

Program of Study Justifications for Information Technology

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(Coding) Programming & Software Development

2016-17 Program of Study	Level 1	Level 2	Level 3	Level 4
Programming & Software Development	Information Technology Foundations (6905)	Programming and Logic I (6098)	Programming and Logic II (6099)	Programming and Software Development Practicum (5908) -and/or- AP Computer Science or AP Computer Science Principles (3635)

Description

The Programming & Software Development program is study 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 program of study 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. Upon completion of this course, 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, the rate of employment is expected to grow in these occupations (See Figure 1 for details). Computer Programmers will grow at a slower rate (4 percent) compared to Software Developers (10 percent). However, related occupations as Computer Systems Analysts (13 percent) will increase well above average growth.²

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 February 26, 2016).

² Jobs4Tn online at www.jobs4tn.gov (visited February 26, 2016).

Although these occupations are all related to Programming and Software Development, 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

Figure 1. Employment Projection of Programming and Software Development Occupations in Tennessee (2014 – 2024)

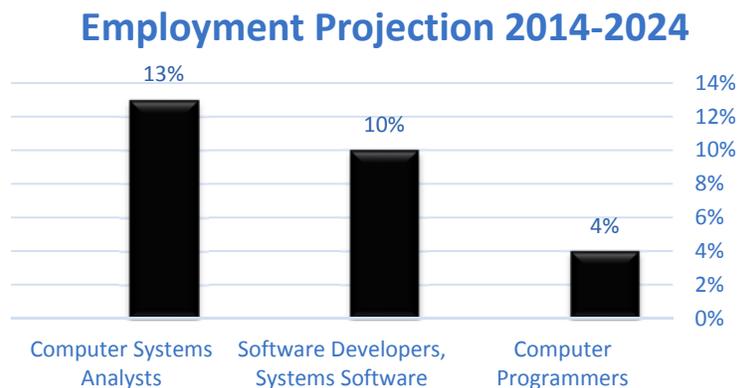


Figure 2. Annual Wages and Potential Candidate Projections

Occupation	Correlation to growth in jobs	Potential Candidates for every job opening in Tennessee*	National Annual Median Wage (2014)	State Annual Mean Wage (2014)
Computer Systems Analysts	Growth in cloud computing cybersecurity, and mobile networks.	.17	\$82,710	\$77,270
Software Developers (Systems)	Increase in the demand for computer software.	.11	\$102,880	\$85,850
Computer Programmers	Increase in the demand of computer systems	.05	\$77,650	\$72,980

³ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, Software Developers, <http://www.bls.gov/ooh/computer-and-information-technology/software-developers.htm> (visited February 26, 2016).

⁴ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, Computer Programmers, <http://www.bls.gov/ooh/computer-and-information-technology/computer-programmers.htm> (visited February 26, 2016).

⁵ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, Computer Systems Analysts, <http://www.bls.gov/ooh/computer-and-information-technology/computer-systems-analysts.htm> (visited February 26, 2016).

As shown in the graphic below, programming and software development requires students who are interested in these occupations to develop 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.⁶

Figure 3. Knowledge, Skills, and Hiring Industries for Programming and Software Development Occupations⁷

Occupation	Knowledge	Skills	Hiring Industries
Computer Systems Analysts	Configuration management software, development environment software, enterprise application software, object or component oriented development software, program testing software, web platform development software	Critical thinking, systems analysis, complex problem solving, programming, systems evaluation	Computer systems design and related services; management of companies and enterprises; insurance carriers; state government, data processing, hosting and related services.
Software Developers (Systems)	Design techniques, tools, and principles; database management software; development environment software; object or component oriented development software; web platform development software; program testing software	Critical thinking, complex problem solving, social perceptiveness, mathematics	Computer systems design and related services; computer and peripheral equipment manufacturing; software publishers; architectural, engineering, and related services; navigational, measuring, electromedical, and control instruments manufacturing.
Computer Programmers	Compiler and decompiler software, database management software, development environment software, object or component oriented development software, web platform development software	Programming, complex problem solving, critical thinking, quality control analysis, operations analysis, systems evaluation, time management.	Computer systems design and related services; software publishers; management of companies and enterprises; employment services; and insurance carriers

⁶O*Net Online on the Internet at <http://www.onetonline.org/> (visited February 26, 2016).

⁷O*Net Online on the Internet at <http://www.onetonline.org/> (visited February 26, 2016).

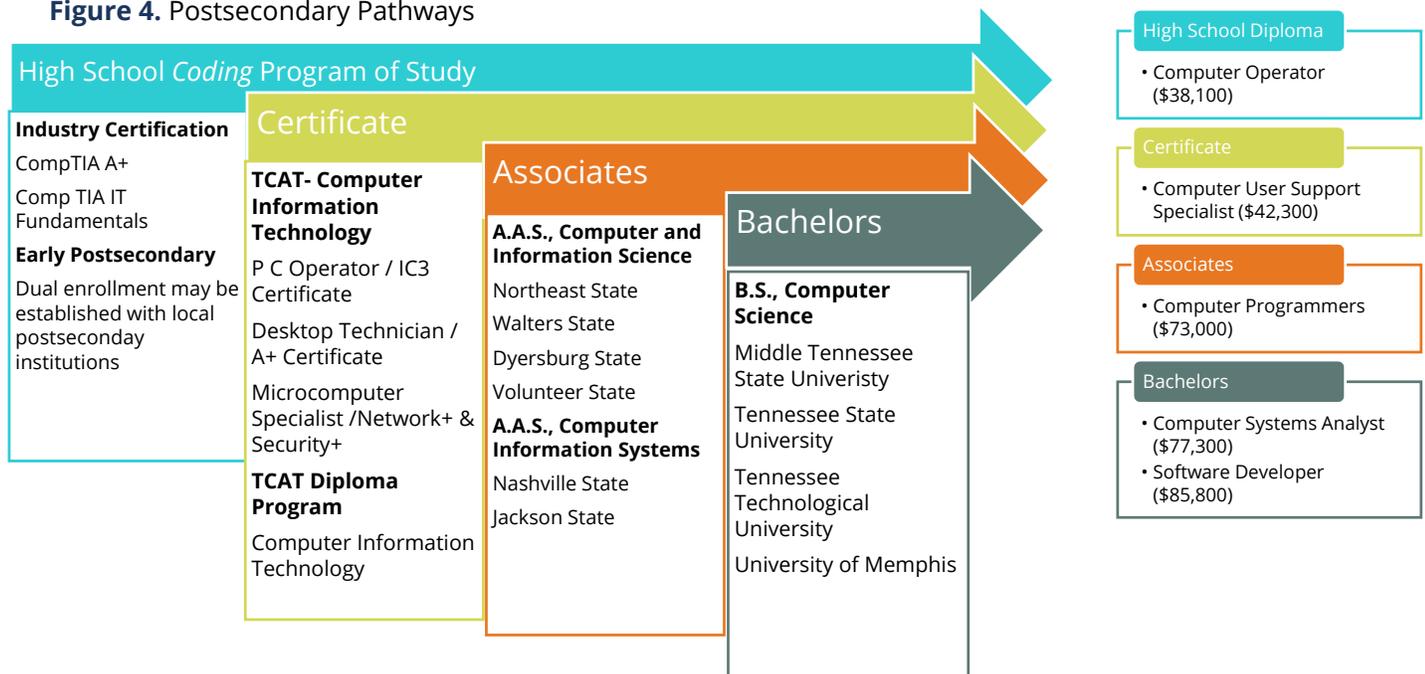
Upon completing a postsecondary education, students will find that the top industries seeking software developers are computer systems design services, software publishers, management of companies and enterprises, insurance carriers, and management, scientific, and technical consulting services.⁸ Please see Table 3 for details.

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 find that occupations in various companies can include: software engineer, IT director, and computer and information systems managers.⁹

Postsecondary Pathways

Although some organizations will hire at the associate’s degree level, bachelor’s degree is the typical educational level one would need to attain prior to entering these occupations. For example, 45 -50 percent of adults, who are 25 years and older in software developer, computer systems analyst, computer programmer occupations had at least a bachelor’s degree during 2012-2013.¹⁰ As a result of growth in job openings, Tennessee may see a demand in these occupations. For example, Jobs4TN.gov reported that there were .11 potential candidates for every software developer (systems software) job opening in Tennessee.¹¹ In 2014, the national median annual wage for software developers was \$102,880, and in 2014, Tennessee’s annual mean wage for software developers was \$85,850.¹²

Figure 4. Postsecondary Pathways



⁸ O*Net Online on the Internet at <http://www.onetonline.org/> (visited February 26, 2016).

⁹ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, <http://www.bls.gov/oes/> (visited February 26, 2016).

¹⁰ Bureau of Labor Statistics, U.S. Department of Labor, *National Occupational Data, December 2015*, Table 1.11. (visited February 26, 2016).

¹¹ Tennessee Department of Labor and Workforce Development. (2015). *Occupation Details: Supply and Demand Data*, Software Developer (systems), on the Internet at www.Jobs4Tn.gov (visited February 26, 2016).

¹² O*Net Online on the Internet at <http://www.onetonline.org/> (visited February 26, 2016).

Current Secondary Landscape

In the 2014-15 school year, 29 schools in Tennessee responded to the demand to grow local talent in emerging information technology fields and instituted special programs of study in Programming & Software Development. District data from SY 15-16 suggests that 28 schools will implement Programming & Software Development at the beginning of the new SY.¹³ These figures demonstrate that while there is an appetite among schools—and students—to explore technology programs of study at the high school level, we will need to add and revise courses to meet the demand of industry and its changing needs.

Figure 5. Open enrollment analysis

		Programming & Software Development
2014-15		29
2015-16		28
		<i>Decrease (-1)</i>

Recommendation

The department recommends changing the name of the Level 1 course from **Information Technology Foundations** to **Computer Science Foundations**. Studying computer science can prepare a student to enter many career areas, both within and outside of computing. Our three programs of study in the Information Technology Cluster encompass three out of four building blocks needed already for a robust computer science pathway. Once students complete the Level 1 **Computer Science Foundations**, they may choose their focus for Levels 2 and 3 to obtain an emphasis in programming & software development, networking systems, web design, or cybersecurity. The capstone programs will consist of practicum courses and AP Computer Science offerings.

The department also recommend creating a new course, **Mobile App Development**, to be added as a Level 3 option. This will allow flexibility to meet the needs for both the student and industry demands. By adding this course, we will in fact add the rigor and new technology that this POS demands.

Finally, the department recommends changing the name of the POS to coding to avoid confusion of districts not knowing where this occupational area falls within the promoted POS.

¹³ Author's calculation of student enrollment data received from the Tennessee Department of Education, 2015.



2017-18 Program of Study	Level 1	Level 2	Level 3	Level 4
Coding	Computer Science Foundations (6095)	Coding I (6098)	Coding II (6099) -or- Mobile App Development -or- Dual Enrollment Coding (4113)	Coding Practicum (5908) -and/or- AP Computer Science (3635) -and/or- AP Computer Science Principles (3634) -or- Dual Enrollment Coding (4113)
	Industry Certification: CompTIA IT Fundamentals		Industry Certification: Comp TIA A+	

References:

Tennessee Department of Labor and Workforce Development. (2014). *Tennessee's Hot Careers to 2022*. Retrieved from:

http://www.tn.gov/assets/entities/labor/attachments/statewide_2020outlooks.pdf

Jobs4Tn online at www.jobs4tn.gov

Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, Software Developers, <http://www.bls.gov/ooh/computer-and-information-technology/software-developers.htm>

Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 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, 2014-15 Edition*, Computer Systems Analysts, <http://www.bls.gov/ooh/computer-and-information-technology/computer-systems-analysts.htm>

Bureau of Labor Statistics, U.S. Department of Labor, *National Occupational Data, December 2015*,

Table 1.11.

Tennessee Department of Labor and Workforce Development. (2015). *Occupation Details: Supply and Demand Data*, Software Developer (systems). Retrieved from: www.jobs4Tn.gov

O*Net Online. Retrieved from: <http://www.onetonline.org/>

Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, <http://www.bls.gov/oes/>

Author's calculation of student enrollment data received from the Tennessee Department of Education, 2015.



Networking Systems

2016-17 Program of Study	Level 1	Level 2	Level 3	Level 4
Networking Systems	Information Technology Foundations (6905)	Computer Systems (6094)	Networking (6097)	Cabling and Internetworking (6093) -and/or- IT Clinical Internship (6096)

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

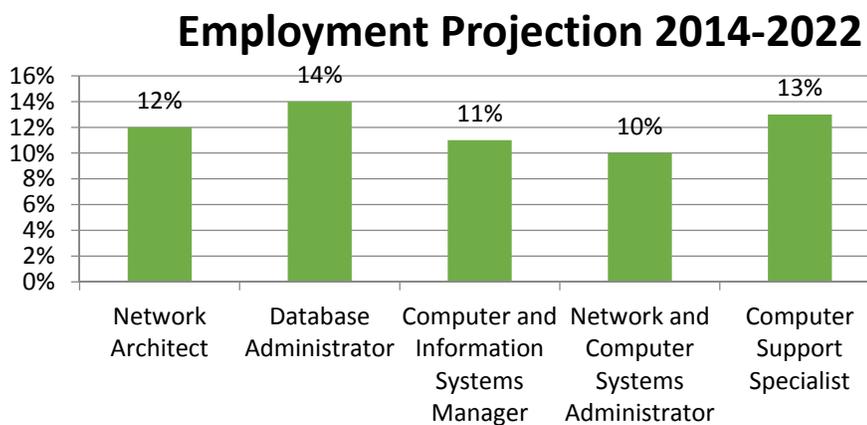
The Tennessee Department of Labor and Workforce Development listed five information technology jobs on the list of *Hot Careers to 2022*. Among these careers were Network and Computer Systems Administrators, Computer and Information Systems Managers, and Computer User Support Specialists.¹⁴ According 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 (13 percent) compared to Network and Computer Systems Administrators (10 percent) or Computer and Information Systems Managers (11 percent), all at above average growth.¹⁵

¹⁴ 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 February 26, 2016).

¹⁵ O*Net Online on the Internet at <http://www.onetonline.org/> (visited February 26, 2016).

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.¹⁶ Database Administrators use specific software to store, organize, and secure data from unauthorized access.¹⁷ Computer and Information Systems Managers plan, direct, or coordinate activities in such fields as electronic data processing, information systems, systems analysis, and computer programming.¹⁸ 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.¹⁹ 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.²⁰

Figure 1. Employment Projection of Networking Systems Occupations in Tennessee (2014 - 2022)



¹⁶Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, Computer Network Architects, <http://www.bls.gov/ooh/computer-and-information-technology/computer-network-architects.htm> (visited February 26, 2016).

¹⁷Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, Database Administrators, <http://www.bls.gov/ooh/computer-and-information-technology/database-administrators.htm> (visited February 26, 2016).

¹⁸ Bureau of Labor Statistics, U.S. Department of Labor on the internet at: <http://www.bls.gov/oes/current/oes113021.htm> (visited February 26, 2016).

¹⁹Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, Network and Computer Systems Administrators, <http://www.bls.gov/ooh/computer-and-information-technology/network-and-computer-systems-administrators.htm#tab-2> (visited February 26, 2016).

²⁰Bureau of Labor Statistics, U.S. Department of Labor on the internet at: <http://www.bls.gov/soc/2010/soc151152.htm> (visited February 26, 2016).

Figure 2. Annual Wages and Potential Candidate Projections

Occupation	Correlation to growth in jobs	Potential Candidates for every job opening in Tennessee*	National Annual Median Wage (2014)	State Annual Mean Wage (2014)
Network Architect	Increase in use of wireless and mobile networks	.16	\$98,430	\$98,970
Database Administrator	Increase in company's data needs	.18	\$80,280	\$79,470
Computer and Information Systems Manager	Expansion to digital platforms	2.33	\$127,640	\$104,950
Network and Computer Systems Administrator	Increase in the adoption of cloud services by small and medium-sized businesses who do not have their own dedicated information technology departments	.66	\$75,790	\$68,650
Computer Support Specialist	Increase in support services will be needed as organizations upgrade their computer equipment and software.	.60	\$47,610	\$42,340

Notes: *Data accessed at www.jobs4TN.gov on February 29, 2016.

Students who are interested in an occupation as a Network and Computer Systems Administrator 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.²¹ Please see Table 3 for details on the following occupations: Network Architects, Database Administrators, Computer and Information Systems Managers, and Computer Support Specialists.

²¹ O*Net Online, Network and Computer Systems Administrators, on the Internet at <http://www.onetonline.org/link/summary/15-1142.00> (visited February 29, 2016).

Figure 3: Knowledge, Skills, and Hiring Industries for Programming and Software Development Occupations^{22 23}

Occupation	Knowledge	Skills	Hiring Industries
Network Architect	Telecommunications, design, Cisco Systems, network operating system enhancement software, network monitoring software, administration management software, switch or router software, network security or virtual private network (VPN) management software.	Critical thinking, systems analysis, operations analysis, complex problem solving, systems evaluation.	Computer systems design and related services; telecommunications; finance and insurance; and management of companies and enterprises.
Database Administrator	Mathematics; backup or archival software; database management software; metadata management software; object or component oriented development software; operating systems software.	Complex problem solving, critical thinking, operations analysis, systems evaluation, and monitoring.	Computer systems design services, educational services (state, local, and private), information, finance and insurance, and management of companies and enterprises.
Computer and Information Systems Manager	Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware, software, programming, mathematics, business management, human resources modeling, leadership techniques, production methods, and coordination of people and resources.	Critical Thinking, reading comprehension, systems analysis, complex problem solving, judgment and decision making	Computer systems design services, finance and insurance, information, management of companies and enterprises, manufacturing
Network and Computer Systems Administrator	Computers, electronics, English, mathematics, and administration	Critical Thinking, reading comprehension,	Computer systems design and related services, information, educational services (state, local, and private), finance and

²² O*Net Online, on the Internet at <http://www.onetonline.org> (visited February 29, 2016).

²³ Bureau of Labor Statistics, U.S. Department of Labor, Work Environment, 2014. Online at <http://www.bls.gov/ooh/> (visited February 29, 2016)

		systems analysis, complex problem solving, judgment and decision making	insurance, administrative and support services
Computer User Support Specialist	Computers, electronics, customer service, English, telecommunications, and clerical	Active listening, speaking, reading comprehension, critical thinking, and writing	Computer systems design and related services, educational services (state, local, and private), information, administrative and support services, wholesale trade

Postsecondary Pathways

Bachelor's degree is the typical educational level one would need to attain prior to entering these network systems occupations. For example, 40-47 percent of adults, who are 25 years and older in Network and Computer Systems Administrator, Network Architect, and Database Administrator occupations had at least a bachelor's degree during 2012-2013.²⁴ As a result of growth in job openings, some states may see a demand in Network and Computer Systems Administrators. For example, Jobs4TN.gov reported that there were .16 potential candidates for every Network Architect job opening in Tennessee.²⁵ In 2014, the national median annual wage for Network and Computer Systems Administrator was \$75,800,²⁶ and in 2014, Tennessee's annual mean wage for Network and Computer Systems Administrator was \$68,600.²⁷ Please see Table 2 for details on the following occupations: Network Architects, Database Administrators, Computer and Information Systems Managers, Network and Computer Systems Administrators, and Computer Support Specialists.

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.²⁸ 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.

²⁴ Bureau of Labor Statistics, U.S. Department of Labor, *National Occupational Data, December 2015*, Table 1.11. (visited February 26, 2016).

²⁵ Tennessee Department of Labor and Workforce Development. (2015). *Occupation Details: Supply and Demand Data*, Network and Computer Administrators, on the Internet at <http://www.Jobs4Tn.gov> (visited September 3, 2015).

²⁶ O*Net Online, Network and Computer Systems Administrator, on the Internet <http://www.onetonline.org/link/summary/15-1142.00> (visited September 3, 2015).

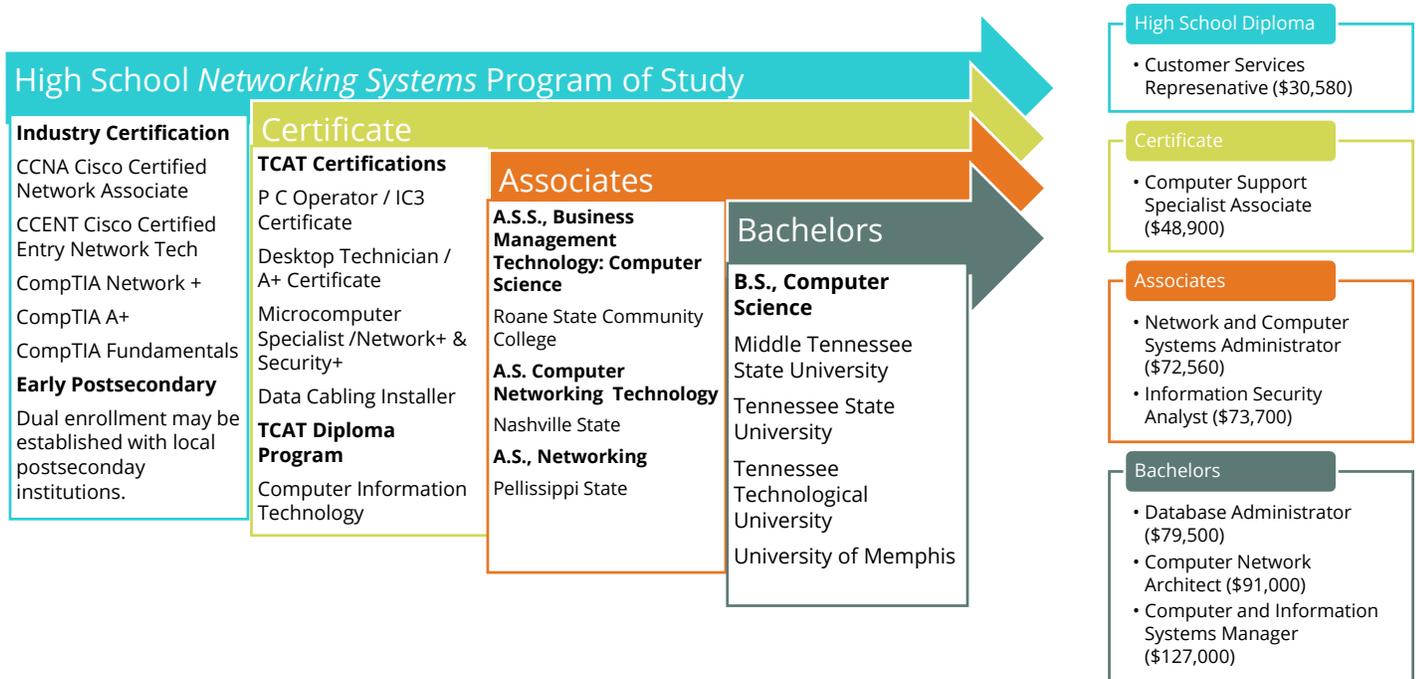
²⁷ O*Net Online, Network and Computer Systems Administrator, on the Internet <http://www.onetonline.org/link/summary/15-1142.00> (visited September 3, 2015).

²⁸ Bureau of Labor Statistics, U.S. Department of Labor, *Work Environment, 2014*. Online at <http://www.bls.gov/ooh/> (visited February 29, 2016)

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 February 29, 2016).

Although education for students interested in computer networking 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 networking should be attained. Upon completing a postsecondary education, students will find that occupations in various companies can include: Computer Support Specialist, Information Security Analyst, Network and Computer Systems Administrator, Database Administrator, Computer Network Architect, or a Computer Hardware Engineer.²⁹

Figure 4. Postsecondary Pathways



Current Secondary Landscape

In the 2014-15 school year, 34 schools in Tennessee responded to the demand to grow local talent in emerging information technology fields and instituted special programs of study in Networking Systems. District data from SY 15-16 suggests that 37 schools will implement Networking Systems at the beginning of the new SY.³⁰ These figures demonstrate that there is an appetite among schools—and students—to explore technology programs of study at the high school level, which bodes well for the growing number of postsecondary institutions to offer technology-related programs.

²⁹ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, Network and Computer Systems Administrators, on the Internet at <http://www.bls.gov/ooh/computer-and-information-technology/network-and-computer-systems-administrators.htm> (visited February 29, 2016).

³⁰ Author’s calculation of student enrollment data received from the Tennessee Department of Education, 2015.

Figure 5. Open enrollment analysis

Networking Systems	
2014-15	34
2015-16	37
	<i>Increase</i>

Recommendation

The department recommends changing the name of the Level 1 course from **Information Technology Foundations** to **Computer Science Foundations**. Studying computer science can prepare a student to enter many career areas, both within and outside of computing. Our three programs of study in the Information Technology Cluster encompass three out of four building blocks needed already for a robust computer science pathway. Once students complete the Level 1 **Computer Science Foundations**, they may choose their focus for Levels 2 and 3 to obtain an emphasis in programming & software development, networking systems, web design, or cybersecurity. The capstone programs will consist of practicum courses and AP Computer Science offerings.

2017-18 Program of Study	Level 1	Level 2	Level 3	Level 4
Networking Systems	Computer Science Foundations (6095)	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)	

References

Tennessee Department of Labor and Workforce Development. (2014). *Tennessee's Hot Careers to 2022*. Retrieved from:

http://www.tn.gov/assets/entities/labor/attachments/statewide_2020outlooks.pdf

O*Net Online on the Internet at <http://www.onetonline.org/>

Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, Computer Network Architects, <http://www.bls.gov/ooh/computer-and-information-technology/computer-network-architects.htm>

Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, Database Administrators, <http://www.bls.gov/ooh/computer-and-information-technology/database-administrators.htm>

Bureau of Labor Statistics, U.S. Department of Labor. Retrieved from:
<http://www.bls.gov/oes/current/oes113021.htm>

Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, Network and Computer Systems Administrators, <http://www.bls.gov/ooh/computer-and-information-technology/network-and-computer-systems-administrators.htm#tab-2>

Bureau of Labor Statistics, U.S. Department of Labor. Retrieved from:
<http://www.bls.gov/soc/2010/soc151152.htm>

Bureau of Labor Statistics, U.S. Department of Labor, *National Occupational Data, December 2015*, Table 1.11.

Tennessee Department of Labor and Workforce Development. (2015). *Occupation Details: Supply and Demand Data*, Network and Computer Administrators, on the Internet at
<http://www.jobs4Tn.gov>

O*Net Online, Network and Computer Systems Administrator. Retrieved from:
<http://www.onetonline.org/link/summary/15-1142.00>

O*Net Online. Retrieved from: <http://www.onetonline.org>

Bureau of Labor Statistics, U.S. Department of Labor, Work Environment, 2014. Retrieved from:
<http://www.bls.gov/ooh/>

Network and Computer Systems Administrators. Retrieved from:
<http://www.bls.gov/ooh/computer-and-information-technology/network-and-computer-systems-administrators.htm#tab-3>

Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, Network and Computer Systems Administrators. Retrieved from:
<http://www.bls.gov/ooh/computer-and-information-technology/network-and-computer-systems-administrators.htm>

Author's calculation of student enrollment data received from the Tennessee Department of Education, 2015.

2016-17 Program of Study	Level 1	Level 2	Level 3	Level 4
Web Design	Information Technology Foundations (6095)	Web Design Foundations (6100)	Web Site Development (6102)	Web Design Practicum (6171) -and/or- AP Computer Science (3635) or AP Computer Science Principles (3634)

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.

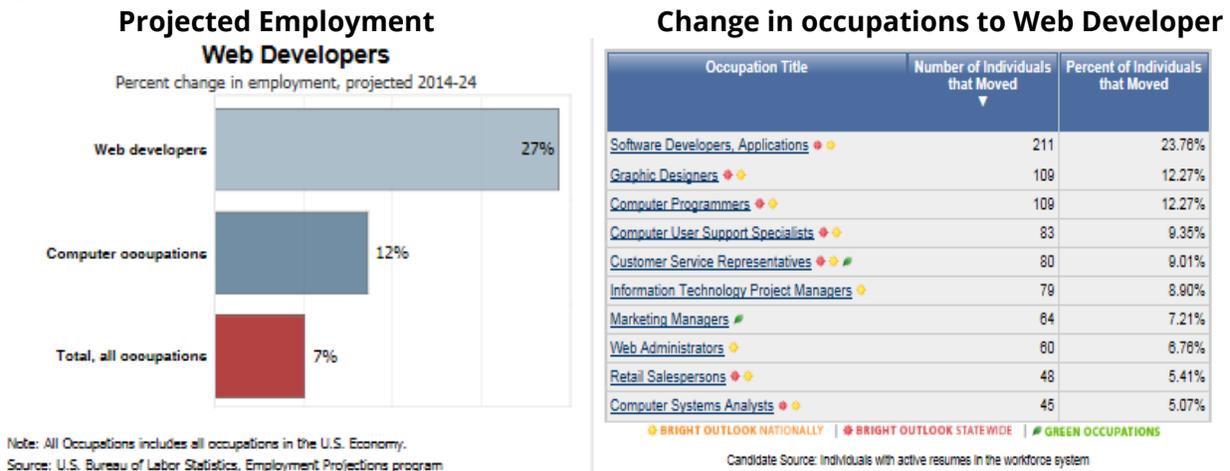
Job Outlook

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.³¹ 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.

³¹ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, Web Developers, on the Internet at <http://www.bls.gov/ooh/computer-and-information-technology/web-developers.htm> (visited February 29, 2016).

Further, individuals in these occupations often times move to other information technology occupations. For example, Jobs4TN.gov reported that over the past five years 23.76 percent of software developers (applications) and 12.27 percent of computer programmers moved to the occupation of web developer.³²

Figure 1.



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.³³ 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 2024.³⁴ 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 .16 potential candidates for every web developer job opening in Tennessee.³⁵ In 2014, the national median annual wage for web developers was \$63,490, and in 2014, Tennessee’s annual mean wage for web developers was \$53,370.³⁶

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

³² Tennessee Department of Labor and Workforce Development. (2014). *Occupation Profile: Occupational Details: Career Ladder*, on the Internet at www.jobs4tn.gov (visited February 29, 2016).

³³ O*Net Online, *Web Developers*, on the Internet at <http://www.onetonline.org/link/summary/15-1134.00> (visited February 29, 2016).

³⁴ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, Web Developers, on the Internet at <http://www.bls.gov/ooh/computer-and-information-technology/web-developers.htm> (visited February 29, 2016).

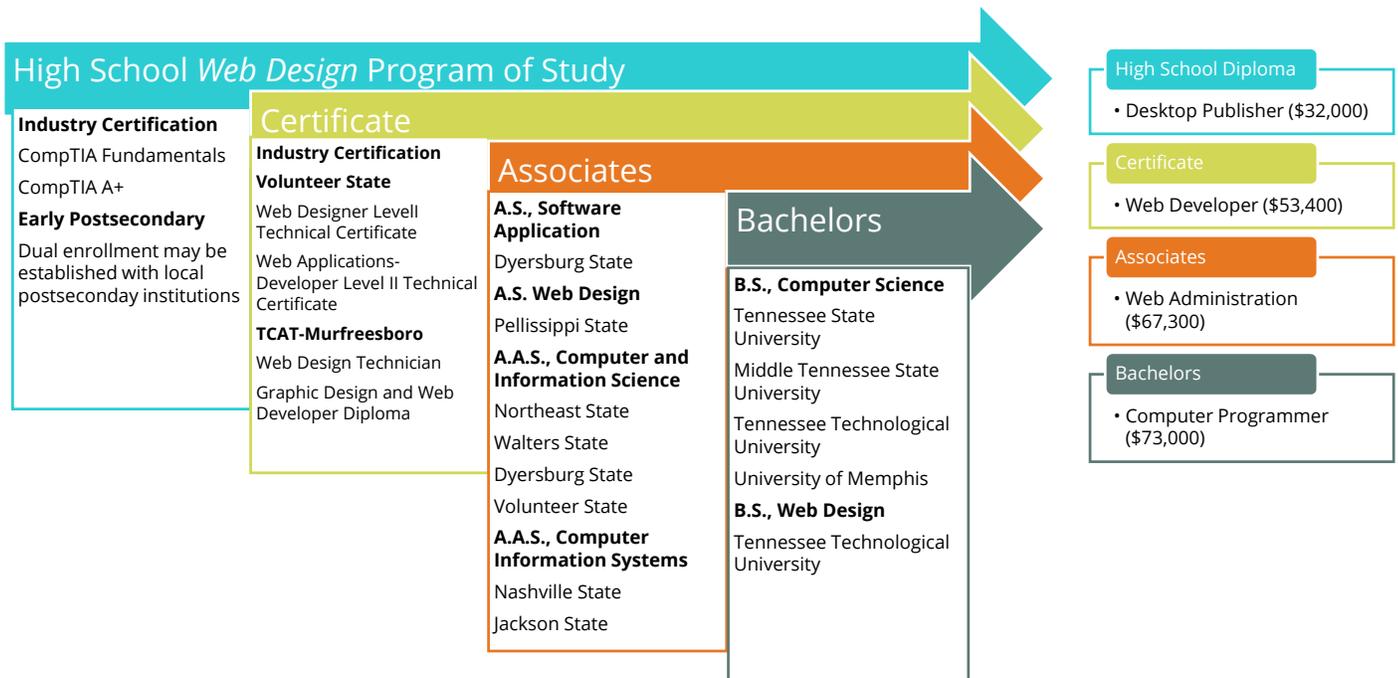
³⁵ Tennessee Department of Labor and Workforce Development. (2014). *Occupation Details: Supply and Demand Data*, Web Developers, on the Internet at <https://www.jobs4tn.gov> (visited February 29, 2016).

³⁶ O*Net Online, *Web Developers*, on the Internet at <http://www.onetonline.org/link/summary/15-1134.00> (visited February 29, 2016).

Basic, HTML, Java Script, C++, Microsoft Active X, and multimedia publishing tools like Flash. Prior to pursuing postsecondary education, students are eligible to earn industry certifications such as the Internet and Computing Core Certification (IC3). This certification does not require prior work experience.

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.³⁷ 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.³⁸

Figure 2. Postsecondary Pathways



³⁷ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 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> (February 29, 2016).

³⁸ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Employment and Wages, 2013*, Web Developers, on the Internet at <http://www.bls.gov/OES/current/oes151134.htm> (visited February 29, 2016).

Current Secondary Landscape

In the 2014-15 school year, 72 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 15-16 suggests that 47 schools will implement Web Design at the beginning of the new SY.³⁹ These figures demonstrate that while there is an appetite among schools—and students—to explore technology programs of study at the high school level, we will need to add and revise courses to meet the demand of industry and its changing needs.

Figure 3. Open enrollment analysis

		Web Design
2014-15		72
2015-16		47
		<i>Decrease</i>

Recommendation

The department recommends changing the name of the Level 1 course from **Information Technology Foundations** to **Computer Science Foundations**. The three programs of study in the Information Technology Cluster encompass three out of four building blocks needed already for computer science pathway. Once students complete the Level 1 **Computer Science Foundations**, they may choose their focus for Levels 2 and 3 to obtain an emphasis in programming & software development, networking systems, web design, or cybersecurity. The capstone programs will consist of practicum courses and AP Computer Science offerings.

³⁹ Author's calculation of student enrollment data received from the Tennessee Department of Education, 2015.

2017-18 Program of Study	Level 1	Level 2	Level 3	Level 4
Web Design	Computer Science Foundations (6095)	Web Design Foundations (6100)	Web Site Development (6101) -or- Dual Enrollment Web Design (4115)	Web Design Practicum (6171) -and/or- AP Computer Science (3635) -and/or- AP Computer Science Principles (3634) -or- Dual Enrollment Web Design (4115)
	Industry Certification: CompTIA IT Fundamentals		Industry Certification: CIW Web Design Specialist	

References

Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, Web Developers. Retrieved from: <http://www.bls.gov/ooh/computer-and-information-technology/web-developers.htm>

Tennessee Department of Labor and Workforce Development. (2014). *Occupation Profile: Occupational Details: Career Ladder*. Retrieved from: www.jobs4tn.gov

O*Net Online, *Web Developers*. Retrieved from: <http://www.onetonline.org/link/summary/15-1134.00>

Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, Web Developers. Retrieved from: <http://www.bls.gov/ooh/computer-and-information-technology/web-developers.htm>

Tennessee Department of Labor and Workforce Development. (2014). *Occupation Details: Supply and Demand Data*, Web Developers. Retrieved from: <https://www.jobs4tn.gov>

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Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2014-15 Edition*, How to Become a Web Developer. Retrieved from: <http://www.bls.gov/ooh/computer-and-information-technology/web-developers.htm#tab-4>

Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Employment and Wages, 2013*, Web Developers. Retrieved from: <http://www.bls.gov/OES/current/oes151134.htm>

Author's calculation of student enrollment data received from the Tennessee Department of Education, 2015.

2017-18 Program of Study	Level 1	Level 2	Level 3	Level 4
Cybersecurity	Computer Science Foundations	Cybersecurity I	Cybersecurity II	Cybersecurity Practicum -and/or- AP Computer Science or AP Computer Science Principles
	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.

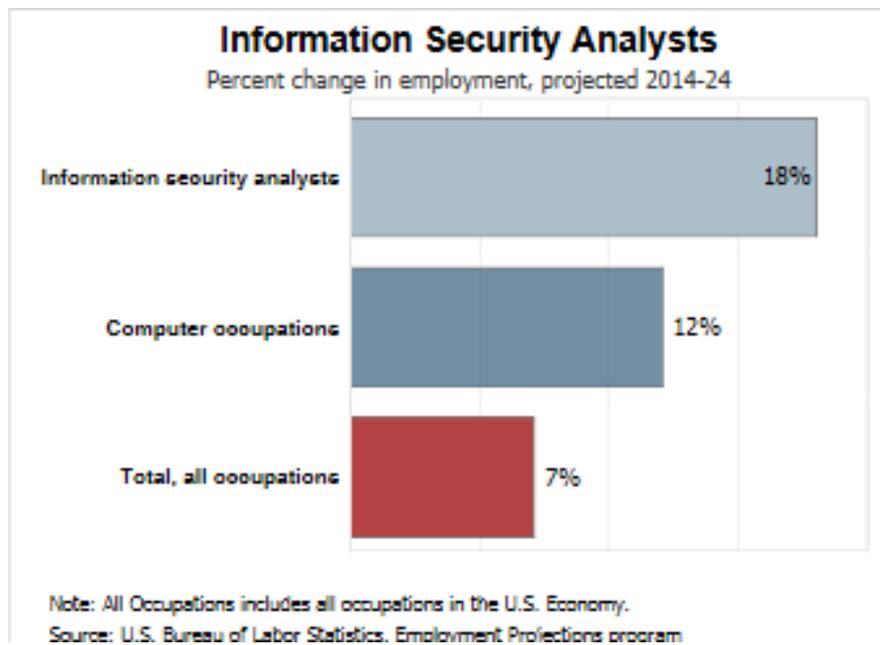
Job Outlook

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.⁴⁰ 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.⁴¹

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. ⁴² ⁴³ 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. ⁴⁴

Figure 1.



⁴⁰ 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 March 14, 2016)

⁴¹ 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 March 14, 2016)

⁴² O*Net Online on the Internet at <http://www.onetonline.org>, (visited February 26, 2016).

⁴³ Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, 2014-15 Edition, <http://www.bls.gov/oes/>, (visited February 26, 2016).

⁴⁴ Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, 2014-15 Edition, <http://www.bls.gov/ooh/computer-and-information-technology/information-security-analysts.htm#tab-1> (visited on March 15, 2016)

Figure 2.

State and National Trends

United States	Employment		Percent Change	Projected Annual Job Openings ¹
	2014	2024		
Information Security Analysts	82,900	97,700	+18%	2,550
Tennessee	Employment		Percent Change	Projected Annual Job Openings ¹
	2012	2022		
Information Security Analysts	800	1,080	+35%	40

¹Projected Annual Job Openings refers to the average annual job openings due to growth and net replacement.
 Note: The data for the State Employment Trends and the National Employment Trends are not directly comparable.
 The projections period for state data is 2012-2022, while the projections period for national data is 2014-2024.

As of March, 14, 2016 there were 36 openings and only 22 candidates to fill these positions. That is .61 potential candidates for every opening. ⁴⁵ In 2014, the national median annual wage for information security analysts was \$88,890, and in 2014, Tennessee’s annual mean wage was \$73,670.

Prior to pursuing postsecondary education, students are eligible to earn the CompTIA Security + certification.

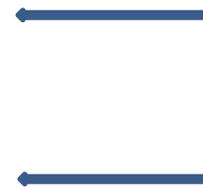
Looking at the training program data on Jobs4TN, computer science and computer systems degrees are the choice for this discipline.

Figure 4.

The table below shows training program completers in 2012 for Information Security Analysts in Tennessee.

Click a column title to sort.

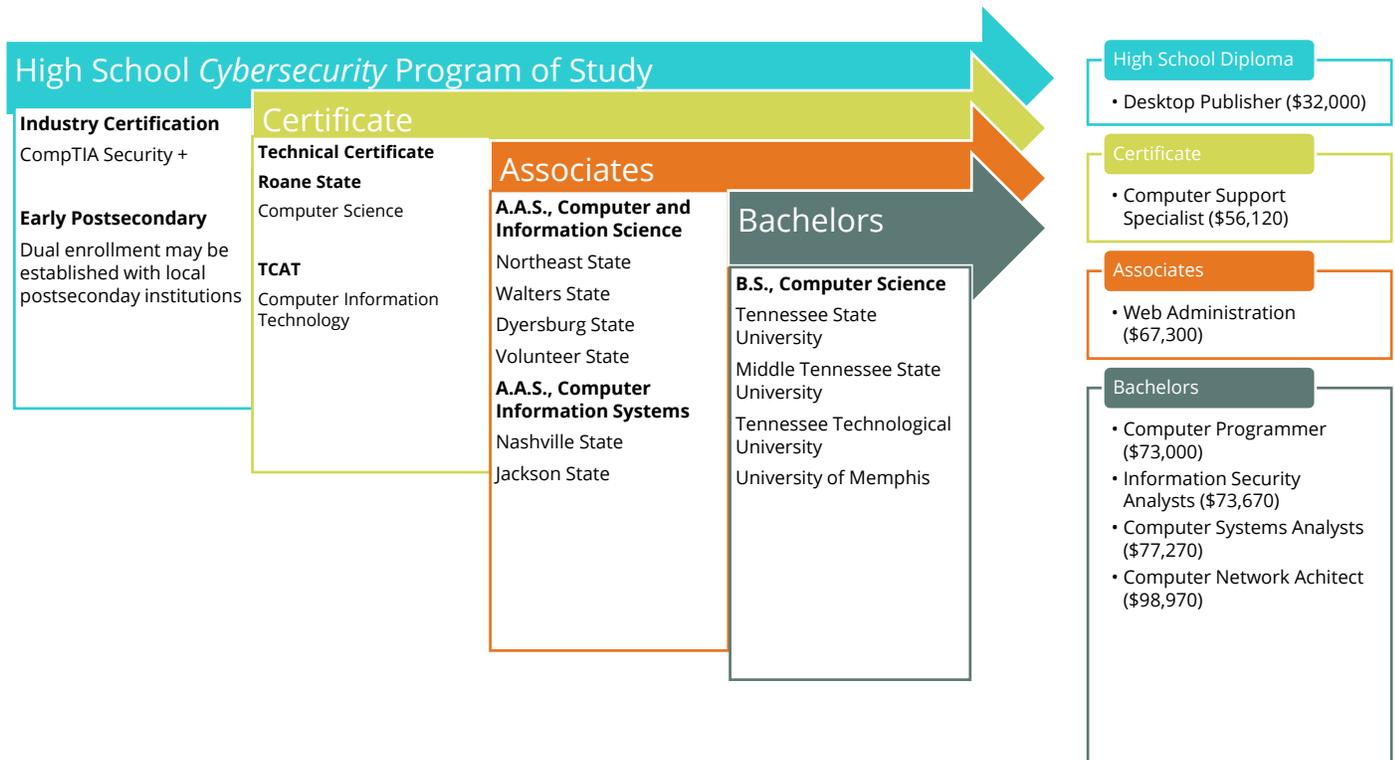
Rank	Training Program / Completer Type	Completers
1	Computer Systems Networking and Telecommunications , Associate's Degree	297
2	Computer Science , Bachelor's Degree	195
3	Computer and Information Systems Security , Bachelor's Degree	79
4	Information Technology , Bachelor's Degree	64
5	Computer Science , Master's Degree	52



⁴⁵ Jobs4Tn online at www.jobs4tn.gov (visited March 15, 2016).

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.⁴⁶ 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.⁴⁷

Postsecondary Pathways



Recommendation

The department recommends adding a new **Cybersecurity** program of study to the Information Technology cluster. Cyber-security is the final block needed for a well-rounded computer science pathway. According to the US News and World Report on education, cybersecurity is ranked #5 out of 11 hot college majors.⁴⁸ 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

⁴⁶ 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 March 16, 2016).

⁴⁷ 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 March 16, 2016).

⁴⁸ 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 March 14, 2016)



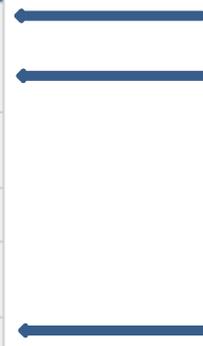
care, energy and at security services firms.⁴⁹ The need for this pathway to be included in our Information Technology cluster is supported by the projected robust job growth in Tennessee.^{50 51} Certifications are also supported in this program of study by preparing students to sit for the CompTIA Security + certification.

Below are tables that represent which degree each occupation completed for their occupation. Computer science is listed for each of the focus areas represented in this proposed POS⁵².

The table below shows training program completers in 2012 for Web Developers in Tennessee.

Click a column title to sort.

Rank	Training Program / Completer Type	Completers
1	Computer Science , Bachelor's Degree	195
2	Computer Science , Master's Degree	52
3	Web Page, Digital/Multimedia and Information Resources Desig , Postsec. Awards/Cert./Diplomas; <1 yr.	49
4	Computer Programming/Programmer, General , Associate's Degree	34
5	Web Page, Digital/Multimedia and Information Resources Desig , Bachelor's Degree	26
6	Computer Science , First-Professional Degrees	17



⁴⁹ 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 March 14, 2016)

⁵⁰ O*Net Online on the Internet at <http://www.onetonline.org>, (visited February 26, 2016).

⁵¹ Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, 2014-15 Edition, <http://www.bls.gov/oes/>, (visited February 26, 2016).

⁵² Jobs4Tn online at www.jobs4tn.gov (visited February 26, 2016).



The table below shows training program completers in 2012 for Computer Programmers in Tennessee.

Click a column title to sort.

Rank	Training Program / Completer Type	Completers
1	Computer Science, Bachelor's Degree	195
2	Management Information Systems, General, Bachelor's Degree	182
3	Computer Programming, Specific Applications, Postsec. Awards/Cert./Diplomas; <1 yr.	57
4	Computer Science, Master's Degree	52
5	Computer Programming/Programmer, General, Associate's Degree	34
6	Management Information Systems, General, Associate's Degree	25
7	Management Information Systems, General, Postsec. Awards/Cert./Diplomas; 1-2 yrs.	22
8	Computer Science, First-Professional Degrees	17

The table below shows training program completers in 2012 for Computer Network Architects in Tennessee.

Click a column title to sort.

Rank	Training Program / Completer Type	Completers
1	Computer Systems Networking and Telecommunications, Associate's Degree	297
2	Computer and Information Sciences, General, Bachelor's Degree	183
3	Computer and Information Sciences, General, Associate's Degree	160
4	Computer and Information Systems Security, Bachelor's Degree	79
5	Information Technology, Bachelor's Degree	64
6	System Administration/Administrator, Associate's Degree	50



The table below shows training program completers in 2012 for Information Security Analysts in Tennessee.

Click a column title to sort.

Rank	Training Program / Completer Type	Completers
1	Computer Systems Networking and Telecommunications Associate's Degree	297
2	Computer Science Bachelor's Degree	195
3	Computer and Information Systems Security Bachelor's Degree	79
4	Information Technology Bachelor's Degree	64
5	Computer Science Master's Degree	52

References

US News and World Report, *Discover 11 Hot College Majors That Lead to Jobs*. Retrieved from: <http://www.usnews.com/education/best-colleges/articles/2013/09/10/discover-11-hot-college-majors-that-lead-to-jobs>

O*Net Online. Retrieved from: <http://www.onetonline.org>,

Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, 2014-15 Edition, <http://www.bls.gov/oes/>,

Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, 2014-15 Edition, <http://www.bls.gov/ooh/computer-and-information-technology/information-security-analysts.htm#tab-1>

Jobs4Tn online at www.jobs4tn.gov

Bureau of Labor Statistics, U.S. Department of Labor. Retrieved from: <http://www.bls.gov/ooh/computer-and-information-technology/information-security-analysts.htm#tab-5>

US News and World Report, *Discover 11 Hot College Majors That Lead to Jobs*. Retrieved from: <http://www.usnews.com/education/best-colleges/articles/2013/09/10/discover-11-hot-college-majors-that-lead-to-jobs>

O*Net Online. Retrieved from: <http://www.onetonline.org>

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