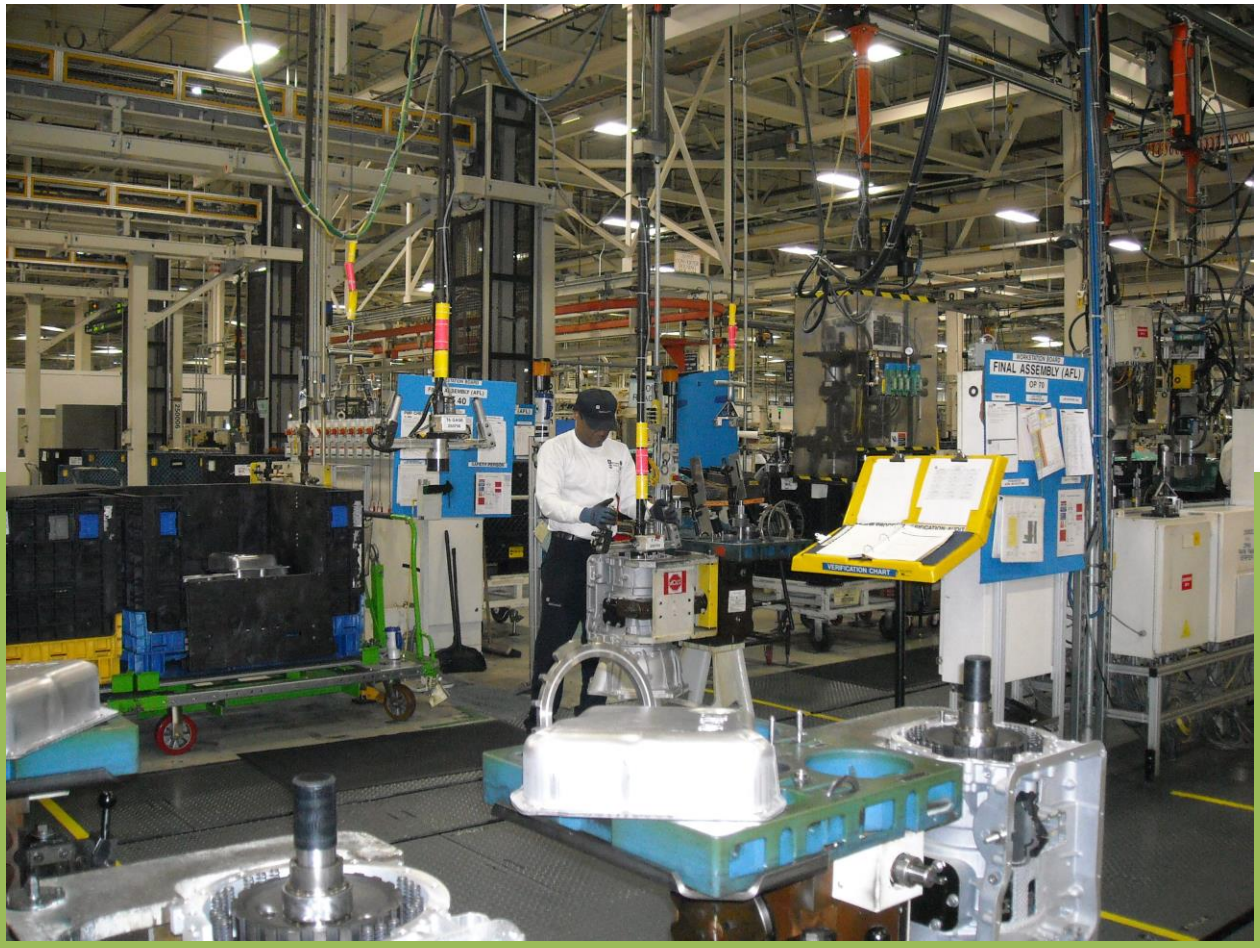

Mid-Skilled Career Pathways in Engineering Technology, Cybersecurity and IT

Anne Arundel County • Baltimore County • Howard County

Field Guide Consulting

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Baltimore Metropolitan Council

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Prepared by

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Project Background

Informed through a combination of research on job vacancy advertisements, discussions with educational institutions and interviews with 20 employers in the cybersecurity and engineering fields, this study identifies the scope of employers' labour force needs for mid-skilled careers in engineering technology, cybersecurity, and information technology fields. The report focuses in particular on mid-skilled careers requiring education beyond a high school diploma but less than a Bachelor's degree. It includes an exploration of the educational infrastructure at colleges in the region and the types of formal education and job training that employers prefer, including apprenticeships, on-the-job training, degree programs, and other types of job training. The study identifies promising entry-level "starting-point" positions and career pathways into jobs that pay a family-supporting wage.

Executive Summary

Anne Arundel County, Baltimore County and Howard County together have a large and growing IT and engineering job market.

- There are approximately 51,000 IT and engineering workers employed in the three counties - approximately 38,000 in IT, cybersecurity, and IT-related engineering occupations and about 13,000 in non-IT engineering occupations.
- Based on a review of job advertisements collected in the Maryland Workforce Exchange (MWE) jobs database[i] from July 2014 through June 2015, there were at least 2,686 IT and engineering job openings in the three-county area. Among these job ads, 88% were for IT and cybersecurity positions, while 11% were for non-IT engineering. For every 1,000 workers employed, there were 64 IT job openings and 24 non-IT engineering job openings.
- Total employment in IT and engineering is highest in Howard County, but Anne Arundel County and Howard County are roughly tied in total new job openings. Anne Arundel County had 1,018 job openings, Howard County had 983, and Baltimore County had 686.

There are relatively few job advertisements for "mid-skilled" jobs that seek workers with education less than a Bachelor's degree and employers see these positions as a small part of their workforce.

- About 8.7% of IT and engineering technology jobs stated educational requirements of an Associate's degree, certificate, high school diploma (or equivalent), or specifically stated that there was no minimum education required (although more than half (52.7%) of job postings do not state any specific educational requirement). The jobs requiring education that is less than a Bachelor's degree are considered "mid skilled" positions and the portion of jobs that are mid-skilled is similar for both engineering and IT positions with 9.7% of engineering job postings and 8.5% of IT job postings falling into the mid-skilled category.
- In interviews, most employers reported that mid-skilled positions are a small part of their workforce with most jobs requiring a minimum of Bachelor's degree.
- Based on a review of job ads and interviews, there is a select set of occupations that are more likely to be filled by workers without a Bachelor's degree. These mid-skilled occupations include user support specialists, systems administrators and computer administrators, network support specialists, web developers, electronics or electrical technicians, mechatronics technicians and other engineering technology occupations.

Experience requirements are high for most IT and engineering job openings and a lack of job applicants with the right amount of experience is a problem for most IT and engineering employers.

- Only 2% of IT and engineering job openings describe the job as an entry-level position or a position requiring less than two years of previous work experience. Approximately 16% of job openings require 4 years of experience (or less), and 25% require more than four years of experience. The remainder of job openings (59%) do not state experience requiremens, but

interviews with employers suggest that the majority of these jobs are open only to workers with 4 or more years of experience (Se Figure 2).

- In interviews, employers in the three-county area confirmed that they place a high emphasis on hiring workers with the ability to be self-motivated learners, capable of mastering new technologies as they emerge, and with an ability to apply technology within changing client environments. Several employers reported that they see years of experience as an indication of these abilities. Without 4 or more years of experience, a Bachelor's degree is seen as a good indication that a new hire will be able to not only apply skills in one technology, but also learn and apply new technologies -- a requirement for productivity in quickly changing IT market.
- Employers in the cybersecurity sector report that they generally do not hire mid-skilled workers with less than a bachelor's degree, regardless of years of experience. Maryland's cybersecurity market is driven in large part by the NSA and other government entities that must comply with Department of Defense Directive 8570[ii] for all workers employed in an information assurance (IA) capacity. DoD Directive 8570 defines the minimum qualifications for education and experience, and while there are levels requiring less than five years of experience and less than a Bachelor's degree, contractors report that practically all government cybersecurity jobs require a minimum of five years of previous work experience and a Bachelor's degree. Requirements for these positions are continuously increasing and in some cases workers who have been filling a position and performing at a high level must be removed from the position because the requirements for the position increases and the worker no longer meets the minimum requirements.
- With the exception of a few internship programs for students working on a Bachelor's degree, government contractors who hire cybersecurity professionals do not have an internal talent development pipeline that involves hiring entry-level workers without previous experience. As a result, there is no starting pipeline for entry-level talent with these employers. In some cases, government contractors hire for summer internships, but jobs are typically restricted to students nearing completion of their Bachelor's degree. As a result, early career cybersecurity opportunities are relatively limited among contractors and these contractors represent a large portion of IT and engineering jobs in the three-county area.

Educational and experience requirements for IT and engineering technology jobs are more dependent on the employer than they are on job duties.

- Requirements for any position differ significantly from employer to employer. For instance, while many of the region's systems administrator job openings require a bachelor's degree, a select number of employers hire systems administrators requiring only a high school diploma. The differences are dependent on hiring policies of the employer as well as regulations set by federal departments for jobs at government contractors.
- During the 2014-2015 period, there were 51 identified employers in the three-county region who advertised for IT job openings stating minimum educational requirements less than a Bachelor's degree (ranging from high school diploma through an Associate's degree). These employers account for 17.6% of the 289 IT employers identified in the Maryland Workforce

Exchange Jobs Database who hired for IT positions in July 2014- June 2015 (See Table 5 for a complete list of employers).

- Among 94 employers hiring engineering technicians in the three-county region, 12 employers had engineering technician positions that were advertised as requiring less than a Bachelor's degree level of education.
- IT employers that advertised multiple mid-skilled positions included NES Associates, Booz Allen Hamilton, Dunbar Armored, ExecuTech Strategic Consulting, Assured Information Security, Chiron Technology Services, COMSO Inc., and ManTech International Corporation (each with 4 openings requiring less than a Bachelor's Degree in 2014-2015). Raytheon, ABM Industries, Whitney Bailey Cox & Magnani, and PRIME AE Group each had multiple engineering technician hires. The majority of mid-skilled hires, however, were at smaller employers with just a single job opening during the year.
- Because employers differ in their requirements for new hires, job training should be focused on the needs of the subset of employers that hire mid-skilled workers into standard IT and engineering positions. A list of those employers is contained in tables 5 and 9.

The region has several opportunities for developing stronger mid-skilled career pathways into IT and engineering technology careers.

Mid-skilled career pathways identified in the IT area fell into several career areas including

(1) Tiered technical support careers,
(2) Careers in network operation centers (NOCs) and security operation centers (SOCs),
(3) IT training/instruction, and
(4) Jobs in multimedia/web development and programming.

Mid-skilled career pathways in the engineering technology field fell mainly into mechatronics/electronics engineering technicians. Mechatronics technicians fill a special role in developing, installing, maintaining, troubleshooting, and servicing the software and hardware for robotics and other high-tech equipment, including equipment produced or maintained by government and defense contractors. The mechatronics field includes a variety of occupations ranging from drafters to test engineers, field engineers, controls maintenance technicians, and other positions that are available in a diverse set of industries including defense, manufacturing, offshore industries, telecom/communications, aerospace, environmental consulting, power utilities, construction, and at IT firms.

Figures A, B and C provide a snapshot of the career pathways in the IT and mechatronics fields that are available to workers with less than a Bachelor's degree.

Figure A Career Paths in Technical Support and NOC/SOC Operations

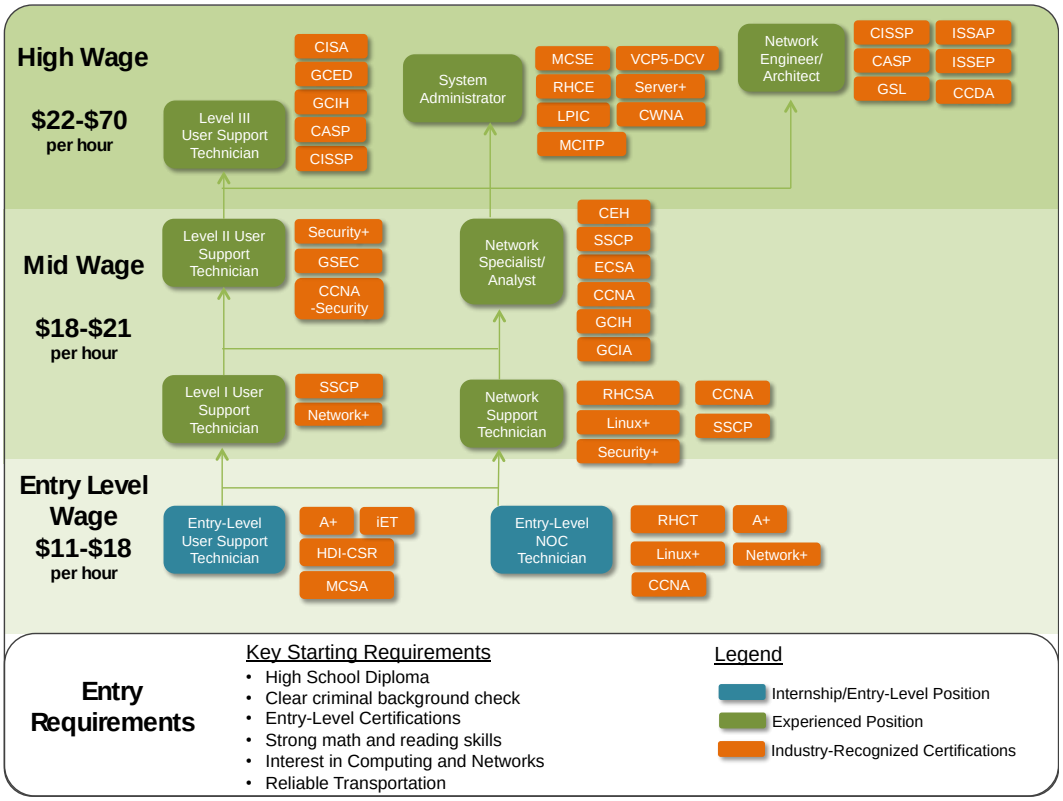


Figure B Training and Instruction Occupations

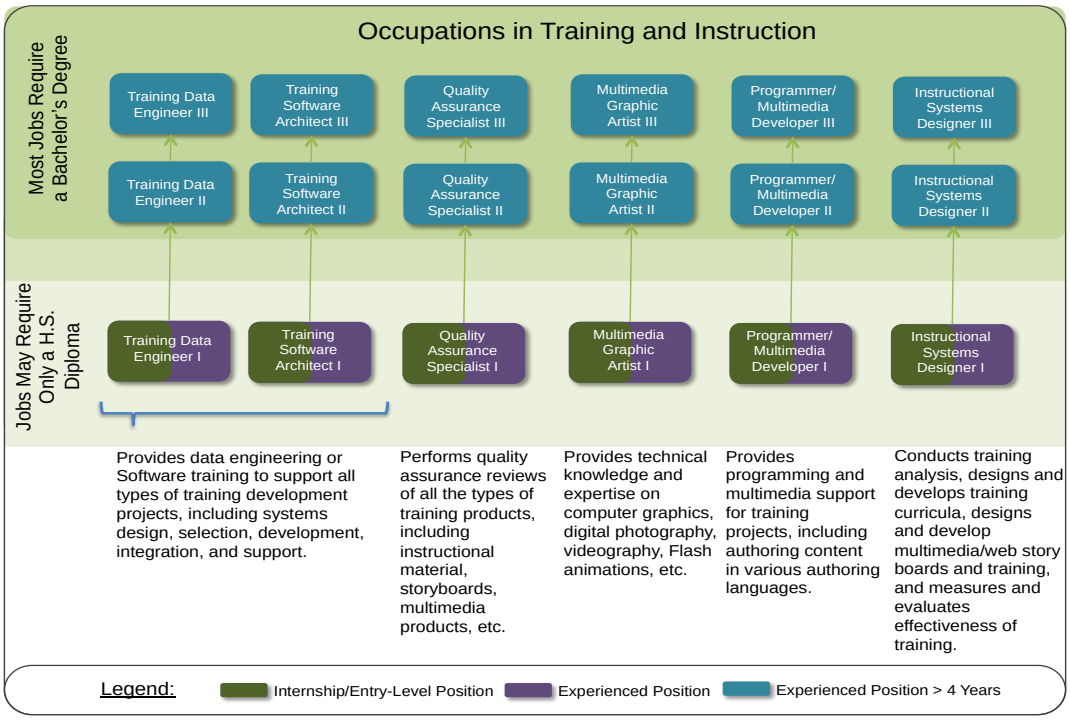
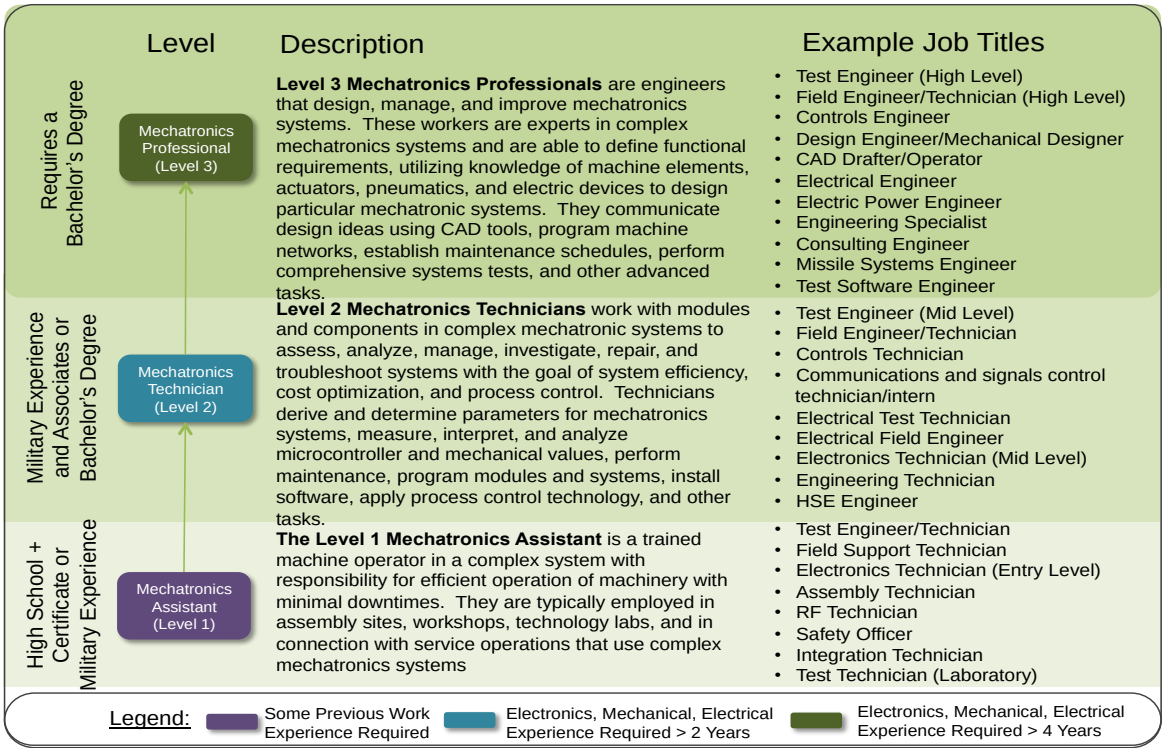


Figure C Career Pathways as a Mechatronics Engineering Technician



Sources: Siemens Mechatronics Certifications Levels 1-3, Analysis of Maryland Workforce Exchange Jobs Database

The region has the educational capacity needed to prepare workers for entry-level positions.

Educational capacity is in place to meet the instructional needs for the occupations where mid-skilled positions are available. Enrolment in these programs is growing and there have also been of new programs coming online. Anne Arundel Community College (AACC), Baltimore County Community College (CCBC), and Howard County Community College (HCC) each provide certificate level programs and associates degree programs leading to educational credentials in cybersecurity, IT and engineering which are generally aligned with the occupations that are in demand.

- In 2013, AACC, CCBC, and HCC had total combined enrollment of 2,809 in IT-related programs below a Bachelor's degree (latest data available). In 2013, a total of 376 certificates and degrees were awarded to graduates of these programs and in 2014 a total of 755 certificates and degrees were awarded. The increase from 2013 to 2014 is attributed mainly to increased graduates at AACC.
- CCBC also increased graduates in selected programs engineering technology programs and computer science, information technology, and network technology.
- Certificates and associates degrees in IT fields were flat at HCC between 2013 and 2014.
- In engineering technology programs, the three community colleges had combined enrollment of 510 students in 2013. The colleges had a total of 91 graduates for certificate and associates

degree programs in 2013 and 81 graduates in 2014. The low graduation to enrollment ratio is attributable mainly to a few CCBC Associate's degree programs that have high enrollment but few degrees awarded.

- AACC has recently added two new programs: a mechatronics certificate level training program and a cybersecurity certificate program, both of which are supported by a DOL grant designed around workforce development for mid-skilled engineering and cybersecurity. Each of the programs is tailored to provide entry-level credentials necessary for workers to begin work as a cybersecurity professional or a mechatronics engineering technician. A total of 97 participants enrolled in the mechatronics program in 2014/15 (44% of cyber technology students completed the program and entered employment) and 50 enrolled in the cyber technology program (about half of the mechatronics program students (49%) completed the program and a third (36%) entered employment). Those who did not enter employment instead opted to continue their studies and progress toward an Associate's degree at AACC. Program managers reported that employer demand for hiring of graduates was high; workers who chose to continue studies did not do so due to a lack of hiring demand from employers.

Table A Program Results from Fall 2014 through August, 2015

Program	Participants	Completers	Still Enrolled	Entered Employment
Cyber Technology	50 (100%)	22 (44%)	12 (24%)	22 (44%)
Mechatronics	97 (100%)	48 (49%)	22 (23%)	35 (36%)

Source: National STEM Consortium, AACC

The AACC students who did not complete the programs faced a number of barriers throughout their program participation. According to the program managers, the major factors that lead to student drop-outs included loss of childcare, loss of transportation, loss of housing (foreclosure/eviction/homelessness), changes in family situations/need to bring in income, related/unrelated job offers too good to turn down, loss of interest – barriers to success that are common to younger and lower-income students.

Some employers were open to the idea of developing training programs that provide workers with an opportunity to gain experience, but views differed on which type of training would be best.

- **Larger employers and government contractors** reported that they prefer internships as the main type of training program for giving workers experience. Internships provide these employers with a means of screening current students as potential new hires once they complete a Bachelor's degree. Most contractors either currently offer internships, or have done so in the past. Some of these employers can envision using certifications to up-skill their existing workforce and most reimburse employees for the cost of obtaining new certifications.
- **Smaller employers and employers serving non-government commercial clients reported that they prefer on-the-job training** as the top preferred means of training new employees. For employers that are in a fast growth mode, on-the-job training funds help to offset the costs of onboarding and training new employees, but it is not seen as a substitute for possessing the prerequisite technician skills, certifications, or experience needed for a position. Some of these

employers expressed interest in an apprenticeship model to improve worker retention (a longer training period may help the employer to retain workers that might otherwise move to a different employer for marginally higher wages). As with larger employers, these employers encourage their workers to add new certifications and diversify their skillset.

- **Employers with a training component in their business** were generally open to any of the top three models that grant workers experience – internships, on-the-job training, and apprenticeships - and they were also expressed interest in developing innovative or collaborative partnerships to train and provide work experience to workers who are new to the IT field. Because students (including working students) are their customers, they are more interested than other employers in shaping hiring and employment practices around the needs of students as well as looking for ways to grow their training businesses.

While these three profiles of companies appear evident from the interviews, it is important to note that individual companies differed somewhat in what they thought would be helpful, and also differed in their level of interest in offering any form of new worker training at all.

There are opportunities to expand IT and engineering career pathways in the three-county area.

While employers are focused mainly on hiring higher skilled workers with a Bachelor's degree and multiple years of experience, there is evidence from the AACC cyber and mechatronics programs that employer demand is reasonably strong for workers for entry-level positions (although time will be needed to track how the program graduates progress in their careers).

Smaller employers, employers in a fast growth mode, and employers with a training component to their businesses were the most interested in providing training for entry-level workers. Career paths into tiered technical support, NOC/SOC opperations, IT training, multimedia/web programming, and mechatronics are in highest demand, but workers must have the prerequisite skills and certifications for positions and employers expect to fill only a small number of positions with mid-skilled workers. Program flexibility will be important to allow for employers to use workforce development programs in a way that fits with their needs. The main benefit that smaller employers and fast growth employers saw in a training program was a means of offsetting labor costs for new hires, and therefore the program should be designed to reduce labor costs. Training models like Year Up (**www.yearup.com**) and Per Scholas (**www.perscholas.com**) have achieved this for employers in the IT field and programs like that operated in the Jane Adams Resource Center (JARC) (**http://www.jane-addams.org/programs/jarc-baltimore/**) have been implemented for computer numerical control (CNC) drafting; this program could be adapted for mechatronics job training. Early stage completion rates at the AACC mechatronics and cyber programs are lower than some other programs, highlighting the role that employment barriers play in undermining success. Year Up, Per Scholas, and JARC have higher completion rates by combining best practices such as simulated work environments, internships, close employer partnerhships, college credits, and comprehensive and intensive support services to help participants succeed.

Leaders in the three-county area can take several steps to strengthen the pipeline of future workers that successfully enter careers in the IT and engineering technology fields.

1. **Create flexible incentives for employers to hire entry-level workers, giving them work experience needed to begin an IT or engineering technology career.** A program that provides cost offsets to increase internship positions is likely to be preferred by larger employers and government contractors. These cost offsets could be created in the form of direct funding (if funding for internships becomes available from the DOL or other entities) or through tax incentives for offsetting costs of interns. Larger employers are likely to make greater use of this type of program if it can target students progressing toward completion of a Bachelor's degree. Programs offering cost offsets for on-the-job training or extended apprenticeships are likely to be preferred by smaller companies, companies with an education/training line of business, and companies undergoing a fast growth phase. These incentives should be designed to offset wage costs for adding new staff, but encourage long-term employment for up to two years or more in order to give workers adequate experience to progress onto their next step along the career ladder.

2. **Develop a career pathway leading to careers in a network operations center (NOC) or security operations center (SOC).** Several of the IT employers interviewed reported that their main hiring for mid-skilled workers were for positions in their NOC/SOC operations and employers with a training portion of their business also target occupations in this area. A NOC/SOC career training program would require (1) education leading to technical knowledge that can be attained through a certification (2) training leading to strong problem-solving ability and self-directed learning, and (3) hands-on experience in a NOC. For incumbent NOC workers, cybersecurity training could be added leading to positions in a SOC. Strong partnership with NOC/SOC employers and NOC/SOC training businesses would be important for job placement. An ideal solution would combine initial training for placement in a NOC with a long-term training program leading to (1) cybersecurity credentials, (2) a Bachelor's degree, and (3) years of experience in a security operations center. To boost success in a NOC/SOC training program, comprehensive wrap around support services would be needed to address destabilizing factors including loss of childcare, transportation, or housing among program participants. Model programs such as Year Up (**www.yearup.com**) and Per Scholas (**www.perscholas.org**) can serve as model programs for developing career training that combines technical education, work experience, and college credits.

3. **Strengthen and expand career pathways for mechatronics technicians and related positions at defense contractors.** While engineering technicians are hired in many industries, the defense industry represents the local area's largest employer and most of these positions are located at Fort Meade or nearby**.** Contractors seek workers who have (or can attain) a federal security clearance and have previous electronics testing experience. These positions are most easily accessible to veterans and workers with previous related experience. The specific work performed by contractors is often classified, making tailored training programs difficult,

however, partnerships with individual large employers could lead to better opportunities for unemployed incumbent workers. Hiring growth at Fort Meade is projected to increase substantially over the next few years creating a growing demand for workers and organizations like the Fort Meade Alliance actively coordinate shared initiatives between employers in and near Fort Meade.

4. **Strengthen employer relationships to create more on-ramps for experienced workers, veterans, and youth to access the region's established career resources.** Anne Arundel County's Cyber Works program is led by Anne Arundel Workforce Development Corporation (AAWDC) and the program has created much of the infrastructure needed to support recruiting and training of workers. Building on this foundation, more can be done to stimulate use of the resources among employers and increase the footprint of the program. Cyber Works has created a growing number of opportunities for experienced workers to connect with employers, but employers involved with the program report that there are too few opportunities for workers to find mid-skilled internships or other opportunities to gain experience. Some employers interviewed for the study were not aware of the Cyber Works program and were interested to participate in order to expand their recruiting network; more can be done to increase awareness of the program. The potential to expand the program should be explored among employers in Howard County as well as Baltimore County where a larger number of employers that serve commercial clients are located. These employers do not face the stringent security clearance requirements or high minimum experience requirements required of government contractors. Another opportunity exists related to changes in WIOA funding. The changes will create more federal funding opportunities to provide workforce development that serves youth age 16 to 24. Youth have higher unemployment rates, have less previous work experience, and are more likely to benefit from the assistance of the workforce development organizations in the region to overcome barriers to employment.

A cooperative approach to implementing these recommendations across Baltimore County, Howard County and Anne Arundel County is more likely to effectively meet the needs of employers by providing access to a larger pool of hiring candidates. Because most mid-skilled hiring is for a single position or just a few positions, expansion of the number of employers connected to jobs training programs will concurrently increase job opportunities for job seekers. Programming that gives employers choices to meet their hiring needs, while concurrently growing the skills in the local labour force will help to strengthen the region's IT and engineering intellectual capital and boost the economic competitiveness of the region.

Current Employment in Information Technology, Cybersecurity and Non-IT Engineering Fields

In May 2014, there were approximately 51,000 workers employed in Anne Arundel County, Baltimore County and Howard County who are employed in Information technology (IT), cybersecurity, and non-IT engineering occupations (such as civil engineering, mechanical engineering, etc.). Of these workers, it is estimated that 38,000 (75 per cent) of these workers were employed in IT and IT-related engineering (computer engineers, network engineers, etc.), including cybersecurity, and about 13,000 (25 per cent) were in engineering occupations.

Mid-Skilled Occupations

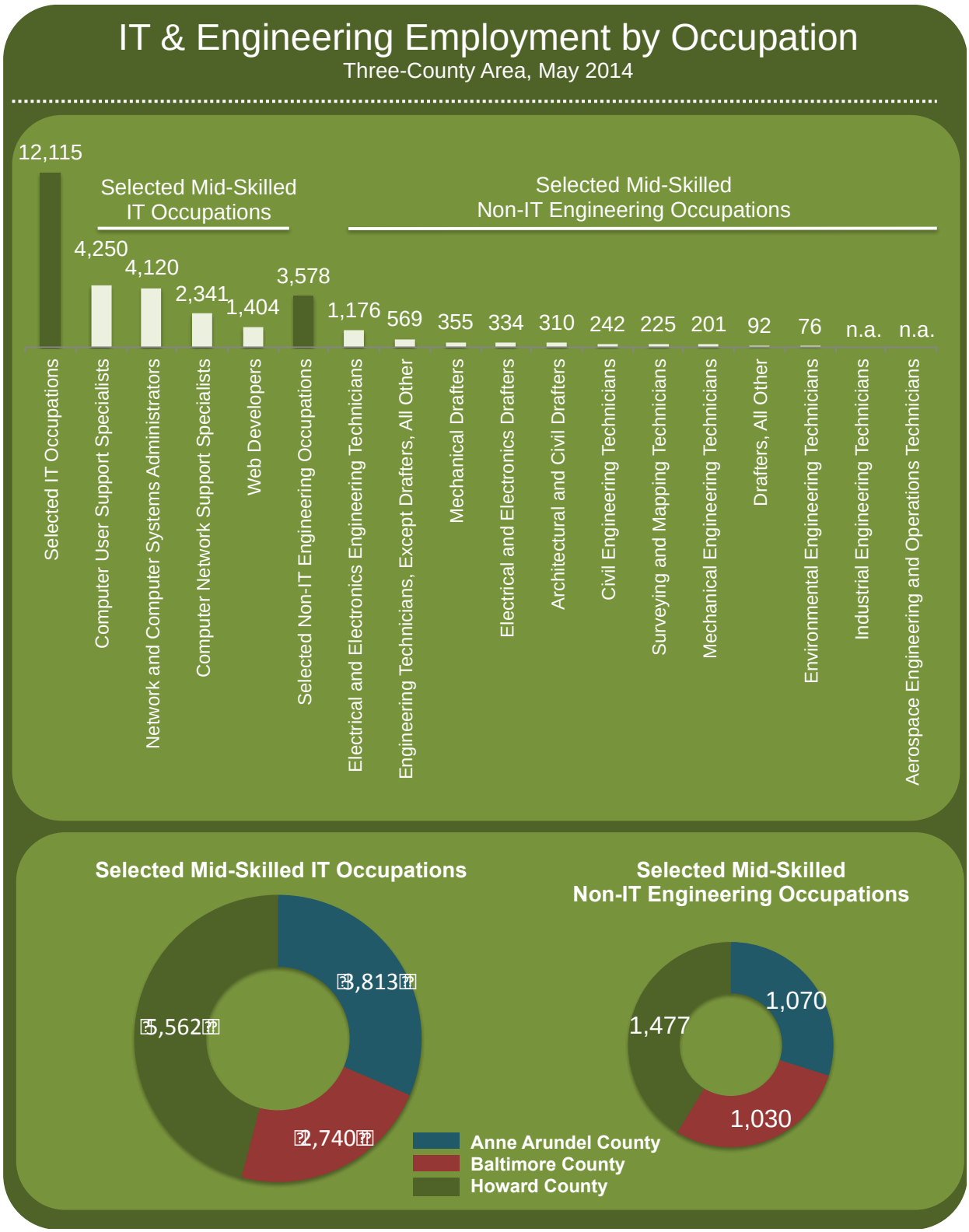
Based on national trends, it is expected that the majority of jobs in these sectors have education requirements of a Bachelor's degree, however some occupations are considered to be mid-skilled occupations and are filled by workers with an Associate's degree, a college certificate, or a technology-specific certification that is beyond a high school diploma but less than a Bachelor's degree. According to the O*Net database, the IT and engineering occupations that are more likely to be filled by workers with less than a Bachelor's degree include:

- **User support specialists** (an estimated 4,200 people were employed as user support specialists in the three county area in 2014),
- **Systems administrators and computer administrators** (4,100 workers in the three county area),
- **Network support specialists** (2,400 workers in the three county area),
- **Web developers** (1,400 workers in the three county area), and
- **Non-IT engineering technician and drafter occupations** (approximately 3,600 workers in the three county area) [iii]

The non-IT engineering technician occupations include a broad number of specialist technicians. The largest group of these workers is classified as **electronics or electrical technicians**, with over 1,100 workers employed in the three-county region. There are also over 1,000 workers employed as drafters but with specializations in mechanical engineering, electrical engineering, civil engineering, and architectural drafting. Engineering technology positions that are in demand include mechatronics technicians and other specialist technicians, environmental technicians, industrial engineering technicians, aerospace engineering technicians, survey and mapping technicians, and other technicians and drafters (see Figure 1).

Within the three-county area, approximately 45% of the IT, cybersecurity, and engineering jobs in the above-mentioned occupational categories are in Howard County (nearly 5,200 workers). Nearly a third of these jobs (31%) are in Anne Arundel County and about a quarter (24%) are in Baltimore County. Among the non-IT engineering jobs, Baltimore County accounts for 29% of jobs, Anne Arundel accounts for 30% and Howard County accounts for 41% of total workers currently employed (Figure 1).

Figure 1 IT & Engineering Employment by Occupation



Source: 2014 Occupational Employment Statistics Database, BLS, Baltimore Regional Talent Development Pipeline Study, Updated County Estimates by the Author

Table 1 Employment by Occupation 2014, Baltimore Region, Anne Arundel County, Baltimore County, and Howard County

Code	Occupation	Baltimore Region	Anne Arundel County	Baltimore County	Howard County	Three County Total
15-1111	Computer and Info. Research Scientists	1,030	189	124	409	722
15-1121	Computer Systems Analysts	6,330	1,346	813	2,124	4,283
15-1122	Information Security Analysts	1,590	334	201	528	1,063
15-1131	Computer Programmers	2,780	614	303	974	1,891
15-1132	Software Developers, Applications	6,810	1,456	721	2,427	4,604
15-1133	Software Developers, Systems Software	7,200	1,445	710	2,622	4,778
15-1134	Web Developers	2,100	442	265	697	1,404
15-1141	Database Administrators	1,870	370	289	579	1,238
15-1142	Network and Computer Systems Administrators	6,260	1,264	1,010	1,846	4,120
15-1143	Computer Network Architects	2,880	606	364	956	1,925
15-1151	Computer User Support Specialists	6,390	1,359	944	1,947	4,250
15-1152	Computer Network Support Specialists	3,520	749	520	1,072	2,341
15-1199	Computer Occupations, All Other	5,880	1,153	870	1,918	3,942
17-2061	Computer Hardware Engineers	2,260	373	223	903	1,498
Total IT		**56,900**	**11,700**	**7,357**	**19,001**	**38,057**
Total Mid-Skilled IT Occupations*		***12,010***	***2,549***	***1,730***	***3,716***	***7,995***
17-2011	Aerospace Engineers	640	88	76	271	435
17-2041	Chemical Engineers	260	39	59	75	173
17-2051	Civil Engineers	3,310	723	660	752	2,135
17-2071	Electrical Engineers	2,460	392	481	692	1,565
17-2072	Electronics Engineers, Except Computer	1,990	346	233	673	1,252
17-2081	Environmental Engineers	540	117	99	148	365
17-2111	Health and Safety Engineers, Except Mining Safety Engineers and Inspectors	250	49	49	57	155
17-2112	Industrial Engineers	1,190	201	166	336	702
17-2131	Materials Engineers	290	43	45	105	192
17-2141	Mechanical Engineers	2,490	440	402	664	1,506
17-2199	Engineers, All Other	1,560	276	243	487	1,006
17-3011	Architectural and Civil Drafters	480	105	95	109	310
17-3012	Electrical and Electronics Drafters	540	108	104	121	334
17-3013	Mechanical Drafters	670	126	110	119	355
17-3019	Drafters, All Other	150	31	29	32	92
17-3021	Aerospace Engineering and Operations Technicians	110	n.a.	n.a.	n.a.	n.a.
17-3022	Civil Engineering Technicians	370	81	75	85	242
17-3023	Electrical and Electronics Engineering Technicians	1,900	322	318	536	1,176
17-3025	Environmental Engineering Technicians	110	26	22	27	76
17-3026	Industrial Engineering Technicians	710	n.a.	n.a.	n.a.	n.a.
17-3027	Mechanical Engineering Technicians	320	56	50	95	201
17-3029	Engineering Technicians, Except Drafters, All Other	850	141	152	276	569
17-3031	Surveying and Mapping Technicians	340	73	74	78	225
Total Non-IT Engineering (incl. Engineers, Technicians, and Drafters)		**21,530**	**3,783**	**3,545**	**5,737**	**13,065**
Total Non-IT Engineering Technicians & Drafters		***6,550***	***1,070***	***1,030***	***1,477***	***3,578***

Source: 2014 Occupational Employment Statistics Database, BLS, Baltimore Regional Talent Development Pipeline Study, Updated County Estimates by the Author *Includes SOCs 15-1134, 15-1151, 15-1152, and 15-1142 **Includes SOCs 17-3011, 17-3012, 17-3013, 17-3019, 17-3021, 17-3022, 17-3023, 17-3025, 17-3026, 17-3027, 17-3029, and 17-3031

What's in Demand: Job Openings in Cybersecurity, IT, and Engineering Technology

Job openings data provides a more detailed and current view on the minimum requirements that employers are seeking for new hires today. Based on a review of job advertisements collected in the Maryland Workforce Exchange (MWE) jobs database[iv] from July 2014 through June 2015 there were at least 2,686 job openings in Howard County, Anne Arundel County, and Baltimore County in the fields of information technology (IT), IT engineering (e.g. systems engineering, software engineering, etc.), cybersecurity (a sub-set of IT), and in non-IT engineering (e.g. civil, electronics/electrical, mechanical, industrial, manufacturing, and other non-IT engineering). Among these job ads, 88% were for IT and cybersecurity positions, while 11% were for non-IT engineering, reflecting the higher demand for IT jobs, as compared to non-IT engineering. Hiring demand from July 2014 to June 2015 was highest in Anne Arundel County (total of 1,018 job ads), followed by Howard County (983 job ads), and Baltimore County with 686 job ads. While the MWE jobs database may not collect 100% of all job openings, it suggests that current hiring is highest in Anne Arundel and Howard Counties. Among the non-IT engineering jobs, hiring demand appeared comparatively low in 2014-2015. For every 1,000 workers employed, there were 24 non-IT engineering job openings in the three county area, compared to nearly three times as many job openings per employee in the information technology and cybersecurity sector (see Table 2 and Figure 2 for more details).

Table 2 Employment by Occupation 2014, Baltimore Region, Anne Arundel County, Baltimore County, and Howard County

	Anne Arundel County	Baltimore County	Howard County	Three-County Area
Total Employment				
Information Technology & Cybersecurity	11,700	7,357	19,001	38,058
Non-IT Engineering	3,783	3,545	5,737	13,065
IT and Engineering (Combined)	15,483	10,902	24,738	51,123
Employment in Mid-Skilled Occupations				
Information Technology & Cybersecurity	2,549	1,730	3,716	7,995
Non-IT Engineering	1,070	1,030	1,477	3,577
IT and Engineering (Combined)	3,619	2,760	5,193	11,572
Total Job Openings				
Information Technology & Cybersecurity	892	612	863	2,367
Non-IT Engineering	126	74	119	319
IT and Engineering (Combined)	1018	686	983	2,687
Job Openings Per 1,000 Employed Workers				
Information Technology & Cybersecurity	76	83	45	62
Non-IT Engineering	33	21	21	24
IT and Engineering (Combined)	66	63	40	53

Sources: Maryland Workforce Exchange Jobs Database, 2014 Occupational Employment Statistics Database, BLS, Baltimore Regional Talent Development Pipeline Study, Updated County Estimates by the Author;

Figure 2 Advertised Job Openings by Education Level

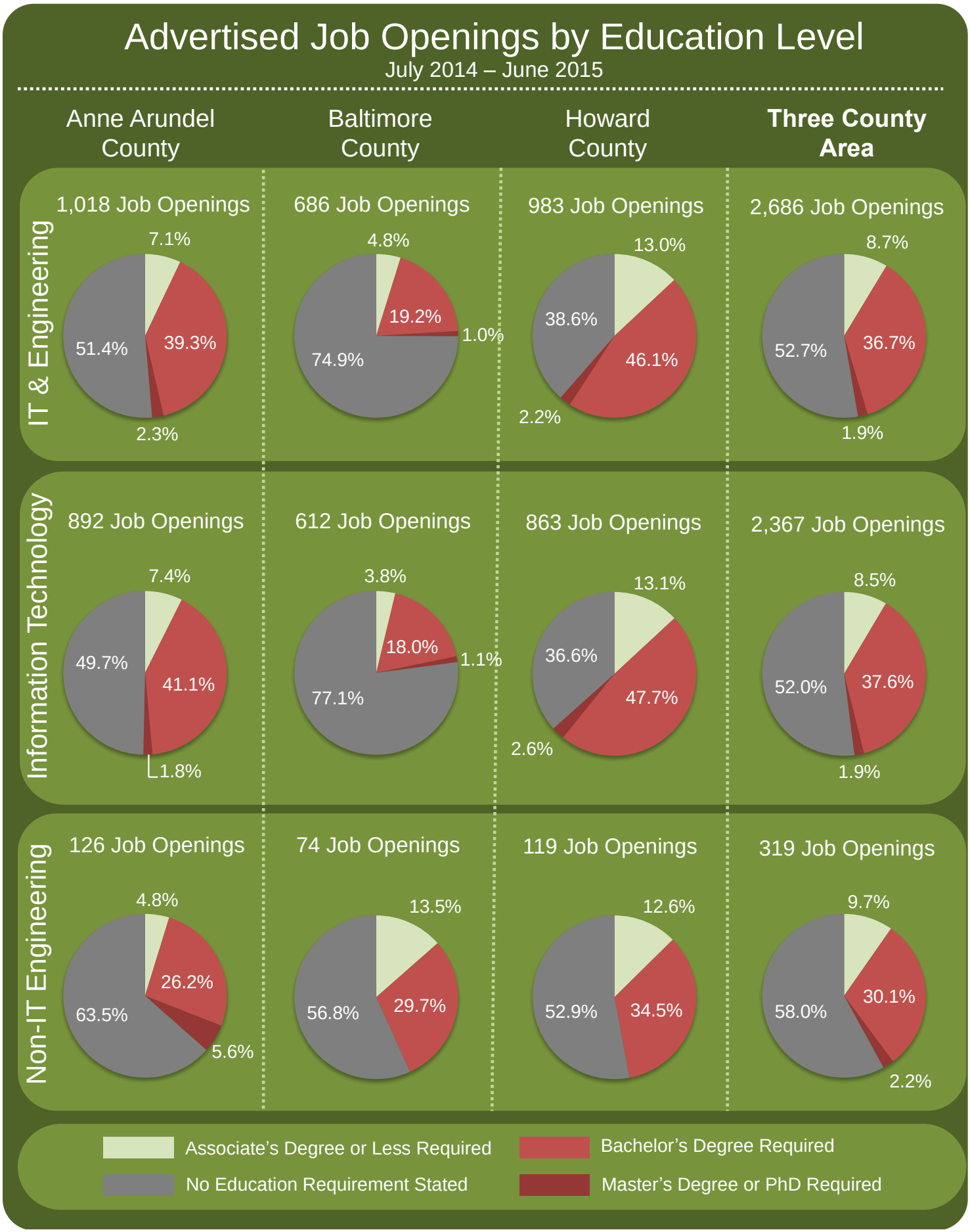
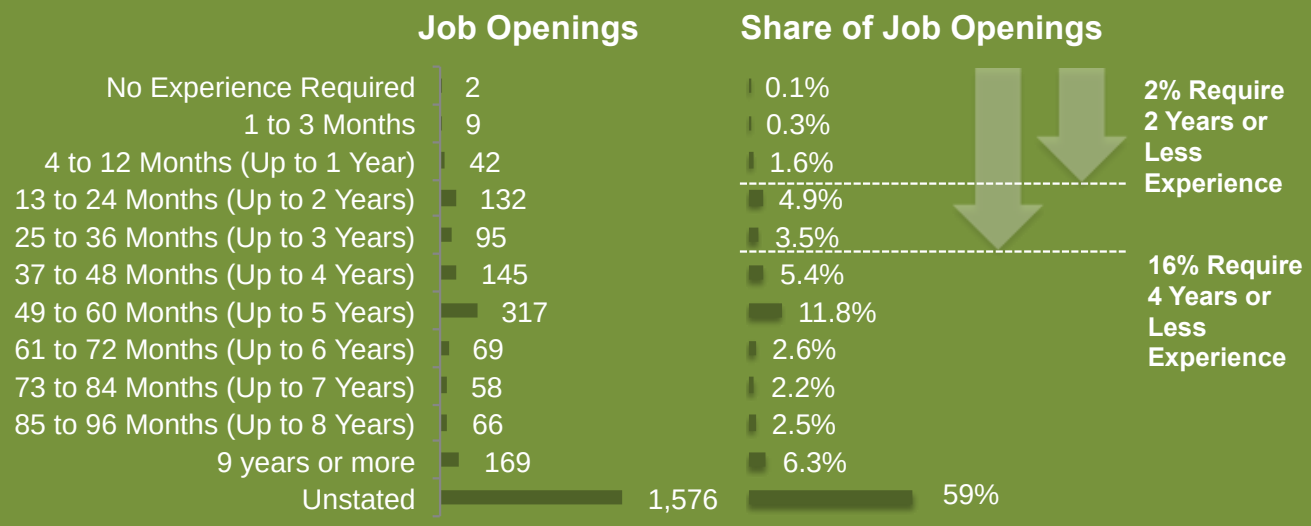


Figure 3 Advertised Job Openings by Experience Level and Job Tyle

Advertised Job Openings by Experience

July 2014 – June 2015

IT and Engineering Job Openings by Experience Required Anne Arundel, Howard, and Baltimore Counties



Advertised Job Openings by Job Type

July 2014 – June 2015

	Job Openings				Share of Job Openings			
IT Jobs	Anne Arundel County	Baltimore County	Howard County	Three County Area	Anne Arundel County	Baltimore County	Howard County	Three County Area
Contract	13	24	24	61	1.5%	3.9%	2.8%	2.6%
Regular	670	453	775	1,898	75.1%	74.0%	89.8%	80.2%
Temporary	1	10	1	12	0.1%	1.6%	0.1%	0.5%
Unstated	208	125	63	396	23.3%	20.4%	7.3%	16.7%
Total	**892**	**612**	**863**	**2,367**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Non-IT Engineering Jobs								
Contract	1	2	0	3	0.8%	2.7%	0.0%	0.9%
Regular	79	45	73	197	62.7%	60.8%	61.3%	61.8%
Temporary	0	0	0	0	0.0%	0.0%	0.0%	0.0%
Unstated	46	27	46	119	36.5%	36.5%	38.7%	37.3%
Total	**126**	**74**	**119**	**319**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Required Education

Data from the job ads reveals that more than half (52.7%) of all job openings in IT, cybersecurity and non-IT engineering lack a specific educational requirement (no minimum education stated in the job ad). Over a third (36.7%) stated minimum requirements of a Bachelor's degree, about 2% required a minimum of a Master's degree or higher, and about 8.7% of jobs stated educational requirements of an Associate's degree, certificate, high school diploma (or equivalent), or specifically stated that there was no minimum education required (See Figure 2).

In interviews, employers in the three-county area report that they place a high emphasis on hiring workers with the ability to be self-motivated learners, capable of mastering new technologies as they emerge, and applying technology in changing client environments. Several employers report that they see a Bachelor's degree as a good indication that a new hire will be able to not only apply skills in one technology, but also learn and apply many technologies, a requirement for productivity in quickly changing IT market.

Experience Required

Analysis of job ads reveals that employers in the three-county region are mainly looking for workers with two years of experience or more and employers reported the same in interviews. Of the 2,686 job openings in IT, cybersecurity and non-IT engineering in 2014-2015, only 2% state minimum experience requirements of 2 years or less, while a much larger number of jobs - at least 16% of job openings - are available to workers with 4 years of experience (the actual percentage of jobs requiring less than 4 years of experience may be greater than 16%, because 59% of job ads do not have experience requirements stated in the job advertisement). While 59% of jobs do not state a minimum experience requirement at all, a qualitative review of these jobs suggests that many of these jobs are likely to require a Bachelor's degree, even though a Bachelor's degree is not an explicitly stated requirement. Interviews with employers confirmed this view.

Contract vs. Permanent Positions

Despite the large role that contractors play in the IT field, the majority of positions in IT are advertised as permanent hires (80% of job openings in IT and Cybersecurity). Only 2.6% of IT jobs openings in the three county area are advertised as contract and only about 0.5% are temporary positions (the balance not stating whether they are permanent, contract, or temporary). In the engineering technology field, there were no temporary job openings identified in the 2014-2015 period and only three job openings that were noted as contract positions (the remainder being permanent or unspecified).

Limited Mid-Skilled Careers in Cybersecurity

"There is not a big demand in the cyber world for workers with a mid-skilled skill set. As an IT contractor, there is a Bachelor's degree requirement for most – practically all – of the positions we have."

- Angela Robinson, Soft Con

Maryland's cybersecurity market is driven in large part by NSA and other government entities. According to a study by the Abell Foundation, the majority (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 2013. These employers must comply with Department of Defense Directive 8570[v] for all workers employed in an information assurance (IA) 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 requirements, and other requirements. The experience and certification requirements for the cybersecurity workforce are contained in Tables 3 and 4.

Table 3 DoD Directive 5870 Minimum Workforce Certifications and Experience for Information Assurance (IA) 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
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 4 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.

Experience and Education Requirements for Government Contractors in Cybersecurity

Interviews confirm that most contractors are unable to place workers in open contract positions without the minimum experience requirement for the position (typically 4-5 years), minimum certifications (identified in Tables 3 and 4), minimum education (typically a Bachelor's degree), and security clearance. In addition, most contractor employers have few or no non-contracted positions and therefore have no hiring demand for workers who do not meet all of the above-mentioned requirements. Without an internal talent development pipeline for workers who do not meet these minimum criteria, these companies offer very few early career opportunities. In some cases, employers hire for Summer internships, but generally these are restricted to students nearing completion of their Bachelor's degree. As a result, early career opportunities are relatively limited among contractors.

While positions classified as an Information Assurance Technician I, Information Assurance Manager I, or Information Assurance System Architect or Engineer I (see Table 3) technically may not require any prior work experience to meet the requirements of DoD Directive 8570, contractors report that practically all government cybersecurity positions require a minimum of 4-5 years of prior work experience. Interviews with contractors reveal that the government agency or prime contractor that is recruiting for the position sets the exact experience requirements and education requirements for these jobs. Individual contractors and subcontractors report that they have no control over the requirements and little flexibility to fill a job opening with a candidate that lacks any of the stated requirements.

In addition, employers reported that the level of qualification being required by government agencies is generally increasing over time. For instance, some contractors report that they employ workers who have been filling a contracted position – sometimes for years – but that they routinely are notified that these workers are no longer suitable to continue to provide the services they have been providing due to inadequate certifications, education, or experience levels, which have been increased through policy change. This sometimes results in workers being removed from a contract where they have been performing well – or else having to obtain certifications in a technology where they are already proficient. In some cases, the worker is performing at an expert level but in order to remain in compliance with education, certification, or experience requirements, she or he must obtain an entry-level certification. In most cases, workers are permitted a limited amount of time to obtain certifications needed.

For workers who lack the educational requirements for a position, they may in some cases substitute years of experience to meet the minimum educational requirement. Technically, this results in the potential for workers who have education below a Bachelor's degree to fill a Bachelor's level position, but decades of experience are sometimes required for the worker to quality. Contractors report that, in effect, most requisitions require a minimum of a Bachelor's degree, especially for workers just entering the cybersecurity field today.

Mid-Skilled Careers in IT (Beyond Cybersecurity)

Employers that Hire Mid-Skilled Workers

Job requirements vary considerably by employer, with some employers requiring a Bachelor's degree while others do not for a similar position. During the 2014-2015 period, there were 51 identified employers in the three-county region who advertised for IT job openings stating minimum educational requirements less than a Bachelor's degree (ranging from high school diploma through an Associate's degree). These employers account for 17.6% of the 289 IT employers identified in the Maryland Workforce Exchange Jobs Database who hired for IT positions in July 2014- June 2015 (Note: not all jobs list an employer). Twelve of the employers hiring workers with less than a Bachelor's degree were larger employers that advertised for 10 or more open positions through the course of the year and the remainder (39 employers) were mid-sized to smaller employers with few job openings throughout the year. Most of the smaller employers - 30 of the 39 employers - had just one open position during the year that required less than a Bachelor's degree. The top employers hiring workers with less than a Bachelor's degree included NES Associates (8 positions), Booz Allen Hamilton (7 positions), Dunbar Armored (5 positions), ExecuTech Strategic Consulting (5 positions), Assured Information Security, Chiron Technology Services, COMSO Inc., and ManTech International Corporation (each with 4 openings requiring less than a Bachelor's Degree in 2014-2015). Table 5 summarizes the employers who hire workers with less than a Bachelor's Degree.

Table 5 Employers Hiring Mid-Skilled Workers with Less than a Bachelor's Degree

Employer	IT Job Postings < Bachelors	Total IT Job Postings	Share of Job Postings < Bachelors
NES Associates, LLC	8	11	73%
Booz Allen Hamilton INC.	7	38	18%
Dunbar Armored	5	6	83%
ExecuTech Strategic Consulting	5	5	100%
Assured Information Security, Inc.	4	7	57%
Chiron Technology Services	4	4	100%
COMSO, Inc.	4	38	11%
ManTech International Corporation	4	46	9%
Integrity Applications Inc.	3	4	75%
Amyx, Inc.	2	3	67%
Apex Systems, Inc.	2	24	8%
ASI Government, Inc.	2	5	40%
Axom Technologies Inc.	2	26	8%
Berico Technologies	2	2	100%
Engility Corporation	2	18	11%
IJET Intelligent Risk Systems	2	2	100%
NTT Data Inc.	2	5	40%
Red Arch	2	2	100%
Sungard Availability Services LP	2	4	50%
Transportation Security Administration	2	2	100%
Tresys Technology, LLC	2	2	100%
ABM Industries, Inc.	1	1	100%
American Systems Corporation	1	3	33%
American Urological Association	1	1	100%
Aon	1	12	8%
Blackbird Technologies, Inc.	1	2	50%
CareFirst BlueCross BlueShield	1	23	4%
Chameleon Integrated Services	1	11	9%
Ciena Corporation	1	17	6%
CliftonLarsonAllen	1	1	100%
Concentrix Corporation	1	2	50%
CSC	1	1	100%
CSX Transportation, Inc.	1	1	100%
Data Systems Analysts, INC	1	3	33%
DELTA Resources, Inc.	1	4	25%
Diamond Comic Distributors, Inc.	1	1	100%
Eagle Ray Inc.	1	1	100%
Evolver, Inc.	1	1	100%
Force 3, Inc.	1	1	100%
Helion Technologies	1	1	100%
HH MedStar Health, Inc.	1	4	25%
KCI Technologies, Inc.	1	5	20%
Lockheed Martin Naval Elect.	1	1	100%
Networking Technologies + Support, Inc.	1	1	100%
R.E. Michel Company, Inc.	1	1	100%
Serco, Inc.	1	32	3%
Solers, Inc.	1	2	50%
Spectra Tech, LLC	1	1	100%
Staffmark Investment LLC	1	1	100%
Systems Integration Inc.	1	2	50%
Whitney Bailey Cox & Magnani, LLC	1	1	100%

Source: Maryland Workforce Exchange Jobs Database

Top Mid-Skilled IT Jobs in Demand

Based on a review of job postings, the top IT jobs in demand that require less than a Bachelor's degree include:

- Systems administrators,
- Network analysts/engineers/technicians,
- Software developers/programmers/engineers (with an emphasis on cloud/java/hadoop, .NET, and C/C++)
- Help desk/technical support positions, and
- A wide variety of other positions.

Table 6 contains a list of the most common job titles not requiring a Bachelor's degree. Additional job titles with fewer postings are listed after table 6. Note that security-related positions are a portion of the jobs available, but a qualitative review of these jobs confirms that most of these positions have high direct experience requirements (4+ years), despite not requiring a Bachelor's degree.

Table 6 Employers Hiring Mid-Skilled Workers with Less than a Bachelor's Degree

Job Title	Job Openings
Systems Administrators	18
Software/Application Engineer	12
Network Analyst	8
Help Desk Specialist	5
Network Engineer	5
Cloud Engineer/Developer	4
Help Desk Analyst	4
SIGINT Specialist	4
Test Engineer	4
Programmer/ Programmer Analyst	3
SOC Analyst	3
Software Developer	3
System Engineer	3
Technical Writer	3
Web Developer	3
Configuration Manager	2
Data Scientist	2
Database Administrator	2
Desktop Support	2
Engineer	2
Help Desk Coordinator	2
Information Systems Security Specialist	2
Java Developer	2
National Defense Operations Analyst	2
Network Intelligence Analyst	2
NTMCSS	2
Operations Specialist	2
Penetration Tester	2
Security Engineer	2
SIGINT Reporter/Analyst	2
Signature Reduction Technician	2
Software Specialist	2
Systems Engineer	2

Source: Maryland Workforce Exchange Jobs Database

Other Job Titles with Educational Requirements Less than a Bachelor's Degree:

- .NET Developer
- Acquisition Professional
- All-Source Cyber Threat Analyst
- CASS
- CNO Engineer
- Communications System Analyst
- Computer Network Exploitation Analyst
- Computer Security Systems Specialist Intermediate
- Configuration Analyst
- Cyber Analyst
- Cyber Exercise Scenario Planner
- Cyberspace International Affairs Analyst
- Deskside Support Specialist
- Director, Technical Operations
- Electronic Warfare Technician
- Embedded Software Engineer
- Engineer Signal Construction
- Field Technician
- Full Scope Poly Linux System Administrator
- Full Scope Poly Software Engineer
- Information Specialist
- Information Systems Security Officer
- Intelligence Analyst (Cyber)
- ISSE
- IT Analyst
- IT Consultant
- IT Help/Service Desk Analyst
- IT Manager
- IT Operations Analyst
- IT Performance Management Specialist
- IT Project Manager
- IT Security Analyst
- IT Specialist
- IT Support Engineer
- IT Support Specialist
- Linux System/Software Engineer
- Malware Reverse Engineer
- Mobile Engineer
- Multi-Media Designer
- National Defense Operations Analyst Associate
- Network Engineer/System Admin
- Network Threat Malicious Code Reverse Engineer
- Oracle DBA
- Program Assistant
- QA Engineer Junior
- Queue Coordinator
- Service Desk Analyst
- SharePoint Designer
- SIGINT Collection Manager
- SIGINT Geospatial Analyst
- SIGINT Trainer/Instructor
- Software Automation Tester
- Software Engineer
- Software Test Engineer
- Software/System Architect
- SQL Developer
- Storage Network Engineer
- Subject Matter Expert
- Support NT/Unix Technician
- Systems Analyst
- Tech Support Engineer
- Tech Support/POS Specialist
- Technical Analyst
- Technical Lead/Release Manager
- Tester
- NOC Technician
- Traditional Compliance Reviewer, Mid
- Trainer
- Unified Communications Engineer
- User Support Specialists
- Win 7 Refresh Tech
- Windows Compliance Reviewer

IT Fields with Demand for Mid-Skilled Workers

In interviews, employers reported that the following functional work areas have entry-level positions for workers with less than a Bachelor's degree and afford an opportunity to gain experience and career advancement:

- Help Desk/Technical Support
- Network Operations Center (NOC)/ Security Operations Center (SOC) Occupations

- Training Instructors
- Multimedia/Web Development

The requirements for these areas of work usually include a combination of education, certification, and/or experience – and workers without the prerequisite experience or education are sometimes hired because they have the right certifications, are working on a degree, or have some experience. Employers report that they have hired recently in areas of work, either because they are growing or to replace workers who are progress into higher skilled positions.

Career Pathways with Entry Points as a Help Desk/ Technical Support Technician

Technical support and help desk operations are often subdivided into tiers or levels (L1, L2, L3), to efficiently triage problems and route them to the appropriate specialist. Employers reported that tier I technical support positions are often available to workers without a Bachelor's degree and provide workers with an opportunity to determine and develop an area of specialization. Tier I support is typically responsible for basic customer support for desktop/device technical support issues, basic user administration, and application support, although the specific requirements differ by employer. Typical job titles for technical support technicians include:

- Technical Support/Help Desk Specialist
- Help Desk Technician
- Help Desk Analyst
- IT/Help Desk Coordinator
- Data Center Technician

The requirements for most positions are a high school diploma, progress toward obtaining a technical degree (Associate's or Bachelor's), some industry certifications (A+, Microsoft certifications, Network+, or other desktop support certification), customer service skills, and some experience in desktop support or troubleshooting (See Figure 4).

Career Pathways in an Network Operation Center or Security Operation Center

Network Operation Center (NOC) and Security Operation Center (SOC) Positions

Network Operation Centers (NOCs) provide critical monitoring and operations services for networks that must remain available and online. Workers employed in a NOC perform network monitoring, incident response, communications management (including unified communications), and reporting and resolution of problems. The operations of a NOC can include help desk/technical support functions in addition to technicians to perform network management and troubleshooting, network architecture and

engineering, systems administration, and other functions. Some NOCs are operated internally and others are implemented by IT service providers to support their clients' servers, systems and information infrastructure.

Employers who operate NOCs describe the NOC as a good career starting point for workers who have obtained some certifications (and perhaps an Associate's degree), where they are able to gain experience while they continue to work toward a Bachelor's degree that will open additional mid-level and senior-level career opportunities.

Figure 4 Career Paths in Technical Support and NOC/SOC Operations

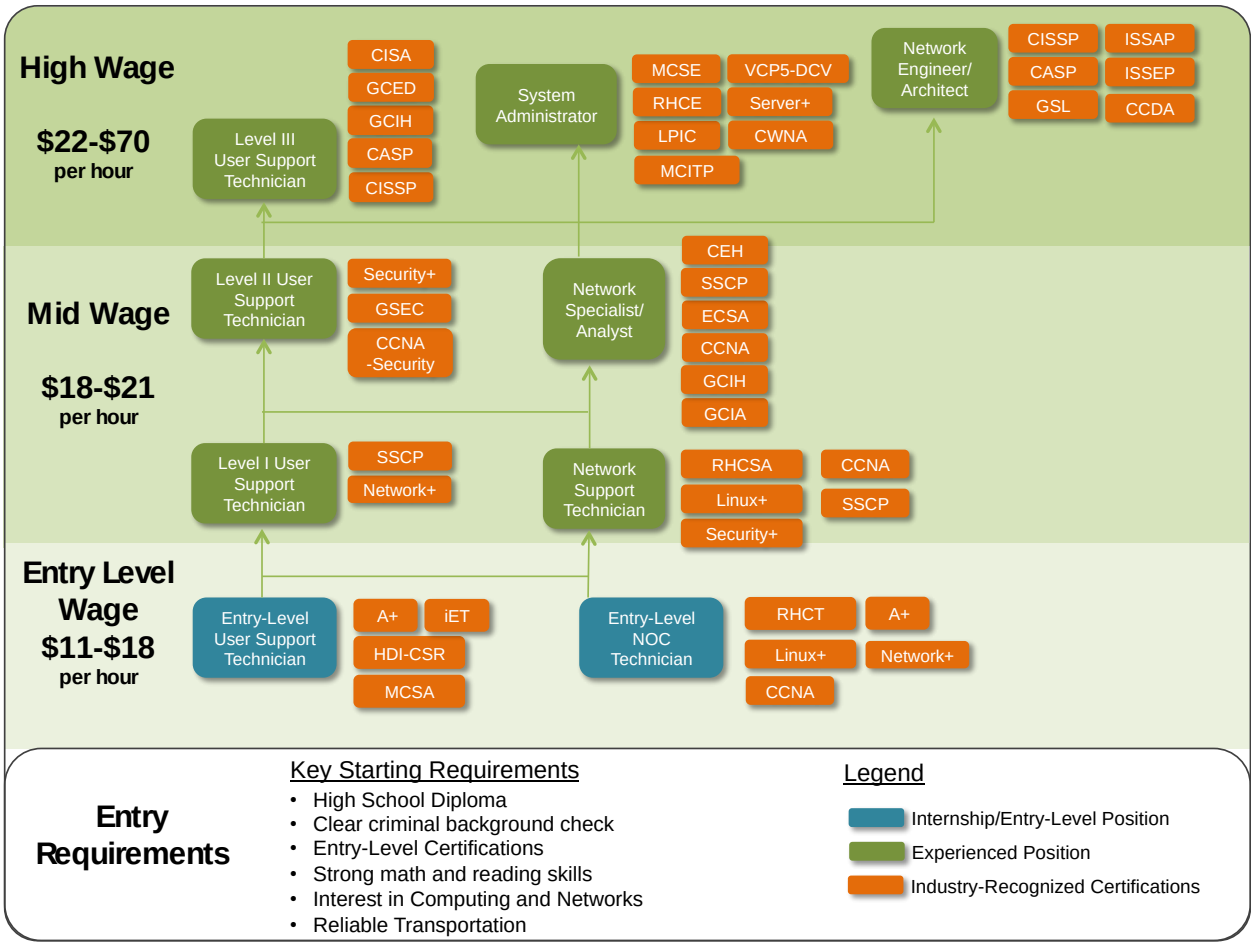


Table 7 Certifications and Providers

	Certification Name	Certification Provider
CCNA	Cisco Certified Network Associate	Cisco
CCNA-Security	Cisco Certified Network Associate-Security (CCNA-Security)	Cisco
CCDA	Cisco Certified Design Associate	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
RHCT	Red Hat Certified Technician	Red Hat

	Certification Name	Certification Provider
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.

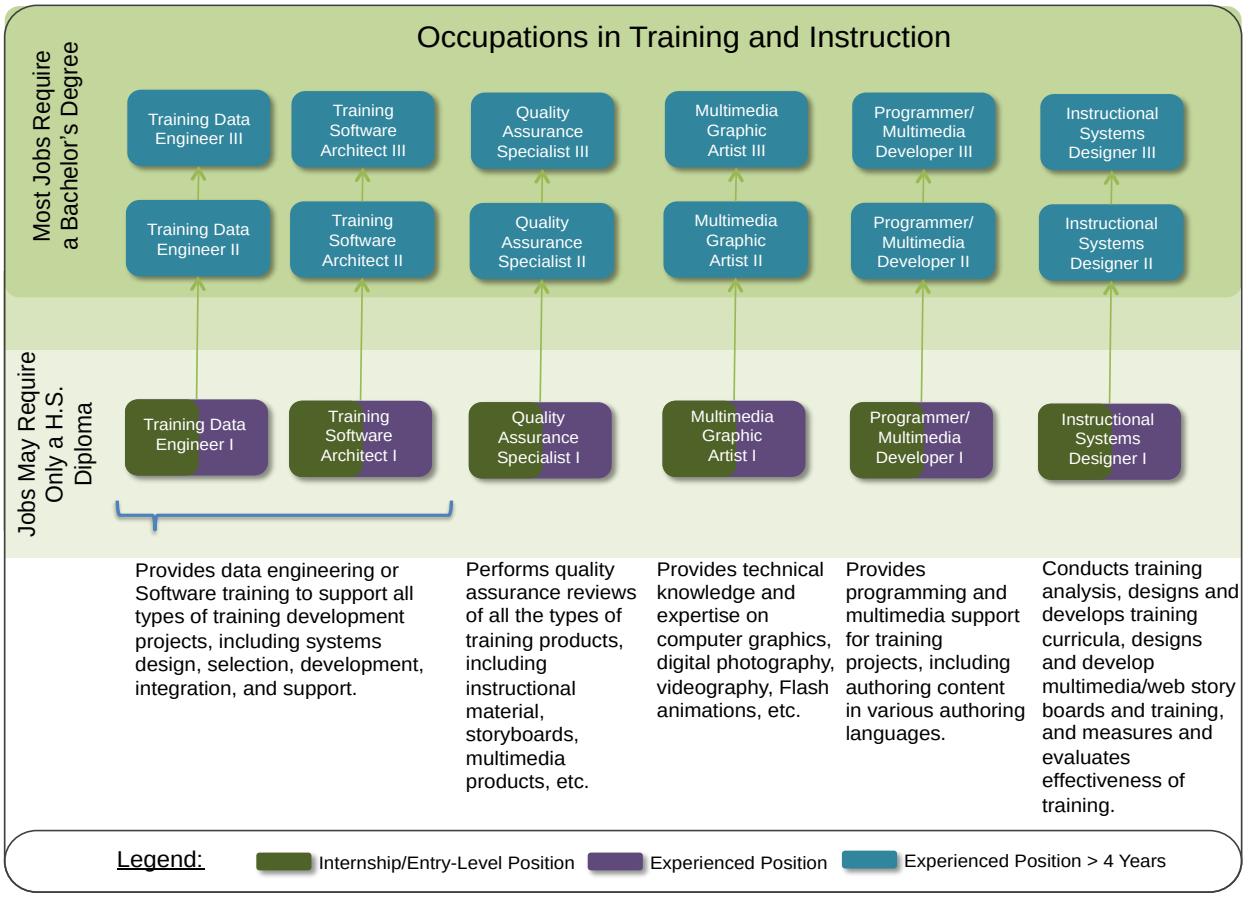
The occupations of workers in a NOC vary based on the needs of employers but can include:

- Network Technician
- Network Engineer/ Junior NOC Engineer
- Telecommunications Specialist
- Information Technology Specialist (Network Services)
- Server/Network Administrators
- Hosting Operations Specialist (hosted servers)
- Help Desk Technician (Levels I, II, and III)
- Unified Communications Engineers
- Wireless Engineers
- Solution Architects

Security Operations Centers (SOCs) were also mentioned by employers as an area of growing demand. SOCs are dedicated sites where enterprise information systems including web sites, applications, databases, data centers and servers, networks, desktops and other devices are monitored, assessed, and defended. Workers beginning careers in a NOC can sometimes specialize in a security-related field that leads to employment in a SOC, but positions in a SOC typically require a minimum of 2-4 years of work experience and are more likely to require a Bachelor's degree. Within the help desk/NOC/SOC fields, several career pathways are available that often begin with an entry-level technical support position or position as a NOC technician.

Career Pathways for Instructors and Software Training Professionals

Figure 5 Booz Allen Hamilton Training and Instruction Occupations



Source: Booz Allen Hamilton GSA Schedule MOBIS Labor Categories

Some employers interviewed for the study provide software training to corporate, institutional, or government clients. They may also train students to prepare for certifications and provide other types of instruction. These employers report that their instructors must have completed the training for which they are providing instruction, but often do not require prior work experience to deliver the course instruction. These positions are sometimes available to workers with limited experience.

The online job posting database did not contain many jobs for instructors (only 3 were identified) however Booz Allen Hamilton, one of the region's largest employers hiring mid-skilled workers, offers government employers a contracted supply of workers who can meet the government requirements for SIN 874-4 (Training Services). These include workers in six occupational areas described in Figure 5. For lower level occupations, positions are filled with entry-level workers or workers with one to four years of experience and a high school diploma. Higher-level occupations (levels II and III) are filled by workers with a minimum of a Bachelor's degree. The areas of training include data engineering, software architecture training, training in quality assurance, graphics training, programmer and multimedia training, and instructional systems design.

Other Mid-Skilled Careers in IT

Multimedia / Web Development/ Programming

A few employers mentioned that positions as graphics developers, web developers, and web programming, and software engineering are occasionally available to workers without a Bachelor's degree. For these positions, some employers emphasized that they prefer to hire workers with either a broad set of experiences working in different programming languages or workers who have completed a Bachelor's degree. Employers report that these workers are better able to learn new programming languages or frameworks and demonstrate a level of curiosity, ability to learn new languages, and self-motivation to increase the breadth of their programming/IT skills.

Employers mentioned ongoing demand for Java programmers (which was also confirmed in job openings) and several employers reported active hiring for experienced cloud developers (in particular, workers with experience in SQL, Java, Linux, Scripting Language (e.g. Javascript), .NET, C#, C++, CSS, and Python).

Other Mid-Skilled Opportunities in IT

Beyond the above-noted areas of demand for mid-skilled workers (help desk, NOC/SOC, instructors, and multimedia/web development/programming), employers also made note of other mid-skilled jobs for:

- Workers with considerable **management experience** (there is an opportunity for non-technical workers to become project managers),
- Workers with strong **technical sales experience** (must be able to learn new technologies and services quickly and put together meaningful solutions for clients),
- Workers with significant **military experience** (some employers report that they have hired veterans who have software testing experience or other transferable skills)

There may be opportunities to develop talent pipelines around workers with these backgrounds, but interviews suggested that the hiring in these areas is not as large as the aforementioned areas.

Mid-Skilled Careers in Engineering Technology

Fields of Engineering Technology

Between July 2014 and June 2015, there were 94 employers in the three-county area that posted engineering and engineering technology advertisements. Electronics engineering was the top in-demand field of engineering technology, with 168 job openings, followed by general and other engineering technicians (126 openings). Other areas in demand included electrical technicians, specialized drafters, and other varieties of engineering technicians (See Table 8).

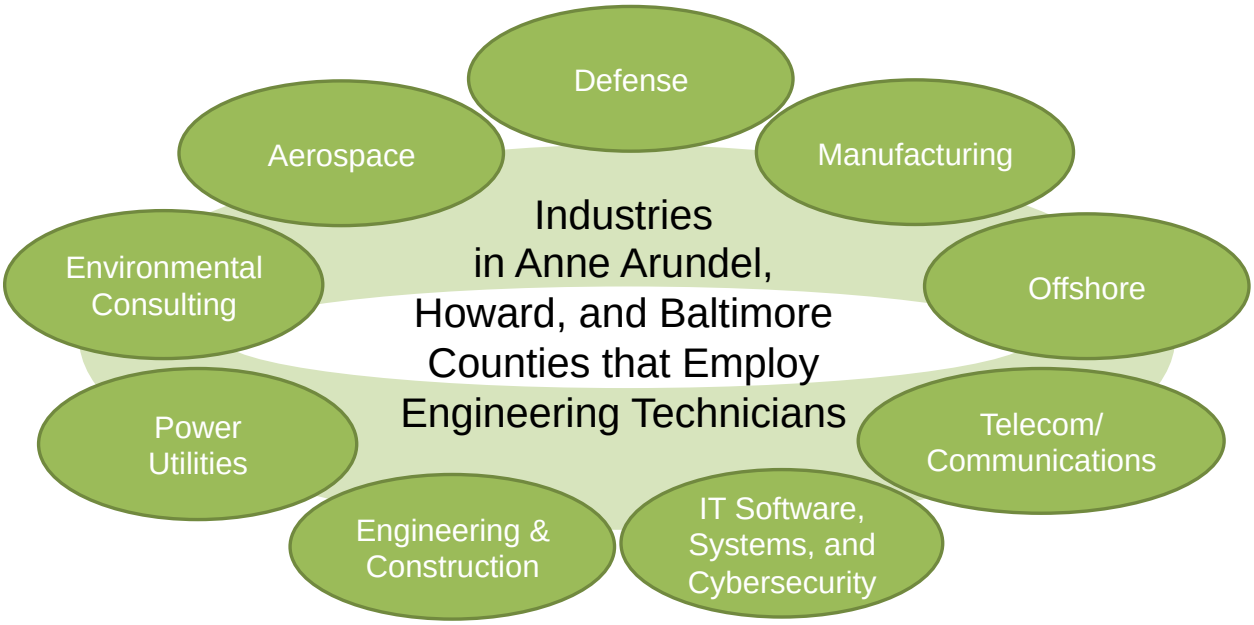
Table 8 Job Advertisements by Field of Engineering Technology

Type of Technician / Technologist	Job Openings
Electronics Engineering Technicians	168
Engineering (General)	116
Other Engineering Technicians	10
Electrical Technician	8
Other Drafters (Specialized)	5
Mechanical Technicians	4
Industrial Engineering Technologists	3
Civil Drafters	2
Industrial Engineering Technicians	2
Civil Engineering Technician	1

Source: Maryland Workforce Exchange Jobs Database

Employers Hiring Engineering Technicians

Figure 6 Industries the are Hiring Engineering Technicians



There are a wide variety of industries in the three-county area that hire engineering technicians. The largest employers are those in the defense and IT systems integration/cybersecurity fields, but there are also employers in telecommunications, offshore energy (oil and gas as and likely wind energy in the future), environmental consulting, power utilities, manufacturing, and other industries (see Figure 6).

Defense contractors and businesses linked to Fort Meade are the top employers of engineering technicians and are expected to represent the main businesses hiring engineering technicians in the future. More than 51,000 people currently work on Fort Meade and there are over 95 defense contractors with offices in the surrounding area. According to the Fort Meade Alliance Annual Report 2015, continued growth over the next five years (2015-2020) will add more than 2,300 new jobs linked

to activities at Fort Meade, and an additional 6,000 to 9,000 employees currently working in leased space around the region will move inside the gates.

Raytheon, KEYW Corp, Oceaneering International, Northrup Grumman, Michael Baker Corporation, ManTech, Bridges Consulting, CACI, Computer Sciences Corporation, Cubic Corporation, CyberCore Technologies, Entegra Systems, and Hewlett-Packard were the top companies hiring engineering technicians between July 2014 and June 2015. Each of these companies advertised for at least five open engineering technician positions throughout the year. The remainder of companies had fewer open positions and a large number had just one opening during the course of the year (See Table 9).

Table 9 Job Advertisements by Employer: Electronic Engineering Technicians and Engineering Technicians (General)

Electronic Engineering Technician Employers	Job Openings	Engineering Technician (General) Employers	Job Openings
Raytheon Company	25	Oceaneering International, Inc.	9
KEYW Corp	12	Northrop Grumman Corporation	8
ManTech International Corporation	7	Michael Baker Corporation	8
Bridges Consulting, Inc.	6	STV Incorporated	4
CACI International Inc.	6	Honeywell International Inc.	3
Computer Sciences Corporation	5	McCormick & Company, Inc.	3
Cubic Corporation	5	Chameleon Integrated Services	2
CyberCore Technologies LLC	5	Intralox LLC	2
Entegra Systems	5	Johnson, Mirmiran & Thompson, Inc.	2
Hewlett-Packard Company	5	KEYW Corp	2
CRGT Inc.	4	Parsons Brinckerhoff, Inc.	2
Data Computer Corporation of America	4	Stanley Black & Decker, Inc.	2
M.C. Dean, Inc.	4	ABM Industries, Inc.	1
Northrop Grumman Corporation	4	AECOM International/URS	1
ProObject, Inc.	4	API Technologies Corporation	1
CyberCoders, Inc.	3	Baltimore Aircoil Co.	1
Exelis, Inc.	3	Booz Allen Hamilton Inc.	1
Lockheed Martin Corporation	3	Brocade Communications Systems, Inc.	1
ProSync Technology Group	3	Burns & McDonnell	1
Varen Technologies, Inc.	3	CBRE Group, Inc.	1
Booz Allen Hamilton Inc.	1	Chugach Alaska Corporation	1
Flash Technology Group LLC.	2	Continental Technologies, Inc.	1
General Dynamics Information Technology	2	GDKN Corporation	1
General Electric Company	2	Gray & Son, Inc.	1
Leidos Holdings, Inc.	2	Guest Services, Inc.	1
MOSAIC Technologies Group, Inc.	2	Holiday Inn Express Baltimore - BWI Airport West	1
Parsons Corporation	2	IET, Inc.	1
Ross Technologies, Inc.	2	Knowledge Consulting Group	1
Sotera Defense Solutions, Inc.	2	L-3 Communications Holdings, Inc.	1
The ACI Group, Inc.	2	MRA	1
2HB Software Designs, Inc.	1	Randstad US	1
AT&T, Inc.	1	RMF Engineering, Inc.	1
BCT LLC	1	Textron Inc.	1
Belcan Corporation	1	The Robert B. Balter Company	1
Bingham Technical Solutions	1		
DRS Technologies, Inc.	1		
Exceptional Software Strategies, Inc.	1		
General Dynamics	1		
Harris Corporation	1		

Electronic Engineering Technician Employers	Job Openings	Engineering Technician (General) Employers	Job Openings
Honeywell International Inc.	1		
InfoTek Corporation	1		
Intelligent Decisions, Inc.	1		
Minerva Engineering, LLC	1		
NBS Enterprises, LLC	1		
Oceaneering International, Inc.	1		
Preferred Systems Solutions, Inc.	1		
SAK Construction, LLC	1		
TASC, Inc.	1		
Textron Systems: Unmanned Systems	1		
The Josef Group, Inc.	1		

Source: Maryland Workforce Exchange Jobs Database

Mid-Skilled Engineering Technician Employers

Among the 94 employers hiring engineering technicians, only 12 employers (13% of employers) had engineering technician positions that were advertised as requiring less than a Bachelor's degree level of education (ranging from a high school diploma to an Associate's degree). Raytheon, ABM Industries, Whitney Bailey Cox & Magnani, and PRIME AE Group were the only employers to offer multiple (two or more) positions below the Bachelor's degree level (See Table 10).

Table 10 Mid-Skilled Engineering Technology Job Openings in the Three-County Area

Employer	Job Postings < Bachelors	Total Engineering Job Postings	Share of Engineering Job Postings < Bachelors
Raytheon Company	7	26	27%
ABM Industries, Inc.	2	3	67%
Whitney Bailey Cox & Magnani, LLC	2	2	100%
PRIME AE Group	2	2	100%
Booz Allen Hamilton, Inc.	1	1	100%
Bridges Consulting Inc.	1	1	100%
CSX Transportation, Inc.	1	1	100%
PRIME AE Group, Inc.	1	3	33%
Oceaneering International, Inc.	1	10	10%
STV Incorporated	1	5	20%
LGS Innovations	1	2	50%
Sheet Metal Fab	1	1	100%

Source: Maryland Workforce Exchange Jobs Database

Top In-Demand Engineering Technician Positions

Test Engineers

The top highest demand position in engineering technology is for Test Engineers (109 job postings between July 2014 and June 2015). The majority of job postings are for positions are at government defense contractors. The scope of work for test engineers includes integration of software and hardware components for a variety of defense systems. Some positions for test engineer positions require only a high school diploma and these workers are employed primarily in system assembly and

automated testing, while other test engineer positions require a Bachelor's degree and these workers typically have higher-level analytical and design responsibilities. Most positions require a security clearance and most require at least two years or previous relevant work experience. Many of the advertisements by defense contracts encourage veterans with prior military experience to apply.

Technicians (In the field of Mechatronics)

Mechatronics technicians combine mechanical, electronic, and software skills in the fields of robotics, defense systems, renewable energy systems, controls, data recovery, computer forensics, computer device repair and other areas; many of the test engineer positions use mechatronics competencies. While only a few job postings make mention of "mechatronics" as a requirement, jobs for computer electrical controls technicians, forensics intrusion analysts, and some test and field engineers state mechatronics skills requirements explicitly.

Field Engineers/Technicians/Inspectors

Field engineers are employed by civil engineering firms, consulting engineers, and environmental consulting firms to collect field measurements and samples. They are employed by construction companies to coordinate and direct the work of skilled trades workers at a job site, by civil engineering companies and governments to inspect infrastructure such as highways, pipelines, bridges or marine structures, and by manufacturers to perform quality control and quality assurance functions. The exact job duties of field technicians and inspectors vary by employer.

CAD Drafter+

There is demand for CAD drafters in several engineering technology positions. Employers report that generalized drafting work is in decline, but applied drafting for civil engineering and mechanical engineering continues to have stable demand for workers. While openings for a "CAD Drafter" continue to appear, most open positions list CAD as a required area of skill or experience, rather than in the occupation job title.

Electronics Technicians

Electronics technicians assemble, troubleshoot, repair, modify, inspect, and test printed circuit boards and other electronic products/components. In some positions they perform assembly or mechanical components, test computing operating systems, software, drivers, and other programs and perform other duties with electronic controls and components. Several of the electronics technicians positions in the region are with defense contractors, but a portion of these jobs are available in other industries including power utilities and offshore/marine employers.

Other Engineering Technician Occupations

There are a variety of other engineering technician job titles in jobs advertised online (see Table 11), but no large cluster of similar positions. In interviews, some engineering employers reported hiring occasional technician positions, but most reported that their planned and current hiring needs were focused on engineers with a minimum of a Bachelor's degree and internships for students progressing toward a Bachelor's in engineering.

Table 11 Mid-Skilled Engineering Technology Job Openings in the Three-County Area

Field of Engineering and Job Title	Job Openings
Civil Drafters	**2**
CAD Drafter - bridge/highway design	2
Civil Engineering Technician	**1**
Traffic Field Technician	1
Electrical Technician	**6**
Engineering Technician	2
Electrical Test Technician	2
Communication & Signals Management Training Program	1
Electrical Engineering Technician	1
Electronics Engineering Technicians	**129**
Test Engineer	109
Electronic Technician	6
Field Engineer	6
Electrical Controls Technician	2
Engineering Technician	2
Electrical Engineering Tech	1
RF Technician	1
Test and Integration Technician	1
Industrial Engineering Technicians	**2**
Engineering Technician	1
Plant Engineer / Manufacturing Manager	1
Mechanical Technicians	**4**
Mechanical Technician	3
Mechanical Designer	1
Other Drafters	**4**
CAD Drafter	2
CAD Drafter/Structural	1
Drafter / CAD Operator	1
Other Engineering Technicians	**8**
Engineering Technician	4
Engineering Technician/Construction Inspector	1
CAD Drafter	1
High Performance Computing Engineering Technician	1
Engineering Aide	1
Engineering (General)	**59**
Engineering Technician	13
Computer Forensic and Intrusion Analyst	5
Mgr. Electrical Engineering	3
Mgr. Structural Engineering	3
Lead Building Engineer	2
Biopharmaceutical Manufacturing Associate	2
Operations Specialist	2
Chemical Engineering Technician	2
Controls Engineer	2
Engineering Tech Electrical	2
HSE Engineer	2
Mechanical Design Engineer – Entry Level	2
Mechanical Engineering Lead	2
Process Engineer	1
Automation Technician	1
Consultant, Field Systems Engineering	1
Industrial Engineering Co-op	1

Field of Engineering and Job Title	Job Openings
Materials Engineering Co-op	1
Mechanical Engineering Co-op	1
Maintenance Technician	1
Aviation Electrical Engineer	1
Design Engineer	1
Electro-Mechanical - Cordless Fastening Innovations	1
Electronic Technician	1
Geotechnical Technician	1
Mechanical Design Engineering Technician	1
Equipment Design Group Technician	1
Production Technician	1
Safety Manager	1
Safety Officer (Training)	1
Drafters	**1**
Drafter	1

Source: Maryland Workforce Exchange Jobs Database

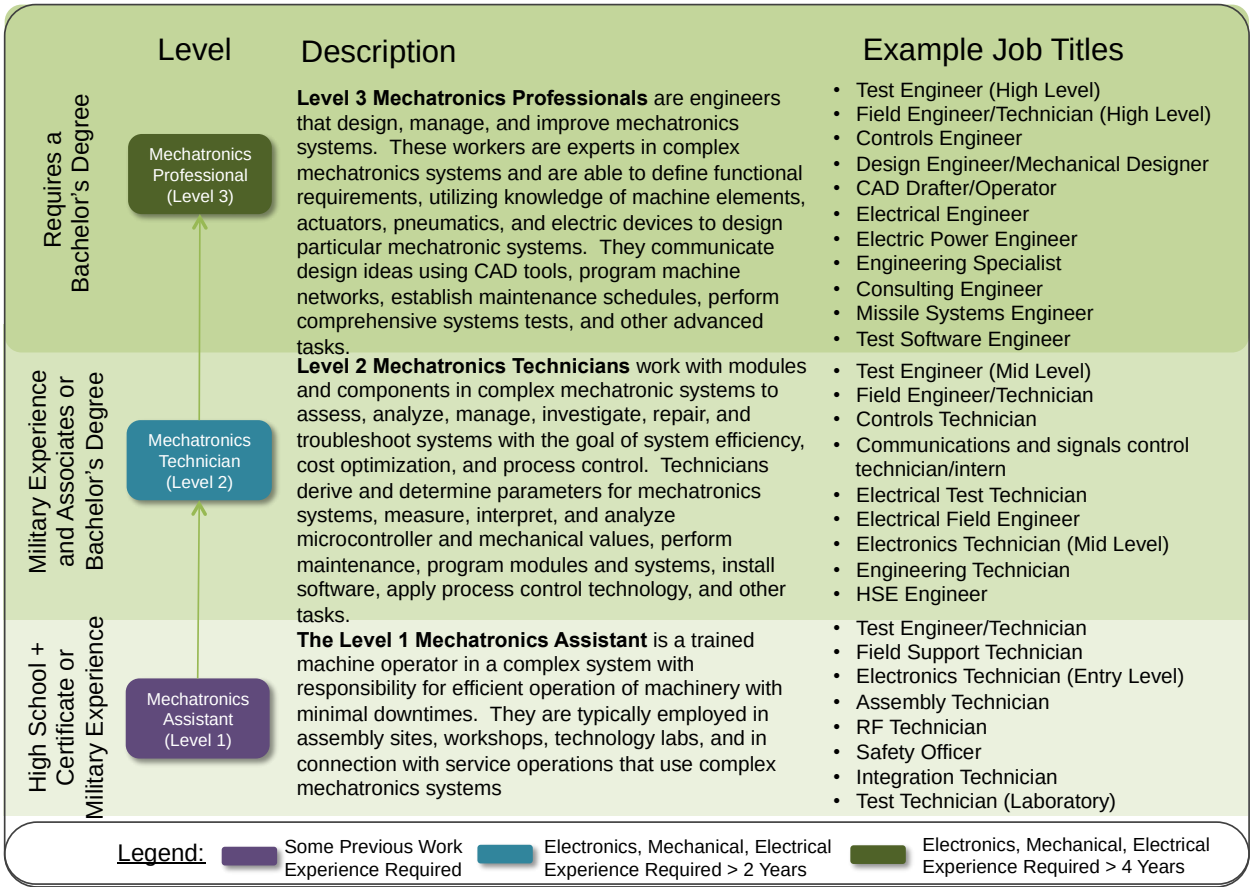
Career Pathways in Engineering Technology

While employers in many industries hire engineering technicians, the desired education, skills, and experience for technicians varies by industry and employer. The greatest current demand for engineering technicians is in the defense contractor sector where technicians are employed for testing, maintenance, and deployment of systems for missions. Defense contractors do not have uniform career pathway for workers at the engineering technician level; rather engineering technician careers vary by company, depending on the type of manufacturing or services provided by the defense contractor. In addition, no standardized scope of competencies is defined for engineering technicians.

Mechatronics is a field of engineering technology that is closely aligned with the needs of some defense contractors in the region. Anne Arundel Community College has recently added a mechatronics technician certificate program to prepare workers for mechatronics positions at defense contractors and other employers. The program is built around the Siemens Certification in Mechatronics. The one-year program leads to a certificate that prepares students to pass the Level 1 Siemens certification. The Siemens Level 1 certification typically does not appear as a specific job requirement, however, many of the skills desired by employers are covered in the Level 1 competencies. The Level 1 certificate may provide an on-ramp for students to pursue a career in the field of mechatronics, however, the job postings that do not require a Bachelor's degree generally prefer workers who have previous military experience and are able to (or already have) a security clearance.

Careers in mechatronics have varying levels of educational requirements, but the highest demand within the field is for electrical, mechanical, and electronics engineers who can design, test, and manage mechatronic systems and their components. In order to progress into higher-level positions, workers typically must complete a Bachelor's degree in a related field of engineering (see Figure 7).

Figure 7 Career Pathways as a Mechatronics Engineering Technician



Sources: Siemens Mechatronics Certifications Levels 1-3, Analysis of Maryland Workforce Exchange Jobs Database

Current Educational Capacity: Cybersecurity, IT and Engineering Technology

Anne Arundel Community College (AACC), Baltimore County Community College (CCBC), and Howard County Community College (HCC) each provide certificate level programs and associates degree programs leading to educational credentials in Cybersecurity, IT and engineering which are generally aligned with the occupations that are in demand.

In 2013, AACC, CCBC, and HCC had total combined enrollment of 2,809 in IT-related programs below a Bachelor's degree (latest data available). In 2013, a total of 376 certificates and degrees were awarded to graduates of these programs and in 2014 a total of 755 certificates and degrees were awarded. The increase from 2013 to 2014 is attributed mainly to increased graduates at AACC. This includes:

- Increased graduates from the AACC Cisco Certified Network Associate (CCNA) program which is an attractive entry-level credential for workers in NOC positions (112 graduates in 2014),
- An increase in graduates from AACC's General Technology program (102 graduates in 2014),

- An increase in the AACC Advanced Network Security Certificate, which prepares workers with previous network experience for next-step careers in a Security Operations Center (59 graduates in 2014), and
- Increases in graduates of other AACC certificate programs in network security, server administration and security, cyber technology, and computer network management as well as increases in Associate's degrees in information assurance and cybersecurity, and computer information systems.

CCBC also increased graduates in selected programs including introduction to geospatial applications and advanced geospatial applications (which align with some engineering technology positions), and increases in Associate's degree graduates in three fields: computer science, information technology, and network technology. Certificates and associates degrees in IT fields were flat at HCC between 2013 and 2014.

In engineering technology programs, the three community colleges had combined enrollment of 510 students in 2013. The colleges had a total of 91 graduates for certificate and associates degree programs in 2013 and 81 graduates in 2014. The low graduation to enrollment ratio is attributable mainly to a few CCBC Associate's degree programs that have high enrollment but few degrees awarded. Most of the open positions for engineering technology positions in the Maryland Workforce Exchange Jobs Database are concentrated in Howard and Anne Arundel Counties, but about half of the graduates from Associates and certificate level programs are from Baltimore County Community College.

New Programs in IT and Engineering Technology

As mentioned earlier, Anne Arundel Community College (AACC) has recently added two new programs: a mechatronics certificate level training program and a cybersecurity certificate program, both of which are supported by a DOL designed around workforce development for mid-skilled engineering and cybersecurity. Each of the programs is tailored to provide entry-level credentials necessary for workers to begin work as a cybersecurity professional or a mechatronics engineering technician.

A total of 97 participants enrolled in the mechatronics program and 50 enrolled in the cyber technology program. Program managers reported that the program is new and time will be needed to follow the career paths of graduates in order to understand the extent of the success of the programs, but initial indications are that the programs are achieving some success: 44% of cyber technology students completed the program and entered employment (24% were still enrolled in the program as of August, 2015). About half of the mechatronics program students (49%) completed the program and a third (36%) entered employment. Those who did not enter employment instead opted to continue their studies and progress toward an Associate's degree at AACC. Program managers reported that employer demand for hiring of graduates was high and workers did not continue studies due to a lack of demand from employers.

Table 12 Enrolment, Completion and Post-Program Employment of Students in AACC's Cyber Technology and Mechatronics Programs, September 2014 – August 2015

Program	Participants	Completers	Still Enrolled	Entered Employment
Cyber Technology	50 (100%)	22 (44%)	12 (24%)	22 (44%)
Mechatronics	97 (100%)	48 (49%)	22 (23%)	35 (36%)

Source: AACC, National STEM Consortium

Those who completed the programs and progressed into employment found work in a variety of jobs related to their field. Mechatronics employers hiring graduates included employers in automation, distribution, manufacturing, and product design. Employers hiring from the cyber technologies program included government agencies and IT support departments for businesses. A representative set of job titles of workers hired from the program are listed below.

Mechatronics jobs:

- Maintenance Technician
- Equipment Repair Technician
- Automation Technician
- Amplifier Technician
- Design Engineer
- Quality Engineer
- Panel Fabricator

Cyber Technology jobs:

- IT Support Technician
- Helpdesk Technician
- Service Desk Technician
- Network Technician
- Lab Technician
- Network Operations Center (NOC), Tier 1 Technician
- Network Specialist
- Network Operations Specialist
- Computer Network Specialist
- Customer Support Engineer
- Technical Support Engineer
- Technical Call Center Representative
- Help Desk Analyst

The cyber technology positions were roughly aligned with jobs found in a NOC or SOC, but may also be employed in other organizations.

The AACC students who did not complete the programs faced a number of barriers throughout their program participation. According to the program managers, the major factors that lead to student drop included:

- Loss of childcare,
- Loss of transportation,
- Loss of housing (foreclosure/eviction/homelessness),
- Changes in family situations/need to bring in income,
- Related/unrelated job offers too good to turn down,
- Student no longer interested in the program (withdrawal), and
- Program dismissal (poor academic performance, academic dishonesty, behavioral issues, unreliable attendance, etc.).

Specific examples for the students in the programs included unexpected pregnancies; needing to get a job to support their partner; grieving for the loss of a parent, grandparent or child; giving up a newborn for adoption; vehicle accident and related limb amputation; other medically-required surgeries; and relocation.

Best Practices and Alternative Training Models

While AACC provides some levels of support to students facing barriers, the support structure is different from that offered in some other workforce development programs such as Year Up (offered through Baltimore City Community College) and Per Scholas (based in NYC) that have notably high completion and placement rates. Year Up and Per Scholas programs offer comprehensive and intensive wrap-around support services that are designed around common barriers. For instance, Year Up provides a stipend to students to meet basic financial needs, which helps to lower the number of students leaving the program because they need income. These programs also coordinate to help workers gain access to childcare, transportation, and housing. Beyond addressing barriers, these programs also streamline the acquisition of credentials needed for an IT career: for instance, Year Up participants complete training leading to college credits and a paid internship that forms a close relationship with an employer.

According to an interview with the national Year Up program director, following their time at Year Up, most students continue to work full-time and work on completion of a college degree. The graduation rate of Baltimore's Year-Up participants is 68% and 81% of Baltimore graduates are employed or in school full-time four months following graduation, rates that are recognized as some of the highest in the US. The average wage earned by Baltimore City graduates is $14.46 and the conversion rate of internships to post-internship hires is 26%.

Enrolment and Degrees/Certificates Granted

Tables 12 and 13 summarize the 2013 enrolment and the 2013 and 2014 degrees and certificates granted at AACC, CCBC, and HCC for programs below a Bachelor's degree.

Table 13 Enrollment and Graduations of IT Programs Below a Bachelor's Degree, AACC, CCBC, and HCC

College	Certificate / Associates Degree	Program	Enrollment 2013	Certificates/ Degrees 2013	Certificates/ Degrees 2014
AACC	CERT	Intelligence Analytics	5	3	1
AACC	CERT	Computer Information Systems	39	6	10
AACC	CERT	Information and Cybersecurity	14	10	15
AACC	CERT	Computer Information System: Database Administration	11	2	1
AACC	CERT	Advanced Network Security	14	1	59
AACC	CERT	Cisco Certified Network Associate (CCNA)	21	32	112
AACC	CERT	Network Security	23	25	47
AACC	CERT	Server Administration and Security	1	0	4
AACC	CERT	Cyber Technology	32	0	19
AACC	CERT	Internet Application Development	1	0	0
AACC	CERT	Advanced Internet Application Development	1	0	0
AACC	CERT	Mobile Device App Development	1	0	0
AACC	CERT	Computer Network Management	18	0	2
AACC	CERT	General Technology	6	0	102
AACC	AA	Computer Information Systems	107	12	17
AACC	AA	Information Assurance and Cybersecurity	446	66	86
AACC	AA	Computer Network Management	75	8	6
AACC	AA	General Technology	18	3	4
AACC	AA	Comp Sci Internet and Mobile Device Software	13	3	2
CCBC	CERT	E-Business Management Certificate	5	0	0
CCBC	CERT	E-Business Technology Certificate	1	0	0
CCBC	CERT	Computer Applications	3	0	0
CCBC	CERT	Information Management	2	2	3
CCBC	CERT	Information Systems Security	4	5	7
CCBC	CERT	CIS General Information Technology	3	1	0
CCBC	CERT	Information Technology Support Certificate	20	1	1
CCBC	CERT	Programming	7	1	0
CCBC	CERT	Database	2	1	1
CCBC	CERT	Object-Oriented Programming	0	3	0
CCBC	CERT	Office Specialist Certificate	2	1	0
CCBC	CERT	Advanced Geospatial Applications	7	5	11
CCBC	CERT	Introduction to Geospatial Applications	4	6	12
CCBC	CERT	Preparation for CISCO	10	10	5
CCBC	CERT	Preparation for Network+	3	7	4
CCBC	CERT	MCITP Certificate	0	1	1
CCBC	CERT	General Networking	2	3	1
CCBC	CERT	Information Security	4	0	0
CCBC	CERT	Redhat LIMUX RHCT Certificate	2	1	1
CCBC	CERT	A+	12	12	5
CCBC	AA	Computer Science	415	14	28
CCBC	AA	E-Business Management	19	0	0
CCBC	AA	E-Business Technology	3	0	0
CCBC	AA	Office Administration	94	4	6
CCBC	AA	Information Technology	308	23	39

College	Certificate / Associates Degree	Program	Enrollment 2013	Certificates/ Degrees 2013	Certificates/ Degrees 2014
CCBC	AA	Information Systems Security	140	8	32
CCBC	AA	Network Technology	435	34	47
CCBC	AA	Geospatial Applications	30	7	9
HCC	CERT	Computer Support Technology	23	2	0
HCC	CERT	Network Administration	11	8	7
HCC	CERT	Web Developer	7	1	2
HCC	AA	Computer Engineering (ASE)	72	2	3
HCC	AA	Computer Support Technology	37	3	6
HCC	AA	Network Administration	42	6	8
HCC	AA	Information Technology	234	33	29

Source: Maryland Higher Education Commission

Table 14 Enrollment and Graduations of Engineering Programs Below a Bachelor's Degree, AACC, CCBC, and HCC

College	Certificate / Associates Degree	Program	Enrollment 2013	Certificates/ Degrees 2013	Certificates/ Degrees 2014
AACC	CERT	Design and Drafting Tech	12	4	5
AACC	CERT	Electronic Engineering Tech	49	10	7
AACC	AA	Electronic Engineering Tech	48	10	13
CCBC	CERT	AutoCAD Operator	7	8	14
CCBC	CERT	CAD Architecture	17	14	6
CCBC	CERT	CAD Management	3	2	2
CCBC	CERT	CAD Mechanical Modeling	9	2	6
CCBC	CERT	Civil Design	4	2	0
CCBC	AA	Engineering Technology	140	8	5
CCBC	AA	Computer-Aided Design for Architecture and Engineering	105	8	5
CCBC	AA	Survey Technology	38	3	4
CCBC	AA	Industrial Electricity/Electronics	1	0	0
CCBC	AA	Computer Automated Manufacturing	1	0	0
HCC	CERT	Computer Aided Design Tech	5	3	1
HCC	CERT	Electronics Tech	5	10	1
HCC	AA	Electrical Engineering (ASE)	32	3	3
HCC	AA	Computer Aided Design Tech	21	2	7
HCC	AA	Electronics Tech	13	2	2

Source: Maryland Higher Education Commission

Giving Workers an Opportunity to Gain Experience

Experience is one of the most important factors employers consider when seeking candidates. In interviews, employers often noted that they prioritized experience over education or certifications. For job seekers without previous relevant experience, it is often difficult to find entry-level positions that afford the opportunity to gain experience.[vi]

In interviews, employers were asked to comment on training models that would give workers access to experience. Employers were asked to note which particular types of training would be most beneficial for their business while providing workers with an opportunity to gain needed experience. Employers were asked to comment on the following types of training:

1. **On-the-job (OTJ) training:** When a new employee is on boarded, it often takes a few months or more for that individual, working with the company's existing staff, to learn how to apply their background, skills and training in the employer's specific setting. OJT is often subsidized to offset the cost of training an individual. OTJ training typically lasts less than 3 months.
2. **Apprenticeships** are longer training programs that usually combine classroom/certifications with years of experience. In the past, they have been most common as a training strategy for trades such as electrician or machinist, but could be adapted for IT or engineering technology fields. They typically last 2 to 4 years.
3. **Internships** are typically academic in nature and intended to give students exposure to a field of work and earn college credit. Internships also help an employer to identify potential future candidates for open job positions in the future.
4. **Direct work experience** typically involves hiring workers to fulfill necessary roles and functions. It is not associated with education or earning college credits and instead provides workers with hands-on experience in an occupation. Work experience is not limited to students; it can be focused on providing experience to dislocated workers or workers making a career shift. It gives them the opportunity to gain relevant work experience in a high-demand IT or engineering technology field.
5. **Training for certifications:** Certifications are career credentials that demonstrate that a worker has the skills, knowledge and abilities to perform a set of required tasks at a high level.
6. **Other training**: Employers were asked there are there other types of training that would be most beneficial.

Employer's Preferences

There is a considerable level of diversity among employers with regard to the type of training they think would be helpful for their businesses. Some employers thought that several of the training formats would be of benefit to their company, while others reported that none of the training formats would be of interest (Note: Some government contractors reported that most of their contracted positions require a security clearance and that there was no model of training that would be helpful in meeting their immediate business needs).

The employer responses generally fell into three categories:

- **Larger employers and government contractors:** These employers tend to prefer internships as a means of screening for potential new hires who are students working toward a Bachelor's degree. Some of these employers can envision using certifications to up skill their workforce. Most contractors either currently offer internships, or have done so in the past, and most reimburse employees for the cost of obtaining new certifications.
- **Smaller employers and employers serving commercial clients:** These employers tend to prefer on-the-job training as the top preferred means of training new employees. For those that are in a fast growth mode, on-the-job training helps to offset the costs of brining new employees up to adequate training, but it is not seen as a substitute for possessing the prerequisite technician

skills, certifications, or experience needed for a position. Some of these employers expressed interest in an apprenticeship model as a means of retaining certain workers who might otherwise move to a different employer for marginally higher wages. As with larger employers, these employers encourage their workers to add new certifications and diversify their skillset.

- **Employers with a training component in their business:** Among other services, some of the employers interviewed provide technology training leading to certifications for corporate clients, individual students, and to government organizations. These employers were generally open to any of the top three models that grant workers experience – internships, on-the-job training, and apprenticeships - and they were also expressed interest in developing innovative or collaborative partnerships to train and provide work experience to workers who are new to the IT field. Because students (and working students) are their customers, they are more interested than other employers in shaping hiring and employment practices around the needs of students as well as looking for ways to grow their training businesses. The exact model of training-to-hire would still need to be explored, but as examples, one such employer suggested hiring graduates to teach a course and another suggested that workers could be trained to work in other lines of business such as that firm's NOC and SOC services.

While these three profiles of companies appear evident from the interviews, it is important to note that individual companies differed somewhat in what they thought would be helpful, and also differed in their level of interest in offering any form of new worker training at all. Several of the employers struggled in the interviews to envision training that would be beneficial to their company for workers without a Bachelor's degree. Many of the employers emphasized that the majority of their positions have a minimum requirement of a Bachelor's degree and the conversation regarding training workers without a Bachelor's degree was somewhat of an unusual circumstance that they would consider only in a few selected positions. Employers questioned whether workers without prior relevant experience would possess the critical analysis skills to solve complex problems, research and create solutions to problems on their own, or learn new technologies. The job ads analysis confirms that most employers hiring for positions that don't require a Bachelor's degree have few positions – or perhaps just a single position - of this type during the year. As a result, most employers saw mid-skilled workers in IT and engineering technology as a small part of their overall workforce, with limited hiring needs. Specific comments on the various training models are described below:

- **On-the-Job Training:** OTJ training was seen positively by more than half of the companies interviewed. Smaller companies and younger companies – including those in a fast growth phase – were more likely to be interested in OTJ training as a means of offsetting the cost of adding staff and reducing training costs. Most government contractors - especially larger contractors - were not interested in OTJ training and didn't see it as useful to their business model because their placements must generally have 4-5 years of experience or more. Only one contractor, which works for commercial clients as well as government clients, saw OTJ training as potentially beneficial to their company.
- **Apprenticeships:** About a quarter of employers were interested in offering apprenticeships, but these employers usually ranked it behind other options such as OTJ training and internships,

unless it was as a means of up skilling and retaining their existing workforce. There were several reasons that employers did not favor an apprenticeship: Government contractors reported that they could not fill any position with an apprentice-level worker. Some non-contractor employers thought the field of IT was too broad, and the career paths too varied and individualized, to support a standardized apprenticeship model. These employers expressed the view that the current system of IT certifications did a better job of allowing the company to prioritize and target selected training that is needed. Others objected to the apprenticeship model on the basis that an apprentice would not have enough skills to perform at a high level and would, in effect, increase HR costs, by taking time away from other experienced and productive staff who must mentor or instruct the apprentice. Some of the companies interested in an apprenticeship model indicated that it would only work if a portion of the mentor/supervisor/instructor's wages during instruction times were paid from an outside source of funds. Those who were interested in an apprenticeship model thought that it could potentially work for NOC/SOC operations and for up skilling their existing workforce, potentially by adding cybersecurity training to existing network technicians. Those who were interested in an apprenticeship thought that the model should allow for multiple pathways into different IT fields, based on the abilities and interests of the worker and the needs of the business at that time.

- **Internships:** About a third of employers reported that internships would be of interest and several contractors – especially very large contractors - operate a summer internship program that allows the company to get to know students working on their Bachelor's degree. The students typically work on "internal" projects (not classified projects for the contractor's end clients) and are used to give the company a chance to test the intern's abilities and assist the team where the intern is assigned. The company then extends offers to some interns and the employer applies for the intern's security clearance while s/he continues his or her education leading to a Bachelor's degree. Employers noted that this model works well for younger workers because security clearances are completed more quickly at a younger age. Some employers reported that they have used internships in the past, but were unable to continue them due to budget constraints, but would offer them again if funds were available to offset wage costs. Internships were generally of less interest to smaller employers.
- **Certifications:** The majority of employers (all but a few) thought that certifications would be a benefit to their business, however, it was mainly seen as a benefit for up skilling their current employees. Government contractors reported that workers must often add certifications to keep current with the requirements of the jobs they fill and smaller employers reported that they encourage their workers to add new certifications to broaden their skillset.
- **Work Experience:** a few of the employers interviewed were involved in Anne Arundel County's Cyber Works program and had hired workers who were gaining experience as part of that program. Employers were generally positive about their experience with Cyber Works, but those interviewed had limited experience with just one or a few workers hired from the program.

- **Other types of experience:** Most employers did not offer any "other" ideas on work experience that would be beneficial to their business, however, several indicated their interest in collaborating to develop a creative approach to providing training.

Recommendations

Create Flexible Incentives for Employers to Hire Entry Level Workers, Giving Them Work Experience.

A lack of IT and engineering experience is perhaps the largest barrier to beginning an IT or engineering technology career, even for workers who have the desired certifications or education. While the need for experienced workers is evident, the largest IT employers – government IT and cybersecurity contractors – operate in a business model that does not support hiring entry-level workers, except for students working toward a Bachelor's degree. Policy decisions at governments drive the hiring requirements, leaving employers little room to adjust their hiring practices or create a talent development pipeline that is available to inexperienced job seekers. Based on the analysis of job advertisements, for workers to be considered for most jobs, they need a minimum of two to four years of relevant IT or engineering experience in their field of work (or prior military experience). In addition, for workers with less than a Bachelor's degree, the experience component is even more important.

Any solution designed to provide workers with experience to start an IT or engineering career will need to be flexible to meet the unique needs of each individual employer.

A program that provides cost offsets to increase internship positions is likely to be preferred by larger employers. These cost offsets could be created in the form of direct funding (if funding for internships becomes available from the DOL or other entities). Larger employers are more likely to have a larger tax burden and tax incentives may be an alternative means of offsetting costs of interns and encouraging the creation of more slots for students to gain work experience. Employers are likely to make greater use of this type of program if it can target students following a traditional route and progressing toward completion of a Bachelor's degree.

Programs offering cost offsets for on-the-job training or extended apprenticeships are likely to be preferred by smaller companies, companies with an education/training line of business, and companies undergoing a fast growth phase. These incentives should be designed to offset wage costs for adding new staff, but encourage long-term employment for up to two years or more in order to give workers adequate experience to progress onto their next step along the career ladder.

Develop a career pathway leading to careers in a network operations center (NOC) or security operations center (SOC).

Several of the IT employers interviewed reported that their main hiring for mid-skilled workers were for positions in their NOC/SOC operations and employers with a training portion of their business also target occupations in this area. A NOC/SOC career training program would require (1) education leading

to technical knowledge that can be attained through a certification (2) training leading to strong problem-solving ability and self-directed learning, and (3) hands-on experience in a NOC. For incumbent NOC workers, cybersecurity training could be added leading to positions in a SOC. Strong partnership with NOC/SOC employers and NOC/SOC training businesses would be important for job placement. An ideal solution would combine initial training for placement in a NOC with a long-term training program leading to (1) cybersecurity credentials, (2) a Bachelor's degree, and (3) years of experience in a security operations center. To boost success in a NOC/SOC training program, comprehensive wrap around support services would be needed to address destabilizing factors including loss of childcare, transportation, or housing among program participants. Model programs such as Year Up (**www.yearup.com**) and Per Scholas (**www.perscholas.org**) can serve as model programs for developing career training that combines technical education, work experience, and college credits.

Strengthen and expand career pathways for mechatronics technicians and related positions at defense contractors.

While engineering technicians are hired in many industries, the defense industry represents the local area's largest employer and most of these positions are located at Fort Meade or nearby**.** Contractors seek workers who have (or can attain) a federal security clearance and have previous electronics testing experience. These positions are most easily accessible to veterans and workers with previous related experience. The specific work performed by contractors is often classified, making tailored training programs difficult, however, partnerships with individual large employers could lead to better opportunities for unemployed incumbent workers. Hiring growth at Fort Meade is projected to increase substantially over the next few years creating a growing demand for workers and organizations like the Fort Meade Alliance actively coordinate shared initiatives between employers in and near Fort Meade.

Strengthen employer relationships and the on-ramps for experienced workers, veterans, and youth to access the region's established career resources.

Anne Arundel County's Cyber Works program has created much of the infrastructure needed to support recruiting and training of workers, but more can be done to stimulate use of the resources among employers and increase the footprint of the program. Cyber Works has created a growing number of opportunities for experienced workers to connect with employers, but employers involved with the program report that there are too few opportunities for workers to find mid-skilled internships or other opportunities to gain experience. Some employers interviewed for the study were not aware of the Cyber Works program and were interested to participate in order to expand their recruiting network; more can be done to increase awareness of the program. The potential to expand the program should be explored among employers in Howard County as well as Baltimore County where a larger number of employers that serve commercial clients are located. These employers do not face the stringent security clearance requirements or high minimum experience requirements required of government contractors. Another opportunity exists related to changes in WIOA funding. The changes will create more federal funding opportunities to provide workforce development that serves youth age 16 to 24. Youth have higher unemployment rates, have less previous work experience, and are more likely to benefit from the

assistance of the workforce development organizations in the region to overcome barriers to employment.

Appendix A Questionnaire for Employers

Target Respondent: Business Owner or Head of HR

Interview Introduction

Thanks for taking time to talk with us. Can I tell you a little about this project?

We would like to position engineering and cybersecurity employers in our region to possibly take advantage of training and workforce development dollars that may be available through federal and state programs over the next few years. I'd like to talk with you about some of your training and workforce needs and see if you would be interested in working with your local workforce office and potentially accessing these resources for training and workforce development.

Discussion Questions

1. In the fields of cybersecurity, IT, and engineering technology, what are some of the mid-skilled occupations that you hire – those in highest demand? We consider "mid-skilled" positions to be any position where a bachelor's degree or higher is not needed. (Probe to complete the table below)

Occupation	Education Requirement	Experience Requirement	Certification Required	Other skills required	Hiring difficulties?	Starting wage
…	…	…	…	…	Y/N	…

Probe further: Are those all of your cyber occupations? Are those all of your engineering tech positions?

2. Could you talk with me about any existing internal training or apprenticeship programs you have in place for these positions? (Probe to complete the table below) What about external training programs – are there some you use/require?

Occupation	Training Description	Internal/ External	Length of Training	Type of training (hands-on, online class, etc.)	Is it adequate? Is more needed?

…	…	…	…	…	…

3. Could you talk about the career path for some of your key occupations? (Note: Probe in depth to understand starting entry-level, and subsequent occupations).

Starting Occupation	Subsequent Occupations	Requirements to Progress to next level
…	…	…

4. What skills, credentials, or training do you see as in greatest demand across the industry?

5. We would like to grow a regional labor force with the right skills to meet what businesses need in mid-skilled cyber and engineering technology careers. There may be funds available to develop meaningful on-the-job training, apprenticeships, and other types of training. Each of these types of training are similar in that they are designed for mid-skilled workers to get the skills they need, without requiring a Bachelor's or Master's degree. Our question for you is "what is the best way for new workers to get the skills you need?" Let me define the different types of training:

- ***OTJ training (OJT)** . When a new employee is on boarded, it often takes a few months or more for that individual, working with the company's existing staff, to learn how to apply their background, skills and training in the employer's specific setting. This OJT can be costly for the employer who covers the full salary of a new hire during a period when he or she is not yet fully productive. OJT subsidies offset the cost of training an individual and are typically less than 3 months in length.*
- ***Apprenticeships** are longer training that usually combines classroom/certifications with years of experience. In the past, they have been most common in the U.S. as a training strategy for trades such as electrician or machinist. In recent years – especially in Europe – apprenticeships have proven to be an excellent, efficient training approach for a wide variety of industries. They typically last 2 to 4 years.*
- ***Internships** are typically academic in nature and intended to give students exposure to a field of work and earn college credit. Internships also help an employer to identify potential future candidates for open job positions in the future.*
- ***Work Experience** typically involves hiring workers to fulfill necessary roles and functions at your company. It is not associated with education or earning college credits and instead provides workers with hands-on experience in an occupation or job at your company. Work experience is not limited to students and instead is focused on providing experience to individuals who have been in the workforce and may have experience. They include dislocated workers and workers with previous work experience, but may be outside of the exact field of work for the job.*
- ***Certifications –** Certifications are career credentials that demonstrate that a work has the skills, knowledge and abilities to perform a set of required tasks at a high level.*
- ***Other training –** Are there other types of training that would be most beneficial?*

Could you talk with me about your company's interest in each of these types of training?

5A. What is the best way for new workers to get the skills you need?

5B. How about to up skill your existing workforce?

6. What would be the important benefits you would want to get out of these programs (Financial offset of training costs? Fast skills acquisition? Special technical skills acquisition? Retention of workers (if turnover is high)?)

7. What would be the keys to success of an [OTJ/apprenticeship/other] program? What would make you participate in it?

8. Would you be interested in serving on an employer council to oversee the development of such a program?

9. Are there some barriers you see to success?

10. What do you see as the next steps to developing an apprenticeship program?

Conclusion

Okay great – that information is very helpful. Can I circle back with you in a few weeks with an update with an update on our project?

Collect contact information if needed.

Endnotes

[i] See Maryland Jobs Exchange at **https://mwejobs.maryland.gov/jobbanks/default.asp?p=0&session=jobsearch&geo=**

[ii] See **http://www.dtic.mil/whs/directives/corres/pdf/857001m.pdf**

[iii] Occupational Employment Statistics, Bureau of Labour Statistics, May 2014; County estimates based on the Batlimore Regional Talent Development Pipeline Study, Opportunity Collaborative

[iv] See Maryland Jobs Exchange at **https://mwejobs.maryland.gov/jobbanks/default.asp?p=0&session=jobsearch&geo=**

[v] See **http://www.dtic.mil/whs/directives/corres/pdf/857001m.pdf**

[vi] Only about 2% of the job openings in the three-county areas that are in the IT and engineering technology fields state minimum experience requirements that are less than 2 years (see Figure 3).