵ Career One Stop. (2017). *Occupation Profile, State and National Trends*. Retrieved from <https://www.onetonline.org/link/summary/15-1121.00>

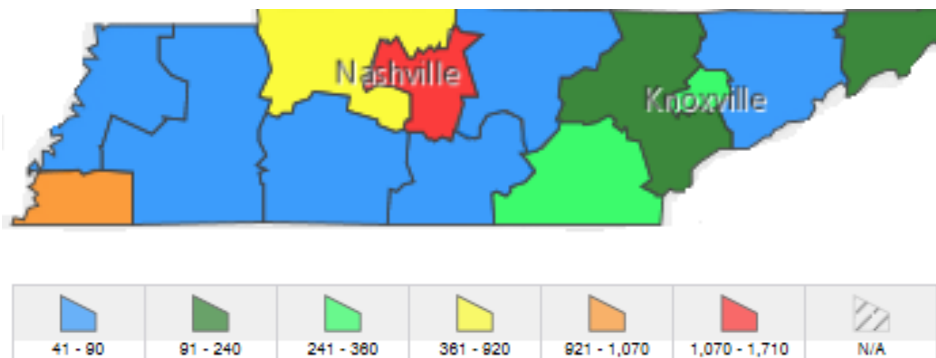
⁶⁶ Career One Stop. (2017). *Occupation Profile, State and National Trends*. Retrieved from <https://www.onetonline.org/link/summary/15-1143.00>

United States	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Computer Systems Analyst	567,800	686,300	+21%	19,160
Tennessee	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Computer Systems Analyst	9,440	12,370	+31%	440

United States	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Computer Network Architect	146,200	158,900	9%	3,150
Tennessee	Employment		Percent Change	Projected Annual Job Openings
	2014	2024		
Computer Network Architect	1,530	1,900	+25%	60

Job opportunities for Information Security Analysts occupations are strongest in urban and surrounding areas in Tennessee. **Figure 3** shows that more cybersecurity occupations in Tennessee are employed and needed in the Memphis and Nashville areas than in surrounding areas.

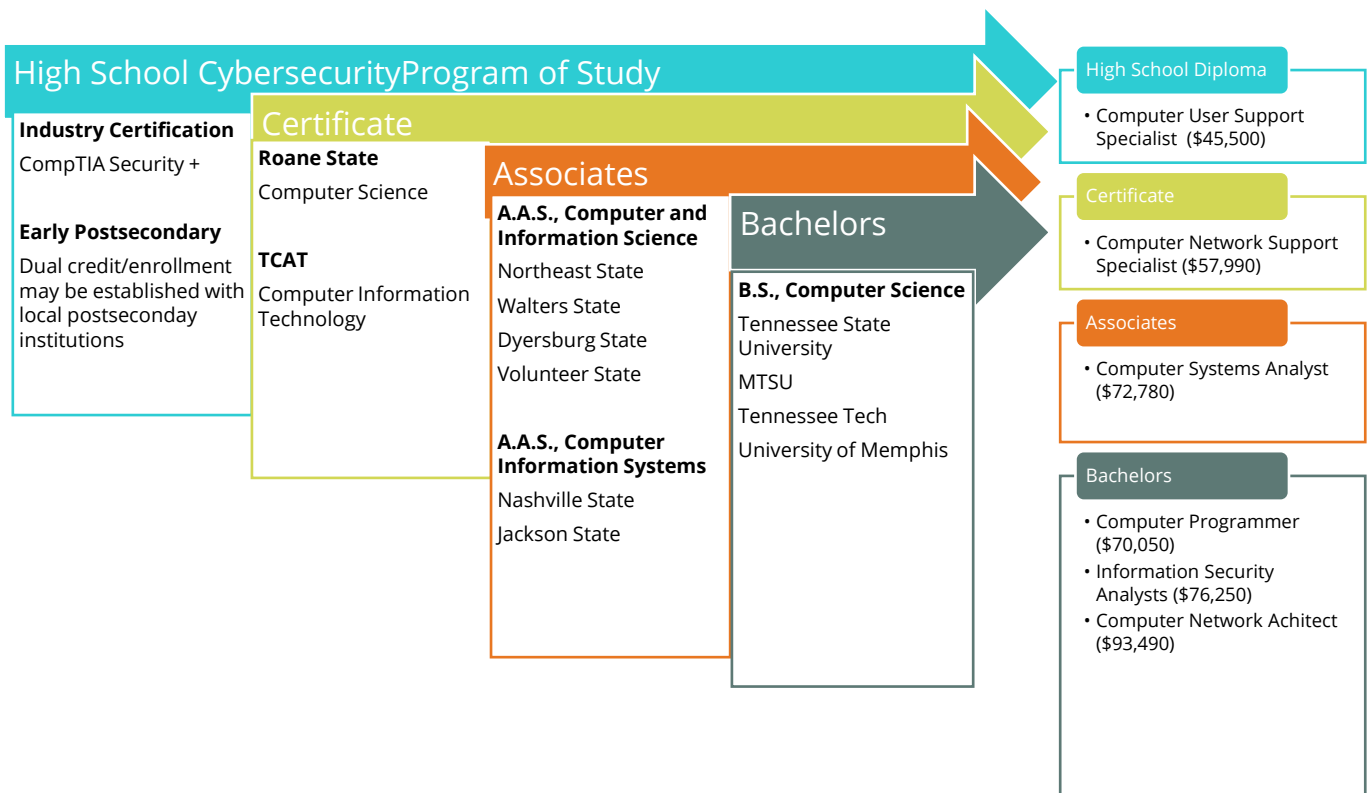
Figure 3. 2014 Estimated Employment⁶⁷



⁶⁷ Tennessee Department of Labor and Workforce Development, Job4TN Online. (2017). *Occupational Projections (Long-term)*. Retrieved from <https://www.jobs4tn.gov/vosnet/analyzer/results.aspx?session=occproj>

Postsecondary Pathways

Although education for information security analysts varies by employer, most students will be able to enter the occupation with an associate’s degree in computer science. However, for students who want to advance in their careers and earn higher salaries, a bachelor’s degree in computer science or management information systems should be attained.⁶⁸ Upon completing a postsecondary education, students will find that the top industries seeking information security analysts are Management, Scientific and Technical Consultation services; depository credit intermediation; computer systems design and related services; and management of companies and enterprises.⁶⁹



⁶⁸ Bureau of Labor Statistics, U.S. Department of Labor, on the Internet at <http://www.bls.gov/ooh/computer-and-information-technology/information-security-analysts.htm#tab-5> (visited June 8, 2017)

⁶⁹ Bureau of Labor Statistics, U.S. Department of Labor, on the Internet at <http://www.bls.gov/ooh/computer-and-information-technology/information-security-analysts.htm#tab-5> (visited June 8, 2017)

Current Secondary Landscape

In the 2017-2018 school year, 19 schools in Tennessee responded to the demand to grow local talent in emerging information technology fields and will institute a special program of study in cybersecurity. These figures demonstrate that there is an appetite among schools—and students—to explore cybersecurity at the high school level, which bodes well for the growing number of postsecondary institutions to offer cybersecurity related programs.

Figure 5. Open Enrollment Analysis⁷⁰

Cybersecurity	
2014-15	0
2015-16	0
2016-17	0
2017-18	19

Recommendation

Through advisory council meetings and discussions with industry and postsecondary partners, it is the recommendation to add cloud technology, Internet of Things (IoT), and data analytics standards to the Level 1: Computer Science Foundations course as an introduction to emerging technologies. These recommendations will add rigor and relevancy to the established courses already in place.

⁷⁰Tennessee Department of Education. (2017). Student Enrollment Data. Retrieved from Author’s calculation of student enrollment data.

2018-2019 Program of Study	Level 1	Level 2	Level 3	Level 4
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	AP Computer Science Principles (3634)			
	Industry Certification: CompTIA IT Fundamentals	Industry Certification: CompTIA A+	Industry Certification: CompTIA Network+	Industry Certification: CompTIA Security + Industry Certification: Associate of ISC ²

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