STEM

MIDDLE-SKILL CAREER PATHWAYS IN THE BALTIMORE REGION

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Acknowledgments

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Introduction

Following the city's unrest on April 27, 2015 Baltimore City's government leaders, nonprofit organizations, business leaders and community activists have been keenly focused on how to provide better opportunities to more of Baltimore's citizens. Baltimore City residents face significant barriers to employment that prevent many from obtaining well-paying jobs. However, there lies great opportunity within the science, technology, engineering, and math (STEM) fields for individuals who do not have a bachelor's degree but are able to obtain some education, training or certifications. These "middle-skill" jobs often pay higher wages than careers with similar levels of education and offer many opportunities for advancement.

The purpose of the study was to examine opportunities and recommend strategies to increase the talent pipeline of workers in middle-skill STEM careers by:

- uncovering career pathway opportunities;
- defining core knowledge, skills and attributes that employers find desirable;
- outlining education and credentialing along each career path; and
- highlighting challenges and barriers faced by workers that keep jobs out of reach.

Many of the region's largest employers contributed to this study and have expressed or demonstrated an interest in partnering with local educational institutions and workforce intermediaries to train and employ workers for these careers.

Of those interviewed for the study, there was broad consensus that in order to improve access to middle-skill STEM careers, Baltimore's workforce development system will need to create and strengthen sector-based strategies that identify clear and effective on-ramps and career pathways leading to middle-skill STEM careers. Concurrently, they will need to help adult job seekers overcome barriers to employment such as substandard reading and math skills, access to reliable transportation and affordable housing, institutional and racial barriers, and prevalent contact with the criminal justice system.

This study builds on the work of the Opportunity Collaborative's reports on the Baltimore Regional Talent Development Pipeline and Regional Workforce Development Strategic Plan and identifies several of Baltimore's existing career pathways that lead to middle-skill STEM careers. The report identifies opportunities to develop new career pathways and strengthen existing ones. For some STEM career fields, local strategies for increasing access to these careers are well-developed and workforce development resources serving these sectors are reasonably robust. For other STEM fields, resources are underdeveloped with few programs providing effective on-ramps for people with barriers to employment opportunity.

This study brings attention to the region's promising middle-skill STEM opportunities. A clear understanding of the viable middle-skill STEM career paths will be critical to capacity-building and effective workforce development investments that provide greater access for more Baltimore residents.

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Executive Summary

As the knowledge economy in the Baltimore region continues to experience steady growth, job opportunities are broadening to include a more diverse workforce with a range of skills. Certain sectors within this economy are offering career pathways with earnings that create a defined trajectory into the middle-class. This is good news in a region where more than half of the residents have a high school diploma but do not have a baccalaureate degree.[i]

Jobs that require high-level knowledge in science, technology, engineering, and math disciplines (collectively "STEM jobs") represent a large and growing component of Baltimore's labor market. Nearly a quarter of all jobs in the Baltimore region – more than 281,000 jobs altogether – require high-level STEM knowledge in at least one STEM field.[ii] Baltimore ranks high in concentration of STEM careers, having the 9th highest concentration of jobs that require high levels of STEM knowledge[iii] and all indications are that future growth in STEM jobs will considerably outpace growth of jobs that are non-STEM.[iv]

Middle-skill STEM jobs represent a significant opportunity for the thousands of unemployed and underemployed Baltimore City residents who seek to move into a career that provides a family-supporting wage. In 2011, workers in middle-skill STEM occupations earned 61% more than workers in non-STEM occupations with similar levels of education. The average wage for middle-skill STEM workers was $58,504 per year, which is above the 2015 living wage in Baltimore City of $52,998 per year (or $25.48 per hour).[v] For workers who move into STEM occupations, there are many opportunities for career advancement, specialization, and transfer into related occupations with even higher earnings.

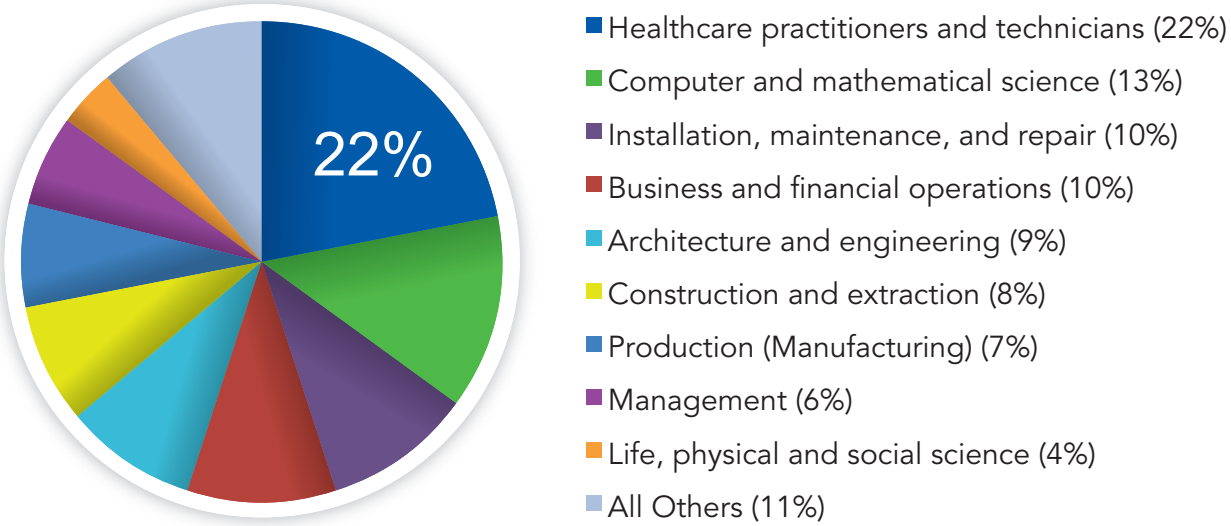
Most STEM jobs require a minimum of a bachelor's level of education, but not by a large margin. According to analysis by the Brookings Institution, a surprisingly large portion of STEM jobs in the Baltimore region are "middle-skill" STEM occupations that require an associate degree level of education or less[vi] (43.3% of STEM jobs in the Baltimore region are middle-skill STEM jobs – about 122,000 jobs). Undoubtedly, workers with a bachelor's degree or even higher levels of education fill some of Baltimore's middle-skill STEM jobs, but growing demand for these jobs is creating an opportunity for workforce development organizations to place qualified middle-skill workers into these positions.

STEM careers are not limited to traditional STEM occupations such as software developers or engineers. Interviews with Baltimore employers revealed that new technology is driving the demand for middle-skill STEM employees in many occupations, and is also driving the creation of entirely new STEM occupations.

What are Baltimore's Middle-Skill STEM Careers?

Baltimore has many jobs that are considered "high-STEM" – jobs that are not identified as traditional STEM careers but require workers to spend a large percentage of their time in at least one STEM discipline – that also fall into the middle-skill category. These jobs span a variety of industry sectors and occupations. For instance, healthcare employs a diverse range of middle-skill employees as clinical technicians in many medical disciplines (radiology, surgical techs, respiratory techs, etc.). Hospitals and practitioner's offices also hire middle-skill IT and medical records staff. According to the Opportunity Collaborative's Baltimore Regional Talent Development Pipeline Study, the healthcare sector stands out as having the highest percentage of middle-skill technician workers out of all industry sectors in the Baltimore region.

Figure 1: Share of US Jobs that are "High-STEM," by Occupation



Source: The Hidden STEM Economy (Brookings, 2013)

The information technology field ranks as the second-largest occupational category for STEM careers. About 13% of U.S. STEM jobs are computer and mathematical occupations – a sector that is growing rapidly in the Baltimore region as the region's strength in cybersecurity benefits from global investment in more secure networks.

The installation, maintenance, and repair occupations are another area where STEM is increasingly important. Building maintenance, for instance, is making use of smart technologies for energy-efficiency that lower operating costs. In addition to the HVAC mechanical knowledge that building maintenance workers have always needed, building maintenance workers who calibrate and program building systems now require advanced knowledge and training in instrumentation, testing, and troubleshooting of smart systems and equipment.

High Opportunity Sectors

Within this report, the research team has identified current and emerging middle-skill STEM career opportunities in six of the Baltimore region's industry sectors. These high opportunity sectors offer promising opportunities for lower-skilled workers to move into a middle-skill STEM careers. For each sector, there is:

- A measure of middle-skill STEM employer hiring needs;
- Identification of key middle-skill STEM occupations in demand;
- Occupational career ladders;
- Training and education providers; and
- Other resources that can support career pathways into middle-skill STEM occupations in the sector.

Figure 2: Middle-Skill STEM Career Paths in Baltimore's High Opportunity Industry Sectors

Sector	Middle-Skill STEM Jobs	Non-STEM Entry-Level Occupations	Wage Range	Middle-Skill STEM Occupations	Wage Range
Energy	More than 12,000	• Utility Trainee	$20.50	• Line Worker • Cable Splicer • Substation Mechanic • Relay Technician • Wind Technician	$21-$28+
Manufacturing	More than 3,400	• Machinist Helper • Machine Operator • Production Assembly	$12-$15	• CNC Set-Up Operator • CNC Machine Programmer • CNC Machinist • Maintenance Machinist • Inspector (QC)	$14-$20+
Technology	More than 16,100	• Entry-Level User Support Technician	$11-$18	• User Support Tech I, II, III • Network Support Tech • Network Specialist • Security Analyst • Network Security Auditor	$18-$21+
Design & Construction	More than 3,800	• Construction Helper • Apprentice • Drafter	$8-$14	• Assistant Estimator • BIM Coordinator/ Technician • HSE Coordinator/ Technician	$16-$30+
Healthcare	More than 30,800	• Transporter • Dietary Aide • Environmental Services • Laundry worker • Materials Handler	$8-$12	• Medical Records Technician • Radiology Specialist • Surgical Technician • Laboratory Technician • Paramedic/EMT	$10-$16+
Bioscience	More than 10,300	• Laboratory Assistant	$12-$15	• Laboratory Technician • Histology Technician • Research Technician	$16-$24+

Career laddering is intrinsic in many of these industries and entry-level opportunities that require limited STEM skills have pathways through which workers can move into middle-skill positions through on-the-job training coupled with additional education. However, some sectors require additional workforce training resources to enable Baltimore residents to fully take advantage of the available opportunities.

Sector 1: Energy

Both established and emerging middle-skill STEM careers are growing in the energy sector. Traditional energy employers Exelon and Baltimore Gas and Electric (BGE) offer on-the-job training for careers that begin as a utility trainee earning a wage of $21.00 per hour. Utility trainees can move into middle-skill careers in areas of specialization that require increasing technology and math skills (e.g. line workers, substation mechanics, relay technicians, and other positions).

In the future, development of emerging offshore wind capacity in Maryland will create new workforce development opportunities. Offshore wind technicians will be needed to serve wind farms both in Maryland and along the East Coast. These positions also require STEM skills and offer many advancement opportunities.

Despite strong opportunities, there is not a cohesive career pathway system serving the energy industry that is preparing workers for specific entry-level positions. According to BGE representatives, only about 1 in 3 applicants are able to pass the math-intensive Edison Electric Institute (EEI) Construction and Skilled Trade (CAST) exam, which is used to screen applicants for utility trainee positions. Workers also need experience in construction trades or a similar field to be competitive for a utility trainee position. Because offshore wind energy is new, Baltimore does not currently offer a training or career pathway program that could lead to careers in wind turbine maintenance. There is an opportunity to create such a program, and programs in other cities typically place their graduates into both local jobs and jobs in which workers reside locally and travel on rotation to remote work sites for a week at a time.

Sector 2: Advanced Manufacturing

The demands of increasingly informed consumers are driving technology changes across the advanced manufacturing sector. Entrepreneurship and innovation are the hallmarks of growing advanced manufacturing businesses and these businesses are using new technologies to design, produce, and maintain new, better products. Key technologies reshaping the advanced manufacturing sector include 3D printing, nanotechnology, predictive maintenance technology, and technologies to connect household electronic devices to the Internet – collectively called the "Internet of Things" (IoT).

Creative talent fuels the companies that design and make products of the future. "Makers" with the aptitude for innovation, entrepreneurship, and product improvement are building non-traditional and cross-functional careers in product design, technical design, prototype build, and product service/maintenance. Makers apply skills for creative problem solving, iterative prototyping and testing, new technology implementation, and advanced maintenance of hardware and software systems (collectively "mechatronic systems") to fill new roles in the manufacturing industry, replacing traditional production line workers or electronics repair technicians with workers who apply a combination of software and hardware skills to complex systems.

For example, the needs of Baltimore's machining employers are rapidly changing as Computer Numerically Controlled (CNC) machines replace old methods of producing metal and plastic parts, tools, and machines. Careers in machining offer excellent career opportunities for Baltimore's low-income residents with employment barriers. Many entry-level positions in machining do not require a high school diploma or GED, but do require basic math skills, especially for working with decimals, fractions, and algebra. On-ramps for machining careers are available through pre-employment training programs, such as those offered at the Jane Addams Resource Corporation (JARC). JARC programs offer training in a simulated workforce environment that has been shown to better prepare trainees for the workplace. The programs address many of the basic skills, workforce readiness training, and technical skills training needed to prepare workers for placement in an entry-level position.

Training courses are also offered at the Community College of Baltimore County (CCBC) and some employers, in coordination with CCBC, offer apprenticeship training programs. Students completing the JARC or CCBC programs, and students enrolling in a qualified apprenticeship training program are qualified to apply for entry-level positions as a machinist helper, machine operator (trained on a single machine), entry-level CNC machine operator (typically working on multiple machines), or a position in production assembly. These positions can lead to progressively higher-skilled positions. With experience, workers can progress into many positions that pay a family-supporting wage.

As evidenced, training resources in advanced manufacturing are available and growing in the Baltimore region but as this sector continues to evolve, specifically the 3D printing industry, more should be done to promote and raise awareness of career and training opportunities.

Sector 3: Information Technology

For workers with limited or no previous experience or education in information technology, an entry-level user support technician is a common point of entry into the IT workforce. With experience, workers can progress into tiered technical support (levels I, II, and III) and into positions in network support (e.g. network technician, specialist or analyst), system administration, or fields such as information assurance auditing, forensics, network engineering & architecture, application development, software development, and programming.

The Baltimore region has the infrastructure to deliver the education needed to begin a career in IT. Maryland Career Technology Education (CTE) programs offer high school students on-ramps to careers in IT and educational institutions – such as the University of Maryland, Baltimore County (UMBC), the Community College of Baltimore County (CCBC) and Baltimore City Community College (BCCC) – offer education leading to a certificate or associate degree. Incumbent IT workers with previous work experience can access programs like CyberWorks, an industry-led, workforce development program designed to help Maryland companies fill their cybersecurity needs with qualified candidates. One program new to the Baltimore area that is providing a strong on-ramp for inexperienced workers to enter the IT field is Year Up, a 12-month program that provides a combination of IT technical training, job readiness skills, college credits, and a 6-month work internship with a local IT employer.

In interviews, IT employers report that a bachelor's degree is required for most positions because it is an indication that a worker is likely to be able to learn and work with new technologies as they develop. When considering a candidate without a bachelor's degree, employers report that certifications are helpful, but often they look to the scope of a worker's previous work experience to indicate if s/he is qualified for the position. A portfolio of previous work demonstrates that a worker has the skills to learn independently and solve problems.

To boost on-ramps into IT careers more programs are needed to give workers experience through internships, opportunities to work on short-term projects, or strategies to help workers build a portfolio of previous work. More models like Year Up are needed to give workers the years of experience and training needed to establish an IT career.

Sector 4: Design & Construction

Construction trades such as plumbing, electrical, carpentry, and HVAC are the most common entry-point into the construction industry. Apprenticeships in these fields require math skills and the ability to work with new construction technologies as they are introduced. Industry leaders report that advances in technology, Building Information Modeling (BIM), and retrofitting represent dramatic changes for the construction industry and will continue to drive change over the next decade. Technologies like mobile computing, GPS, and other new emerging construction-related software are expected to become every day tools and employers report concern that there are few workers skilled in these technologies.[vii]

Adoption of BIM technology, in particular, is driving the creation of new BIM-related occupations across the architectural, engineering and construction fields. Some of the traditional jobs in the building industry – including draftsman positions, cost estimator positions, and project manager positions – are transitioning into high-tech building modeler positions, BIM technicians, BIM coordinator, and BIM cost estimator positions. These positions require many of the same skills as traditional occupations, but also require advanced skills in BIM modeling software and the ability to work within the BIM collaborative design and construction process. In addition to BIM-related occupations, the construction industry offers other middle-skill career opportunities such as jobs for health, safety, and environmental (HSE) technicians and specialists.

Training programs like Job Opportunities Task Force's (JOTF) JumpStart, programs offered at Group Ministries Baltimore, Humanim's deconstruction training program, and CCBC's Construction Apprenticeship Preparation ACE program provide interested people with the training to begin entry-level trade jobs in the construction industry. For incumbent workers with significant experience, there are opportunities to transition into related high-tech jobs related to BIM or HSE. Anne Arundel Community College (AACC) and CCBC each offer certificates and associate degrees in construction management (with a focus on cost estimation and BIM). The community colleges, as well as Johns Hopkins University, each offer degrees in occupational health and safety ranging from certificate level to Master's degree level (for occupational hygiene). Programs in drafting typically lead to a certificate or associate degree and are offered

by the Community College of Baltimore County, Baltimore City Community College, Anne Arundel Community College, Harford Community College, Howard Community College, and ITT Technical Institute. The Maryland Center for Construction Education and Innovation at Towson University has implemented BIM training for experienced incumbent workers in the construction industry.

Sector 5: Healthcare

Over 30,000 workers in the Baltimore region are employed in middle-skill STEM health technician occupations. The healthcare industry accounts for over one in five high-STEM jobs in the U.S. and Baltimore's robust healthcare industry offers many career pathways into middle-skill STEM jobs.

As a starting point, inexperienced workers with a GED or high school diploma can begin non-STEM entry-level positions as a transporter, dietary aid, laundry worker, material handler, or environmental services aid. With experience and additional training, employees can move into higher-skilled careers such as a patient care technician, pharmacy technician, central sterile technician, radiology specialist, or surgical technologist. From these jobs, workers can progress into middle-skill STEM occupations in the healthcare industry such as lab technicians, medical technologists, paramedics, EMTs, medical records technicians, and other health technicians.

One of the strengths of the healthcare sector is that many of the occupations are regulated or standardized across employers, so it is clear what a person needs to do to advance. There is also a coordinated effort among hospitals, nursing homes, and other healthcare facilities to develop standardized occupations.

The Baltimore Alliance for Careers in Healthcare (BACH) plays an important coordinating role in this sector by assuring that people interested in healthcare careers have access to the right training and opportunities to gain work experience in non-STEM jobs. BACH coordinates the work of training providers across the health sector and implements programs that address barriers to employment opportunity and advancement through strategies like mentoring, career coaching, and early career planning in high school.

While the sector has standardized occupations and existing training pathways, there is more work to be done to build pathways that augment wrap-around services to make entrance into a healthcare career and advancement to middle-skill STEM careers more achievable. Coaching in the industry has been used for worker retention, but not for career advancement into STEM careers. Some employers are doing more to establish and support career pathway training. Despite these efforts, the industry as a whole continues to experience significant worker turnover and chronically unfilled healthcare positions with too few qualified candidates. More can be done to assure that workers in entry-level positions have the support, coaching, and access they need to progress from lower-skilled entry-level positions into progressively higher-skilled STEM careers.

Sector 6: Biosciences

Baltimore's biotech industry includes major research labs, established biotech companies, and growing start-ups. The bioscience landscape is vast and ranges from areas in biopharma to bioprocessing and manufacturing. Many of these employers need workers with basic science skills to work in a laboratory in order to perform an array of functions. Others need more skilled technicians, some in specialized laboratory technologist roles, with higher level STEM skills and competencies.

The BioTechnical Institute of Maryland (BTI) is the leading organization providing rapid career on-ramps into the biosciences industry. BTI's Laboratory Associates program spans six months and begins with BioSTART, a 6-week bridge program designed to advance participants' knowledge in basic math, communication and professional development, each presented in the context of the biosciences industry. The Laboratory Associates program combines classroom instruction, laboratory training, and a 100-hour internship with a bioscience employer to prepare workers for a laboratory assistant position. With experience, workers can move into higher-responsibility positions, including a laboratory technician position. The training prepares workers for careers in a variety of different types of employers in biopharma, bioprocessing and biomanufacturing – jobs ranging from food testing to chemical testing to environmental sampling and testing to biocontamination work.

As a second step, lab technicians can gain higher-level biotechnology skills at the Baltimore City Community College (BCCC) Life Sciences Institute (LSI) at University of Maryland BioPark. BTI graduates earn credits that count toward the LSI programs that include a two-year associate degree and one-year certificates in biotechnology. The capstone course for the associate degree in biotechnology is a required 250-hour research internship that gives students crucial on-the-job experience. Many of the biotechnology employers are located on campus.

With experience, workers can progress into a more senior laboratory technologist positions or transfer into a medical laboratory career. Positions as a research scientist are available with a bachelor's degree.

Making Middle-Skill STEM Workforce Development Work

The employer demand for middle-skill STEM occupations is strong and growing in the Baltimore region and the region enjoys robust educational infrastructure to provide much of education needed for STEM workforce development. However, many gaps need to be bridged in order for lower income and lower-skilled adults to successfully begin or progress into middle-skill STEM careers, particularly in the following areas:

- Career Pathways
- Basic Skills Upgrading
- Bridging Gaps with Support Services
- Gaining Experience to Enter or Progress into STEM Positions
- Stronger Pathways for Advancement
- A Stronger Employer Value Proposition and Greater Employer Leadership
- Boost Awareness and Realistic Access to Middle-Skill STEM Careers

Educational and training providers, workforce development organizations, businesses, and governments are encouraged to work together to implement and strengthen career pathways into middle-skill STEM careers. With planning and focused action, STEM careers can become accessible to all Baltimore region residents and provide realistic paths into sustainable employment.

Information Technology

For decades, the information technology sector has been among Maryland's top growth sectors. Continued investment in cybersecurity for both commercial applications and defense has resulted in strong demand for cyber professionals, as well as supporting IT professionals across the spectrum of IT careers.

Maryland Leads in Cybersecurity

Maryland ranks second in the nation for cybersecurity job openings per capita (i.e. per 10,000 residents) and the number of cybersecurity job opening in Maryland nearly doubled from 2007 to 2013 (94% growth) placing Maryland in the top 10 states nationwide for both the number of cybersecurity job openings (6th) and the number of cybersecurity jobs per capita (2nd).[xi]

Most cybersecurity careers require advanced education and experience – including a bachelor's or master's degree coupled with extensive knowledge and skills – which generally place these STEM careers beyond the middle-skill level. However a select set of entry-level job openings is available to workers without a bachelor's degree. According to the National Cybersecurity Workforce Framework (Figure 6), there are seven categories of work in the field of cybersecurity, and among these are some categories that are less cyber-oriented and more oriented toward general IT.

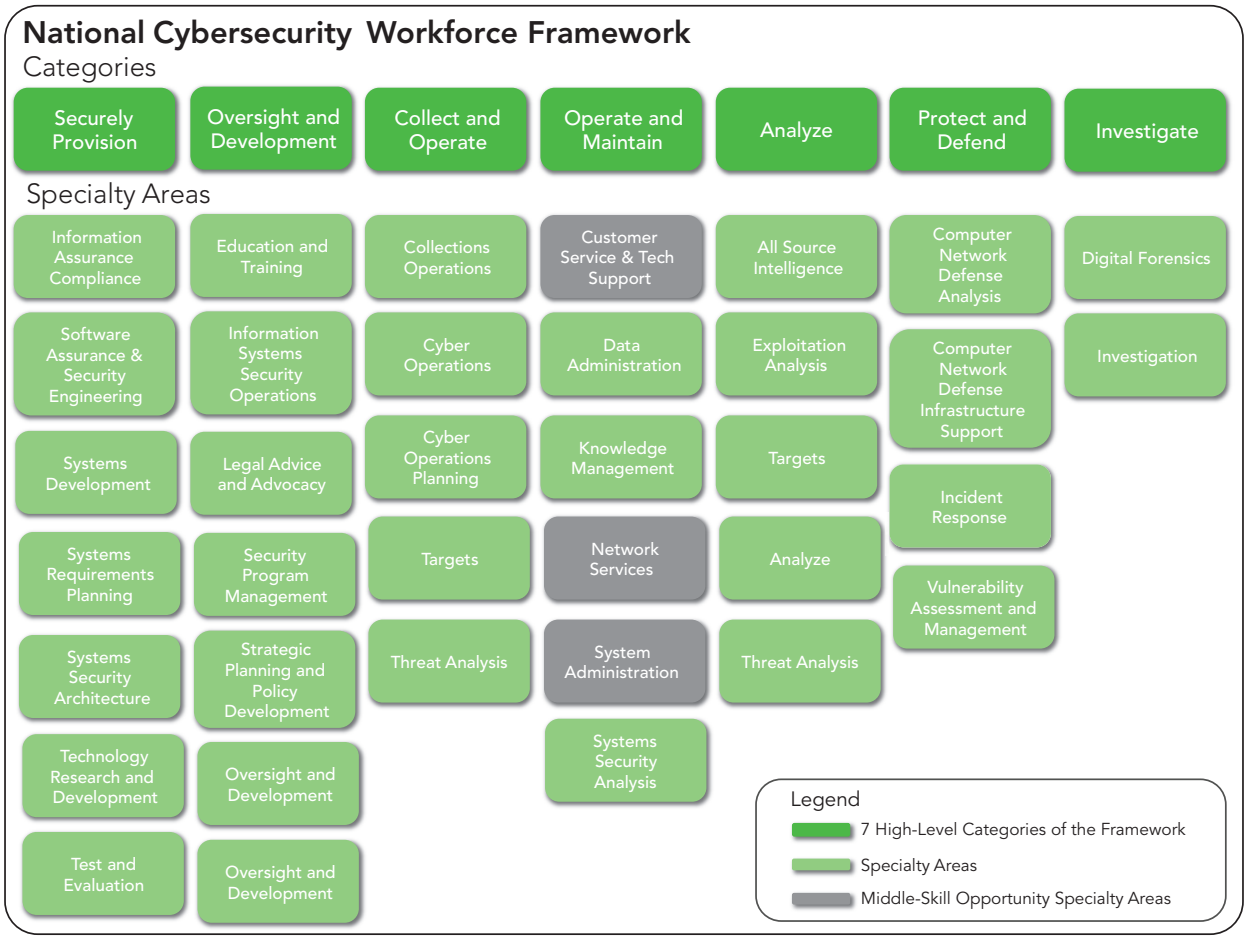
The "Operate and Maintain" category is the most accessible field for workers with less than a bachelor's degree. Within the Operate and Maintain category, jobs are available that focus on the following three specialty areas:

(1) **Customer Service and Technical Support:** These workers address problems, install, configure, troubleshoot, and provide maintenance and training in response to customer requirements or inquiries (e.g., tiered-level customer support).

(2) **Network Services:** These workers install, configure, test, operate, maintain, and manage networks and their firewalls, including hardware (e.g., hubs, bridges, switches, multiplexers, routers, cables, proxy servers, and protective distributor systems) and software that permit the sharing and transmission of all spectrum transmissions of information to support the security of information and information systems.

(3) **System Administration:** These workers install, configure, troubleshoot, and maintain server configurations (hardware and software) to ensure confidentiality, integrity, and availability. They also manage accounts, firewalls, and patches and are responsible for access control, passwords, and account creation and administration.[xii]

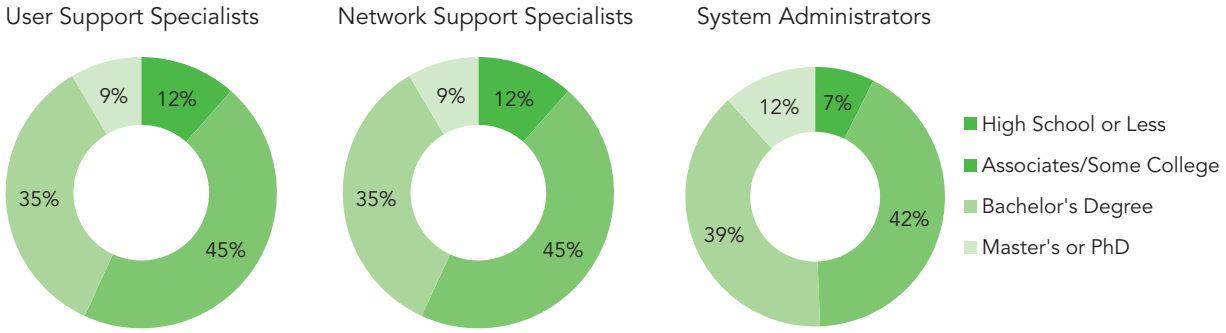
Figure 6: Career Pathways in Cybersecurity



These sub-specialties correspond to occupations like Computer User Support Specialists, Computer Network Support Specialists, and Network and Computer Systems Administrators. More than half of workers in these occupations have an associate degree or lower level of educational attainment (Figure 7) and a significant number have only a high school education.

In 2014, there were about 16,170 workers in the Baltimore region that were employed as user support specialists, network support specialists, and systems administrators. Demand for these workers is growing – in 2014 there were 9,910 technical support workers (customer service and network service combined) in the Baltimore region, up 65% from 2008 levels. Systems administrator jobs are also growing with 6,200 workers in 2014 in the Baltimore region, up 33% from 2008 levels. Wages for computer user support specialists in the Baltimore region start at about $12 per hour but increase with experience, up to mean hourly wages of $24.55 per hour in 2014 (See Table 6). Wages for network support specialists are higher, starting at approximately $20 per hour (mean of $34.51 per hour in 2014) and wages for systems administrators start at about $25 per hour (mean of $45.30 per hour in 2014).

Figure 7: Educational Attainment of Computer User Support Specialists, Computer Network Support Specialists, and Network and Computer System Administrators



Source: Table 111: Educational Attainment for Workers Age 25 and Older, By Detailed Occupation. Data Source: 2010 and 2011 American Community Survey Public Use Microdata, U.S. Department of Commerce, U.S. Census Bureau Table Source: Employment Projections program, U.S. Department of Labor, U.S. Bureau of Labor Statistics. Last Accessed May 2015 at http://www.bls.gov/emp/ep_table_111.htm

In addition to the more advanced positions available in network support and system administration, there are some opportunities for workers to enter careers in programming, software development, application development, and related coding. For workers without a bachelor's degree, previous experience is one of the key factors considered by employers when hiring a candidate. Employers report that they look for candidates who have adequate experience in the technologies they currently use, broad experience in multiple technologies (indicating ability to learn), and a strong capacity to creatively and correctly apply technology tools to solve complex problems. An analytical aptitude to analyze problems, identify the scope of possible solutions, and implement the best one is essential to IT employers who need a workforce that can learn as technology changes.

Table 6: Baltimore-Towson Employment and Wages for Cybersecurity and IT Occupations, 2014

Code	Occupation	Total Employees	2014 Wages					
		2014	Mean Hourly Wage	Lower 10th Percentile	25th Percentile	Median	75th Percentile	90th Percentile
15-1151	Computer User Support Specialists	6,390	$24.55	11.72	18.28	23.41	29.64	37.08
15-1152	Computer Network Support Specialists	3,520	$34.51	20.31	25.39	31.79	41.50	52.18
15-1142	Network and Computer Systems Administrators	6,260	$45.30	25.17	33.36	43.91	56.49	69.00
		Advanced Occupations						
15-1121	Computer Systems Analysts	6,330	$45.17	24.67	32.00	41.56	53.56	69.46
15-1122	Information Security Analysts	1,590	$50.18	24.58	34.01	47.43	62.50	77.47
15-1131	Computer Programmers	2,780	$43.31	24.38	32.09	41.25	54.81	66.71
15-1132	Software Developers, Applications	6,810	$54.98	30.84	38.65	52.57	69.97	85.94
15-1133	Software Developers, Systems Soft ware	7,200	$59.55	34.44	44.96	59.23	73.84	87.31
15-1134	Web Developers	2,100	$35.99	12.88	14.66	29.09	50.44	77.59
15-1141	Database Administrators	1,870	$42.81	24.65	31.48	41.59	52.83	66.02
15-1143	Computer Network Architects	2,880	$52.71	27.52	38.55	52.56	65.81	76.09
15-1199	Computer Occupations, All Other	5,880	$48.32	37.00	42.42	48.99	56.19	61.30

Source: Bureau of Labor Statistics Occupational Employment Statistics Database 2014

Information Technology Career Ladders

For workers with limited or no previous IT experience or education, an entry-level user support technician is the most common point of entry into the IT workforce. With experience, workers can progress into tiered technical support (levels I, II, and III), network support (as a network technician, specialist or analyst), system administration, or even a specialized cybersecurity field such as information assurance auditing, forensics, network engineering and architecture, or application development and programming.

Certifications are an important credential for progressing in IT career ladders. The selection of certifications differ by field of work (see Figure 8). For most occupations, there are a variety of certifications available with variations driven in part by the technology vendor (Microsoft, Oracle, etc.). Table 7 provides a list of the most-desired certifications requested in job advertisements in the Baltimore region.

Experience in the IT field is even more critical for job seekers. Employers in the IT field place a very high emphasis on a worker's previous experience in order to determine the ability of the individual to work in the needed technologies, and to demonstrate their ability to learn new ones.

Figure 8: Information Technology Career Ladder:
Occupations and Common Certification Requirements

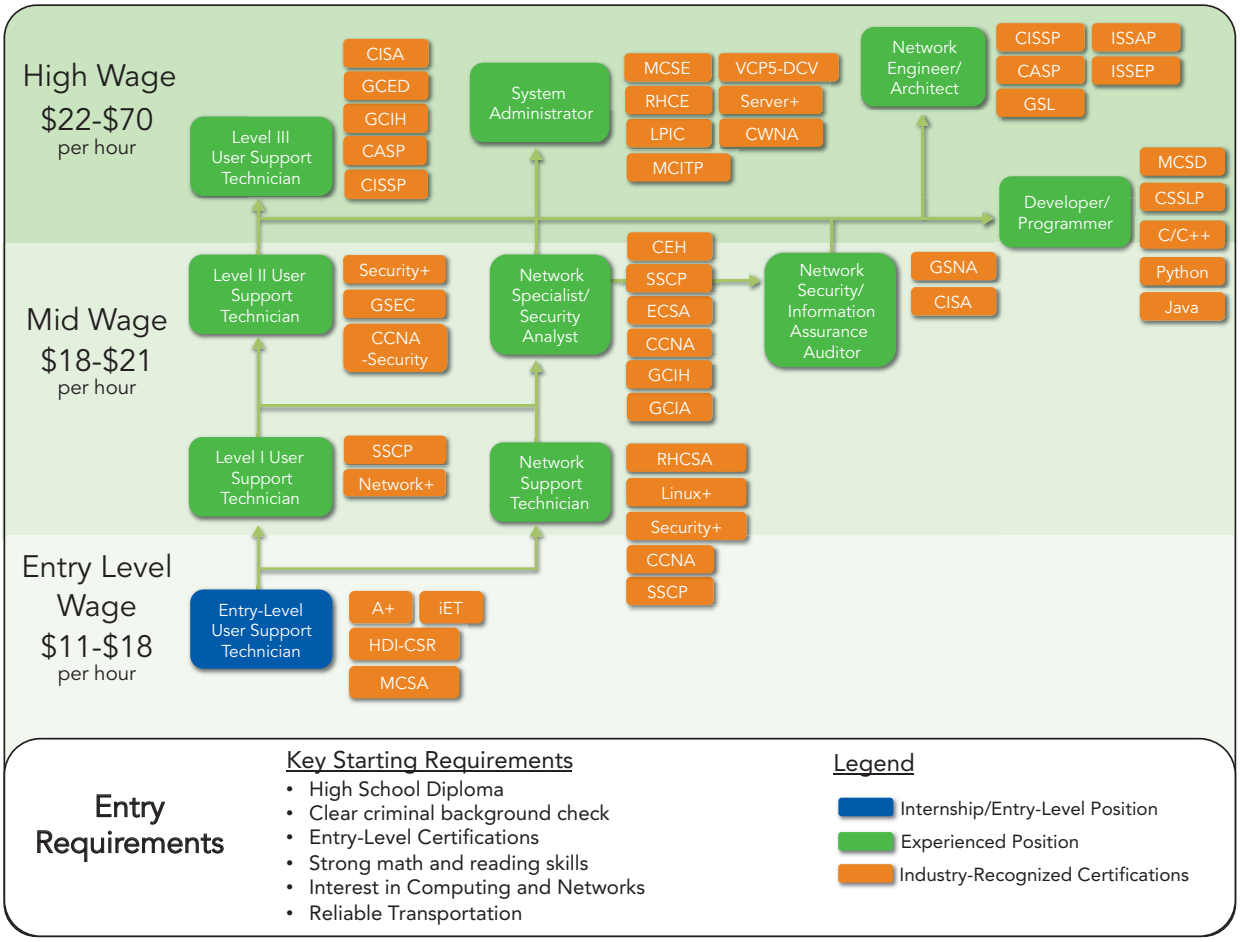


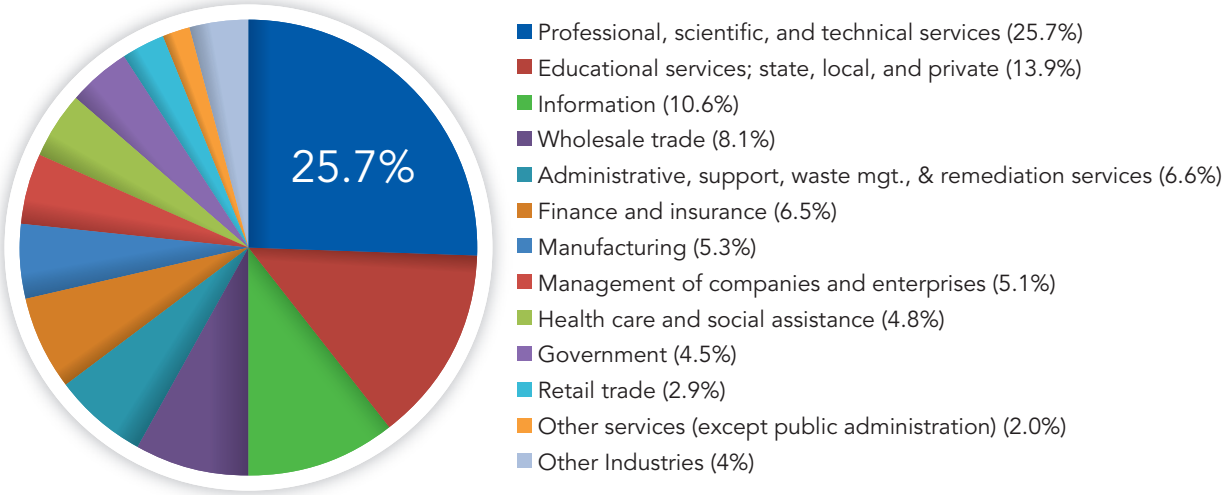
Table 7: Certifications and Providers

	Certification Name	Certification Provider
CCNA	Cisco Certified Network Associate	Cisco
CCNA-Security	Cisco Certified Network Associate-Security (CCNA-Security)	Cisco
iET	iET Service Desk Analyst	Service Desk Institute
HDI-CSR	HDI Customer Service Representative	Help Desk Institute (HDI)
MCSA	Microsoft Certified Solutions Associate (MCSA)	Microsoft
MCSE	Microsoft Certified Solutions Expert (MCSE)	Microsoft
MCSD	Microsoft Certified Solutions Developer (MCSD)	Microsoft
MCITP	Microsoft Certified Information Technology Professional	Microsoft
RHCE	Red Hat Certified Engineer	Red Hat
RHCSA	Red Hat Certified System Administrator	Red Hat
LPIC	Linux Server Professional Certification	Linux Professional Institute
VCP5-DCV	VMware Certified Professional 5 – Data Center Virtualization	VMware
CWNA	Certified Wireless Network Administrator	Certified Wireless Network Professional
Server+	Server+	CompTIA
Linux+	Linux+	CompTIA
A+	A+ IT Fundamentals	CompTIA
Security+	Security+	CompTIA
Network+	Network+	CompTIA
CASP	CompTIA Advanced Security Practitioner (CASP)	CompTIA
CEH	Certified Ethical Hacker (CEH)	EC-Council
ECSA	EC-Council Certified Security Analyst	EC-Council
CSSLP	Certified Software Security Lifecycle Professional (CSSLP)	(ISC)2
CISSP **	Certified Information Systems Security Professional (CISSP)	(ISC)2
ISSAP	Information Systems Security Architecture Professional (ISSAP)	(ISC)2
ISSEP	Information Systems Security Engineering Professional (ISSEP)	(ISC)2
SSCP	System Security Certified Practitioner (SSCP)	(ISC)2
CISA	Certified Information Systems Auditor (CISA)	ISACA
GCIA	GIAC Certified Intrusion Analyst (GCIA)	GIAC
GCED	GIAC Certified Enterprise Defender (GCED)	GIAC
GCIH	GIAC Certified Incident Handler (GCIH)	GIAC
GSEC	GIAC Security Essentials Certification (GSEC)	GIAC
GSNA	GIAC Systems and Network Auditor (GSNA)	GIAC
C/C++	C/C++ Certified	C++ Institute
Python	Python Programming Language Proficiency	Not a Certification
Java	Java Programming Language Proficiency	Not a Certification

Notes: CompTIA is the Computing Technology Industry Association, ISACA is the Information Systems Audit and Control Association, GIAC is the Global Information Assurance Certification, and Carnegie CERT® refers to the Carnegie Mellon Software Engineering Institute CERT®; **CISSP Associate - this means the individual has qualified for the certification except for the number of years experience.

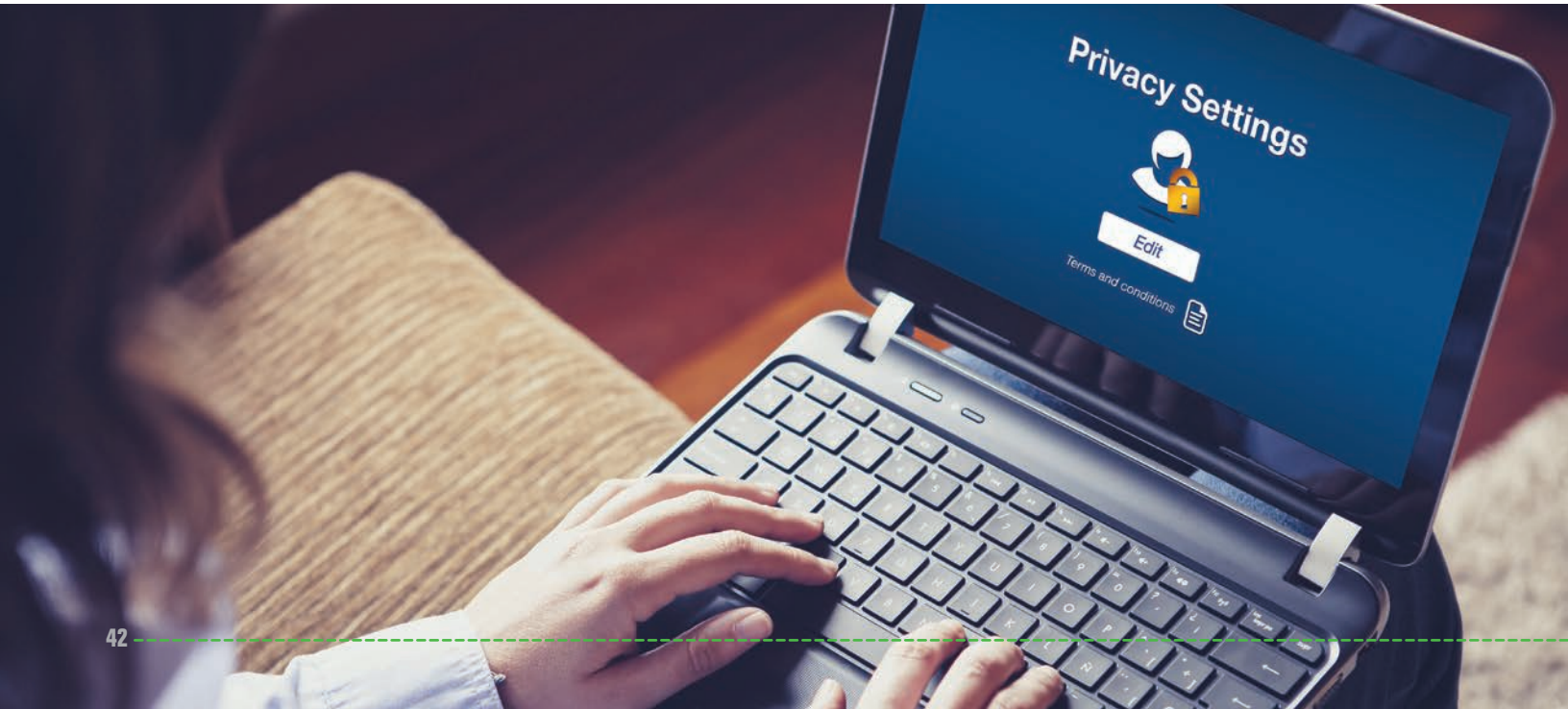
Entry-Level Employers

Figure 9: Computer User Support Technicians by Industry in the US, 2014



Source: Occupational Employment Statistics Database, Bureau of Labor Statistics

Because of the presence of NSA headquarters, many of the cybersecurity jobs in the Baltimore region are for defense contractors or companies directly working for government entities. However, entry-level positions as user support technicians are available in a wide variety of industries outside of government or government contracting (Figure 9). In particular, the higher education sector is a major employer in Baltimore hiring for user support technicians. The information sector – including telecommunications service providers – also hire a significant number of technical support workers. Workers who are new to the IT industry can gain experience in a non-government job before progressing into a higher-paying position in the government sector.



Limited Middle-Skill Opportunities at Government Contractors

Government integrators play a key role in the region's cybersecurity job market. In 2013, 9 out of 10 cybersecurity job openings in the Baltimore region were at government integrators including ManTech International, SAIC, Lockheed Martin, General Dynamics, Northrop Grumman, CSC, Boeing, Booz Allen Hamilton, and L-3 Communications, each of which had over 250 job openings in cybersecurity at the time of the report. These employers must comply with Department of Defense Directive 8570[xiii] for all workers employed in an information assurance capacity. DoD Directive 8570 defines the minimum qualifications for:

- Information Assurance Technicians (IAT) (Levels I, II, and III)
- Information Assurance Managers (IAM) (Levels I, II, and III)
- Information Assurance System Architecture and Engineering (IASAE) professionals
- Computer Network Defense Service Provider (CND-SP) Specialists, including:
  - Computer Network Defense Analysts (CND-A),
  - Computer Network Defense Infrastructure Support workers (CND-IS),
  - Computer Network Defense Incident Responders (CND-IR),
  - Computer Network Defense Auditors (CND-AU), and
  - Computer Network Defense Service Provider Managers (CND-SPM)

For each of these workforce categories, specialties, and levels, the DoD identifies a set of minimum requirements that includes initial training, certifications, years of experience, background investigation, continuing education (CE) requirements, and other requirements. The experience and certification requirements for the cybersecurity workforce are contained in Tables 8 and 9.

Table 8: DoD Directive 5870 Minimum Workforce Certifications and Experience for Information Assurance Professionals

Workforce Category	Minimum Experience	Baseline Certifications (any of the below)
IAT I	0 to 5 years in IA technology or a related field	A+ (CE), Network+ (CE), SSCP, CCNA-Security
IAT II	3+ years in IA technology or a related field	GSEC, Security+ (CE), SSCP, CCNA-Security
IAT III	7+ years of experience in AI technology or a related field	CISA, GCIH, GCED, CISSP (or Associate), CASP
IAM-I	0 to 5 years management experience	CAP, GSLC, Security+ (CE)
IAM-II	At least 5 years management experience	CAP, GSLC, CISM, CASP, CISSP (or Associate)
IAM-III	At least 10 years management experience	GSL, CISM, CISSP (or Associate)
IASAE-I	0 or more years management experience	CISSP (or Associate), CASP, CSSLP
IASAE-II	At least 5 years management experience	CISSP (or Associate), CASP, CSSLP
IASAE-III	At least 10 years management experience	CISSP-ISSEP, CISSP-ISSAP
CND-A	2+ years experience in CND technology or a related field	GCIA, CEH, GCIH
CND-IS	4+ years experience in CND technology or network systems technology	SSCP, CEH

Workforce Category	Minimum Experience	Baseline Certifications (any of the below)
CND-IR	5+ years experience in CND technology or a related field	GCIH, CSIH, CEH, GCFA
CND-AU	2+ years experience in CND technology or a related field	CISA, GSNA, CEH
CND-SPM	4+ years experience in CND management or a related field	CISSP-ISSMP, CISM

Source: DoD 8570 Information Assurance Workforce Improvement Program

Table 9: Certifications and Providers

	Certification Name	Certification Provider
CSIH	Computer Security Incident Handler (CSIH)	Carnegie CERT®
CCNA-Security	Cisco Certified Network Associate-Security (CCNA-Security)	Cisco
A+ (CE)	A+ Continuing Education (CE)	CompTIA
Security+ (CE)	Security+ Continuing Education (CE)	CompTIA
Network+ (CE)	Network+ Continuing Education (CE)	CompTIA
CASP	CompTIA Advanced Security Practitioner (CASP)	CompTIA
CEH	Certified Ethical Hacker (CEH)	EC-Council
CISSP **	Certified Information Systems Security Professional (CISSP)	(ISC)2
CAP	Certification Authorization Professional (CAP)	(ISC)2
ISSAP	Information Systems Security Architecture Professional (ISSAP)	(ISC)2
ISSEP	Information Systems Security Engineering Professional (ISSEP)	(ISC)2
ISSMP	Information Systems Security Management Professional (ISSMP)	(ISC)2
SSCP	System Security Certified Practitioner (SSCP)	(ISC)2
CISM	Certified Information Security Manager (CISM)	ISACA
CISA	Certified Information Systems Auditor (CISA)	ISACA
GCIA	GIAC Certified Intrusion Analyst (GCIA)	GIAC
GCED	GIAC Certified Enterprise Defender (GCED)	GIAC
GCFA	GIAC Certified Forensic Analyst (GCFA)	GIAC
GCIH	GIAC Certified Incident Handler (GCIH)	GIAC
GSEC	GIAC Security Essentials Certification (GSEC)	GIAC
GSLC	GIAC Security Leadership Certificate (GSLC)	GIAC
GSNA	GIAC Systems and Network Auditor (GSNA)	GIAC

Notes: CompTIA is the Computing Technology Industry Association, ISACA is the Information Systems Audit and Control Association, GIAC is the Global Information Assurance Certification, and Carnegie CERT® refers to the Carnegie Mellon Software Engineering Institute CERT®; **CISSP Associate - this means the individual has qualified for the certification except for the number of years experience.

Middle-Skill On-Ramps into Information Technology Careers

On-ramps into careers in the IT sector in the Baltimore region begin at the high school level. Maryland Career Technology Education (CTE) offers an Information Assurance (IA) program with the following academies:

- Academy of Information Technology (IT programming, IT networking, and web design)
- Database Academy (Oracle)
- IT Networking Academy (Cisco)
- IT Computer Science and Cybersecurity

Each of these academies prepares students to take industry certification exams offered through CompTIA, Cisco, Microsoft, and Oracle. In addition to the academy curriculums, Maryland schools are using courses and instructional support materials developed by CyberWatch, which align to international IT standards.

Several educational and training organizations in the region offer on-ramps to adults leading to careers in cybersecurity. These organizations include:

(1) **CyberWorks (www.cyberworksmd.org):** CyberWorks is an industry-led workforce development program designed to help Maryland companies fill their cybersecurity needs with qualified candidates, while simultaneously helping individuals start careers and improve Maryland's economy. Students and job seekers interested in building a career in cybersecurity or IT can benefit from the hands-on, practical work experience and the business mentorship built into the CyberWorks Model.

(2) **CCBC Institute for Cyber Security (www.ccbcmd.edu):** The Institute for Cyber Security offers a 2-year program leading to an Information Systems Security Certificate designed to provide the knowledge and skills needed to analyze security vulnerabilities, create a comprehensive incident-response plan, and implement the equipment, policies and procedures that protect a network and its related resources from unauthorized intrusion, information damage, or theft. CCBC also offers a General Networking Certificate to prepare students for the A+, Network+ and Security+ exams, preparation for the Cisco Certified Network Associate (CCNA) exam, a Red Hat Certified Technician Certificate, and preparation for the Microsoft Certified Information Technology Professional (MCITP) Certificate.

(3) **Baltimore City Community College Cyber Security and Assurance Certificate (www.bccc.edu):** The program provides students with practical experience in understanding the threats and dangers, security assessments and analysis. The program prepares students for vendor-specific or commercially available security certification.

(4) **Anne Arundel Community College Cybersecurity, Forensics, and Network Management Program (www.aacc.edu/computertech/netmang_cert.cfm):** This program offers nine certificate programs including CCNA preparation, Computer Network Management, Network Security, Advanced Network Security, Server Administration and Security, a Unix/Linux System Administrator Option, Advanced Cyber Forensics Certificate, and a Network Operating Systems Letter of Recognition. Three Associate of Applied Science Degree Options are offered including Information Assurance and Cybersecurity; Information Assurance and Cyber Forensics; and Computer Network Management.

(5) **Digit All Systems (DAS)** is a nonprofit organization committed to bridging the digital divide by expanding technology to everyone. DAS teaches coding and cyber security boot camps and provides certification testing.

(6) **UMBC Cybersecurity Academy** (www.umbctraining.com/cybersecurity): UMBC Training Centers provide highly focused skills training and practical experience to address the cyber workforce training needs of the military, the intelligence community, federal civilian agencies, and the commercial sector. Cybersecurity Academy certificate programs combine multiple skills training and hands-on problem solving guided by expert instructors to create high-impact learning. The skills mastered in these programs prepare participants with immediate, on-the-job effectiveness to tackle real-world situations. The certificate programs were designed by UMBC Training Centers in collaboration with senior executives and technical staff from the Department of Defense (DoD), leading government contractors, and Fortune 500 companies.

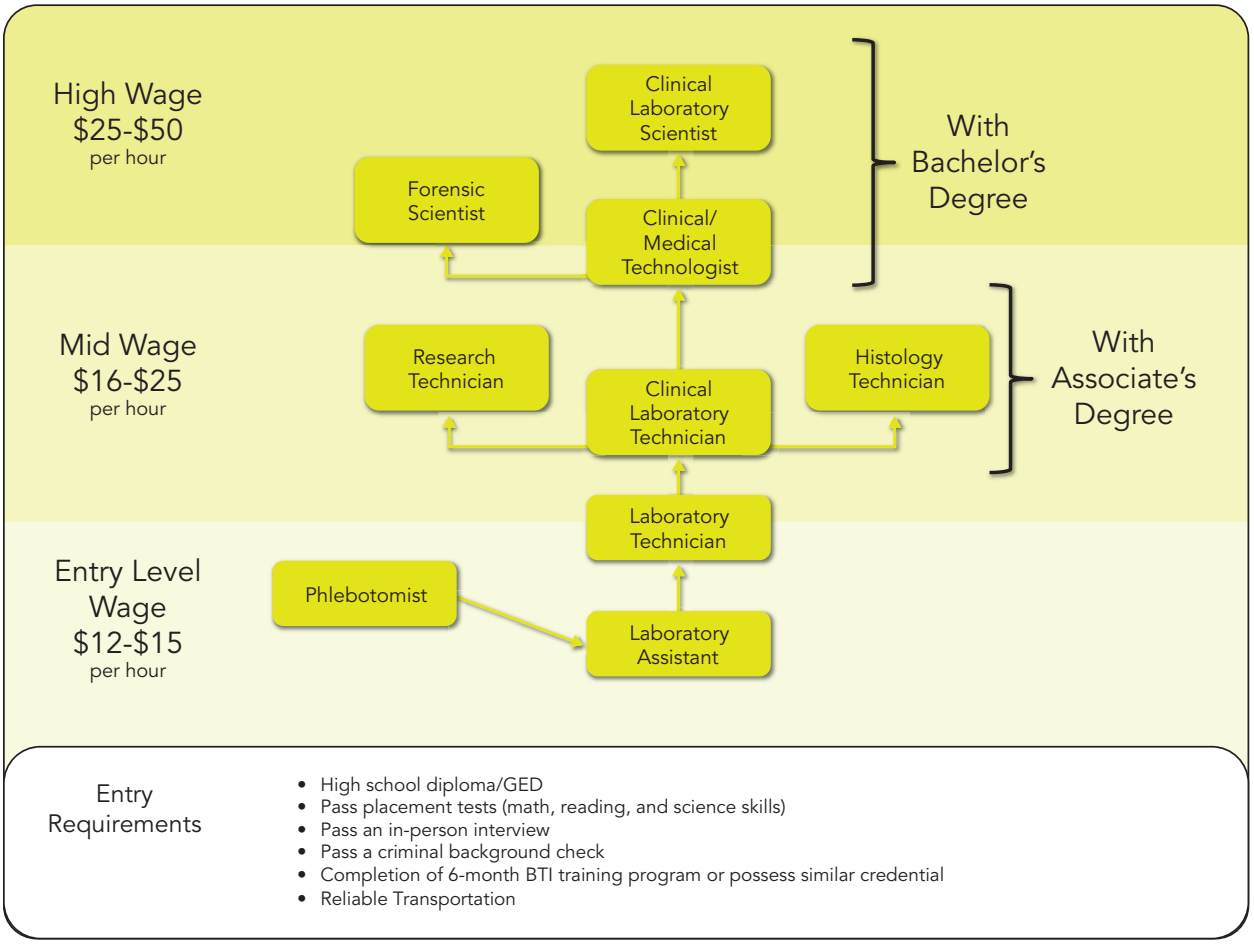
Advancement in the IT Field

Cybersecurity professionals have a variety of career options and specializations available to them ranging from operations to systems engineering and architecture, to programming and development, and other fields. The keys to advancement are certifications and experience. Each path requires a combination of information assurance certifications (e.g. CompTIA Security+, Certified Information Systems Security Professional (CISSP), etc.) as well as vendor-specific certifications (Microsoft, Red Hat, Oracle, etc.).

Biosciences Careers

There are over 6,300 laboratory technicians and technologists working in the Baltimore region, nearly double the number in 2007. The region's growing research sector has created ongoing demand for these workers as generalists. The robust medical research capacity in the region also creates ongoing demand for workers in specialized fields such as a histology technician or pathology assistant.

Figure 13: STEM Career Pathways in Biosciences



Starting a Career as a Laboratory Assistant

The BioTechnical Institute of Maryland (BTI) offers tuition-free training to Baltimore City residents who are high school graduates or have earned their G.E.D. BTI's Laboratory Associates program spans six months and participants must make the commitment to attend classes, study, be actively involved in their academic success, and complete a 100-hour paid internship.

BTI training begins with BioSTART and progresses onto the Laboratory Associates Program. The BioSTART component of the BTI curriculum consists of a 6-week bridge program designed to advance participants' knowledge in basic math, communication, and professional development, each presented in the context of the biosciences industry. Upon completion of BioSTART pre-training, participants progress onto the more technical hands-on bench skills in the Laboratory Associate Program, which includes classroom instruction, hands on laboratory training, guest speakers for the bioscience industry and a 100-hour internship at an area bioscience employer.

Career Progression

Graduates from the Laboratory Associates program can begin entry-level laboratory assistant positions that pay between $12 and $14 per hour. In addition, phlebotomists are also qualified to move into a laboratory assistant position.

With experience, workers can move into higher-responsibility positions including a laboratory technician position. With an associate degree workers can progress into a more senior laboratory technologist position, progressing into work in a research setting or transferring into a medical laboratory setting. Additional positions as a research scientist are available with a bachelor's degree.

Table 15: Baltimore-Towson Employment and Wages for Middle-Skill STEM Occupations in Biosciences, 2014

Code	Occupation	Total Employees	2014 Wages					
		2014	Mean Hourly Wage	Lower 10th Percentile	25th Percentile	Median	75th Percentile	90th Percentile
31-9097	Phlebotomists	920	17.68	14.43	15.63	17.21	18.92	22.22
29-2012	Medical and Clinical Laboratory Technicians	4,040	17.67	12.48	13.98	16.60	19.91	24.08
29-2011	Medical and Clinical Laboratory Technologists	2,330	27.30	18.61	21.29	26.30	33.49	37.81
19-1042	Medical Scientists (Except Epidemiologists)	3,080	37.32	20.71	25.28	33.10	47.08	58.52

Source: Bureau of Labor Statistics Occupational Employment Statistics Database 2014