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ENTRY-LEVEL IT CAREERS IN GREATER CLEVELAND:

OPPORTUNITIES & BARRIERS FOR WORKERS WITHOUT BACHELOR'S DEGREES

Developed with support from the Cuyahoga County Workforce Funders Group
Produced by Team NEO

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- Swagelok
- TEK Systems
- Towards Employment
- We Can Code It
- Westfield

[1] Interviewees held many different titles, including: Academic Advisor of Career Services, Chief Information Office, Chief People Officer, Corporate IT professional, Director Business Intelligence, Director Business Operations, Director of Public Sector Verticals, Director of Security Consulting Team, Director of Student Engagement, Internship Program Administrator, IT Director, IT faculty, IT Student Grant Administrator, Job and Career Placement Professional, Manager of Cooperative Education, Retention Professionals, Talent Program Managers, and Vice President of Engineering.

About

About TeamNEO. TeamNEO works to accelerate the pace of economic growth in 14 counties of Northeast Ohio by enabling business retention, expansion, and attraction opportunities. As one of seven network partners of JobsOhio, TeamNEO works with a strong, coordinated network of economic development organizations, private and public institutions, and many other regional stakeholders to achieve this goal.

About the Cuyahoga County Workforce Funders Group. The Cuyahoga County Workforce Funders Group is a coalition of public, private and philanthropic funders co-investing in workforce development systems change. We've been a hub for funders to elevate, incubate and advocate for workforce solutions in Cuyahoga County (Greater Cleveland) since 2018.

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Executive Summary

Computing roles represent a small yet vital segment of Cuyahoga County's economy. Of these roles, three occupations are most commonly accessible without a bachelor's degree and typically provide a living wage at entry: Computer Network Support Specialists, Computer Systems Analysts, and Computer User Support Specialists, or 3Cs for short.

From 2021 to 2022, demand for computing and IT-related talent peaked as cyber security and post-COVID quarantine savings, spending, and investment drove IT innovations. One of those innovations, generative artificial intelligence (AI), is poised to dramatically reshape both entry points and openings in this field.

While both local and national opportunities for IT employment remain, the hiring landscape is complicated by a strong pool of candidates, an increase in bachelor's educated graduates, and global competition. Local demand is also being shaped by a preference for bachelor's educated talent, complicating access for sub-bachelor candidates.

Employers want to see both technical proficiency and a commitment to lifelong learning from candidates, as well as professional, interpersonal, and intrapersonal skills. Required technology and software skills have been and continue to evolve rapidly, making adaptability essential to IT careers. Work-based learning may offer the best route to preparing talent and staying competitive in these roles, as job candidates must demonstrate both technological aptitude and applied project experience to secure positions. While advancement is possible for the 3Cs, however, real barriers exist.

Workforce interventions for IT careers must be the right size and fit, considering both candidates and employer demand. This can look like scaling interventions to match job accessibility and designing for candidates with the skills and mindset to succeed. One important challenge affecting practitioners is insufficient feedback loops between education and industry operators. While Greater Cleveland has a strong ecosystem of computing education and training, the ability to respond at the same pace as technology poses a significant roadblock to preparing IT talent for the workforce.

This report delves into these themes, supported by insights from regional stakeholders, economic data, and a detailed Appendix.

Background

The intent of this report is to shed light on entry-level Information Technology careers available to jobseekers without a bachelor's degree in Cuyahoga County, amidst a time of great change in the computing field.[2] There are thousands of unfilled IT positions in Greater Cleveland and strong community interest in increasing access to these well-paid careers among local residents, particularly residents facing barriers. According to TeamNEO's 2024 Aligning Opportunities report, approximately 11,000 IT positions went unfilled across the 14-county Northeast Ohio region, about 27% of which were entry-level[3]. At the same time, various trends have shifted the national landscape of IT careers including the ramp up of generative AI, expansion of skills-based hiring, shifts on remote work and more. Our aim in this research is to deepen understanding of local dynamics for IT talent without a bachelor's degree related to demand, career pathways and education, training and civic assets.

This report brings together quantitative insights from numerous publications and data sources (primarily Lightcast labor market data), as well as qualitative insights from direct engagement with Greater Cleveland metropolitan area stakeholders. In all, the research team gathered insights from nearly 30 key stakeholders, including employers from a range of industries, education and training providers, educators, and civic organizations. Insights from a separate regional employer roundtable, via the Department of Labor Opportunities in Tech grant, are also featured.

This study does not aim to deeply explore labor market dynamics related to Bachelor's degree programs, which was beyond the scope of this analysis. Computer science and engineering-related Bachelor's degree programs vary widely, are valued differently by employers (locally, nationally and globally), and are also evolving rapidly.

Analysis for this report began in early February 2025, concluded in July of the same year, and centered on Cuyahoga County, Ohio. At times, we refer to the geographic area "Greater Cleveland", which is used interchangeably to refer to the 6-county metropolitan statistical area comprising Ashtabula, Cuyahoga, Geauga, Lake, Lorain, and Medina counties. This report also uses terms like "Information Technology", "IT", "computing roles" and "computer occupations" to describe Information Technology careers at the heart of this analysis.

[2] Computing is an umbrella term that reflects the use of computers to process data or perform calculations, the act of calculating or reckoning. Information Technology (IT) subarea of computing, especially applied to business that involves the use of computers, telecommunications, and related technologies to store, retrieve, transmit, and manipulate data. IT encompasses a wide range of disciplines and applications, including hardware, software, networking, data management, cybersecurity, and user support services.

[3] "Aligning Opportunities in the Northeast Ohio Region: A resource to aid in addressing the demand and supply imbalance in the region's workforce." TeamNEO Aligning Opportunities, 8th edition. 2024. TeamNEO's 14-county footprint includes Ohio's Ashland, Cuyahoga, Erie, Geauga, Huron, Lake, Lorain, Medina, Portage, Richland, Stark, Summit, Tuscarawas, and Wayne counties.

Core Findings

Finding 1. Computing roles are a small but critical share of Cuyahoga County's economy. Right now, demand for computing talent is complicated and the vast majority of local employers explicitly require or strongly prefer a bachelor's degree for computing roles.

Computing roles enable e-commerce industries, global supply chains, new product development, and cyber-secure platforms, to name a few of its critical roles in the digital economy. U.S. states like Florida, Texas, and California have the highest numbers of computing talent (up to 700K) while the District of Columbia, Washington, and Virginia have the largest percentage of computing roles relative to all jobs (+5%). Employment patterns are attributed in part to where industry operators are headquartered and where new products, or customer support solutions, are developed. Demand for computing roles can also vary depending on adoption of new technology, high consumer demand, and other markers of economic growth.

In Cuyahoga County, computing roles make up over 22,000 jobs, representing roughly 3% of all employment in the County.[4] In addition to roles in companies in the Information Technology sector (which develop and implement computing technology), computing roles are also integrated into other sectors, such as Healthcare and Finance.

Unique job posting data shows demand for computing jobs decreased by 52% in Cuyahoga County from 2019 to 2024. This is in line with both the nation and state, who saw 47-53% drop in demand in the same time period. The decline in demand was most strongly noted locally at the entry level; in interviews conducted for this analysis, employers identified that mid-level and other experienced talent, like those with 3+ years of experience and with bachelor's degrees, remain in relatively high demand. Figure 1 below shows that demand for experienced talent is significantly higher than for less experienced, less degreed talent in the County.

Figure 1. Demand for all Computer Occupations by Experience and Education in Cuyahoga County, 2024

	High School or GED	Associate's Degree	Bachelor's Degree	Master's+ Degree
0-2 years	210	156	485	15
3-5 years	204	157	1,440	8
6+ years	103	260	1,206	19

Source: Lightcast Job Posting Analytics.

[4] Estimates of local computing employment are complicated by remote work; some of these jobs are held by remote workers residing outside of the region, and some local computing talent are employed by companies located outside of Cuyahoga County.

Nationally, while 33 computer occupations are possible to access without a bachelor's degree, in practice, U.S. Department of Labor's Occupational Information Network (O*NET) analysis suggests that a bachelor's degree is usually required (50% of the time or more) for the vast majority of computing roles. Credentialing programs are often focused on supporting students to gain specific tech knowledge and skills. In contrast, Computer and IT-related bachelor's programs integrate the underlying foundations of computer science, computational thinking and engineering, alongside technical knowledge and skills, which helps them be more adaptive and flexible. Bachelor's programs also tend to support students to ramp up complementary skills including communication, teamwork, project management, and applied project experiences.

While many employers nationally have reduced bachelor's degree requirements for computer occupations[5], interviews with Cuyahoga County employers suggest slow adoption of this practice. A more common approach is to indicate "bachelor's preferred" in job postings, which in practice tends to result in more hiring of bachelor's degree holders. This pattern was reinforced by multiple training and educational providers.

Given this report's focus on workforce development, this report dives deeply into key roles where there's a reasonable likelihood to be hired without a bachelor's (required less than 50% of the time per O*NET) that offer an entry-point into Information Technology careers.

There are some specialized occupations that may be available to sub-BA holders nested under occupations that typically require a bachelor's degree. For the sake of data finding and reporting, however, the following occupations were excluded as they are nested under the "Computer Occupations, All Other" family, making insights and data inferences more difficult. The following occupations match these criteria (click the occupation to see the O*NET occupation profile). They include:

Computer Systems Engineers/Architects

Geographic Information Systems Technologists and Technicians

Information Technology Project Managers

Telecommunications Engineering Specialists

[5] Stahle, Cory. "Educational Requirements Are Gradually Disappearing From Job Postings". Hiring Lab Economic Research by Indeed. February 27, 2024.

Finding 2. 3C occupations account for about 7,400 jobs in Cuyahoga County, are accessible to those without bachelor's degrees and pay a living wage at entry.

Three occupations are most likely to be available to talent without a bachelor's degree, dubbed "the 3Cs" in this report. Figure 2 on the following page summarizes key facts about 3C roles. Two of the 3C roles are most often filled by individuals with preparation of less than a bachelor's degree (like certifications or associate's degrees):

- **Computer User Support Specialists** provide technical assistance to computer users, and account for ~3,500 jobs in Cuyahoga County, 16% of computer occupations. This occupation requires both strong technical and communications skills, as well as an instructing skillset, which is likely related to their need to walk customers through solutions to their tech problems. Entry level roles pay around $38K annually, with highly senior roles paying around $87K. Common job titles associated with this occupation include Computer Technician, Desktop Support Technician, Help Desk Analyst/Technician.
- **Computer Network Support Specialists** analyze, test, troubleshoot, and evaluate existing network systems like those on servers or the cloud, and represent ~1,400 jobs, 6% of computer occupations. Entry level roles pay around $45K annually; $108K for highly senior roles. Computer Network Specialist, Network Support Specialist, Network Technician (among others) are common job titles.

A third occupation may be accessed by talent from multiple education backgrounds, from vocational education to Associate's and up. It is increasingly clear, however, that success in this occupation hinges on material likely to be taught or reinforced through a 4-year degree.

- **Computer Systems Analysts** analyze science, engineering, business and other data processing problems to develop and implement solutions to complex application problems, system admin issues, or network concerns. Alongside specific technical skills, these roles require a mathematics foundation and skillsets like team or project coordinating, operations analysis, programming, and quality control analysis. In Cuyahoga County, Computer Systems Analysts account for ~2,400 jobs, 11% of computer occupations. These roles frequently pay around $60K annually at the entry level, and nearly $150K for senior talent. Common job titles associated with this occupation include Applications Analyst, Business Systems Analyst, Computer Analyst, Information Systems Analyst (ISA) and more.

More job titles for 3Cs can be found in the Appendix, Figure A - 1.

Figure 2. 2024 Key facts about 3C Jobs in Cuyahoga County

	# 3C Jobs in 2024	3Cs as % all Computer Occupations	Estimated Entry Wage*	Estimated Senior Wage*
Computer User Support Specialists	*3,509*	*16%*	*$18.32*	*$41.66*
Computer Network Support Specialists	*1,460*	*6%*	*$21.77*	*$52.09*
Computer Systems Analysts	*2,414*	*11%*	*$28.96*	*$71.87*
Total 3C's	*7,382*	*33%*		

Source: Lightcast. 2024 Estimates

**Estimated entry and senior wages use percentile earnings from Lightcast labor wage data. Percentile earnings indicate what percent of the jobs in the occupation earn that amount or less. For example, 10th percentile earnings of $12/hr. indicate that 10% of the workers in that occupation make $12/hr. or less. Median earnings of $15/hr. would mean that half of workers in that occupation make more than $15/hr., and half make less than $15/hr. 10th percentile earnings often serve as a proxy for entry level wages, as they represent some of the lowest earnings in the occupation.*

*"Black or African American and Hispanic jobholders **have both seen 1% growth** in this space…"*

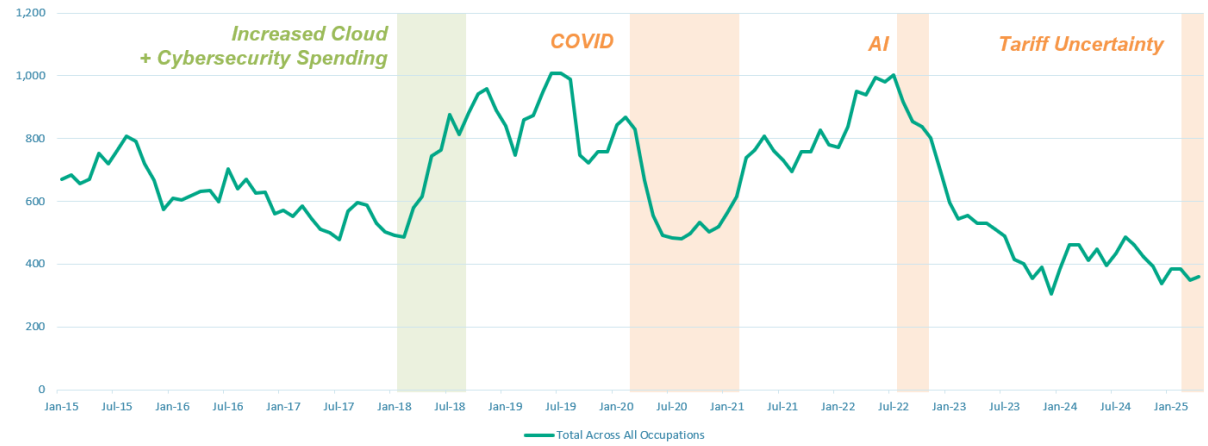
Another key fact about computing and 3C roles is that they are primarily occupied by white, male jobholders. In 2024, national computer jobholders were 56% white and 74% male. In Cuyahoga County, white men make up 73% of these jobs. While Cuyahoga County's overall workforce is predominantly white (71%) and female (51%), women are underrepresented at 26% of all computing jobs.

For 3C roles, however, there is more gender and racial diversity. In 2024, women comprised about 32% of all 3C jobs in the county, with little change since 2019. Black or African American and Hispanic jobholders have both seen 1% growth in this space during the same time period, making up 13% and 4% of 3C roles respectively.

Finding 3. Demand for 3Cs has dropped from a high in 2021-2022, though narrow pockets of opportunity persist.

Since 2022, unique job postings for 3C roles have declined by just over 60% for both Cuyahoga County and the nation. This recent decrease has been attributed to artificial intelligence (AI), including automated coding and AI-augmented computing activities.[6] Between February and April 2025, stakeholders interviewed described entry-level coders as the initial casualties of AI's implementation (additional detail in Figure 4). Relatedly, the number of employers advertising for 3C roles in Cuyahoga County has fallen from its peak of over 100 employers in 2021- 2022, to around 65.

Figure 3. Cuyahoga County Demand for 3Cs Occupations April 2015-2025



Source: Lightcast Job Posting Analytics

Historically, demand for 3C occupations was strong, especially before and shortly after the COVID-19 pandemic quarantine. Periods of high computer job hiring have generally been associated with the increase in high profile cyberattacks, investment in cyber security, increase in connected devices and digital infrastructure across industries, a growing digital economy, new IT business solutions, IoT and smart device adoption, and post-pandemic financial surplus.[7]

Figure 4. Employer Comments on AI

Managed Service Providers, Insurers, and Manufacturers who provided feedback for this analysis acknowledged that AI's potential has led to a slowing of net new hires. In the short term, stakeholders seemed hesitant to comment on what these jobs would look like even six months from now due to AI's impact on business. However, they cited a few examples of how it is emerging in their businesses:

- Companies will take Large Language Models (LLMs), develop their own platforms, and generate training videos to help orient employees.
- One MSP expanded that prompt engineering, AI agents, and AI RAG Models were currently in demand.

[6] Ruwitch, John. "Anyone can use AI chatbots to 'vibe code.' Could that put programmers out of a job?" NPR. May 2025.
[7] Zilberman, Alan. Ice, Lyndsey. "Why computer occupations are behind strong STEM employment growth in the 2019-2029 decade".

- One manufacturer elaborated that AI would help their industry with setting procedures, monitoring performance, and comparing latest industry standards for comparison, though they plan to put off adoption until use is more widespread in the industry as their budget's bottom line is priority #1.

Despite uncertainty associated with AI, there continue to be pockets of opportunity for 3C roles where hiring (and in some cases, employment growth) has continued. Recent demand for the 3Cs in Cuyahoga County (January-May 2025) primarily comes from the Computer System Design Services, including Managed Service Providers (MSPs), Healthcare and Custom Computer Programming Services. Other demand comes from Manufacturers, Finance and Insurance, public entities, and other administrative industries.

Between 2022 and 2024, the industries outlined in Figure 5 employed the majority of 3C talent in Cuyahoga County:[8] Opportunities and nuances vary dramatically by industry, and demand deep dives by segment are included in the Appendix, Figure A-6.

Figure 5. 3C Employment by Industry 2022-2024

Industry	**3C Jobs in Industry (2024)**	**Change (2022 - 2024)**
Custom Computer Programming Services	1,107	(3%)
Corporate, Subsidiary, and Regional Managing Offices	812	(9%)
Computer Systems Design Services*	587	(16%)
General Medical and Surgical Hospitals	405	2%
Local Government, Excluding Education and Hospitals	302	6%
Computing Infrastructure Providers, Data Processing, Web Hosting, and Related Services	217	(40%)
Temporary Help Services	214	(30%)
Elementary and Secondary Schools (Local Government)	189	26%
Colleges, Universities, and Professional Schools	160	(10%)
Direct Property and Casualty Insurance Carriers	152	(67%)

Source: Lightcast Industry Analytics 2024
**IT Managed Service Provider companies can be associated with multiple North American Industrial Classification System codes, which are used to determine industry data and other insights. The MSPs interviewed for this report most closely match the Computer Systems Design Services industry represented in the table above. MSPs may also offer services under Custom Computer Programming Services and Temporary Help.*

[8] Other industries staffing 3C jobs on a large scale (>100 jobs employed in the industry in 2024) include Temporary Help Services, Elementary and Secondary Schools (Local Government), Colleges, Universities, and Professional Schools, Wired Telecommunications Carriers, Software Publishers, and Commercial Banking.

MSPs in particular continue to hire for 3C roles. MSPs provide outsourced tech support (including helpdesk, onsite field support, internet, server engineering, network engineering, phone systems, cybersecurity, and IT strategies) to clients in manufacturing, nonprofits, municipalities, professional services, medical space, and small private colleges, from small to large. MSPs will sometimes work directly with IT professionals at one of these organizations, supplementing IT solutions for a variety of interests. Most MSP staff are typically help desk technicians and field support technicians. This industry can be a great starting point for someone new to the IT field, who may have a couple certificates and strong customer service skills and is able to use personal and company time to train. Local companies in this field include TEK systems, FIT Technologies, and MCPC.

*"This industry can be a great starting point for someone **new to the IT field**, who may have a couple certificates and strong customer service skills and is able to use personal and company time to train."*

In the longer term, and alongside AI, employers cited cyber security, transitions to cloud infrastructure, data collection capacity, and the deployment and development of Internet of Things (IIoT) technology[9] as factors that will shape entry level IT jobs. Employer interviews suggest that cybersecurity-related skills in particular are the next foundations of IT professions. Candidates with a solid foundation in cybersecurity principles, regardless of their area of focus, will have a leg up on their competitors as business insurance costs rise with the cost of ransomware attacks and privacy related lawsuits. Those who can obtain security clearance have an advantage over those who cannot, finding employment with businesses who work on federal contracts.

Multiple interviewees also brought up the dynamic between IT jobs that work with hardware (CPU, RAM, hard drive, keyboards, and monitors) vs non-hardware IT jobs (databases, networks, cloud computing, and AI). There is likely to be a slow transition away from these jobs as employers increasingly use cloud service solutions rather than hardware ones to save on IT costs. This could lead to hardware IT occupations becoming hyper specialized, like those maintaining quantum computers or special data center technology.

[9]Strategic planning dollars could yield downstream opportunities for workers to develop and maintain this type of advanced technology, per Honeywell's Smart City Accelerator Program in Cleveland. However, federal policy changes to smart and green initiatives, as well as impacts from tariffs on necessary technology, could complicate these efforts.

Finding 4. Cuyahoga County currently has a robust bench of candidates for 3C jobs who are competing with global talent. And, bachelor's prepared talent is increasing in numbers, making candidates without a bachelor's less competitive. To compete, technological aptitude, work-based learning and applied project experiences are critical.

There is an overall strong supply of entry-level Computer & IT talent available to Cuyahoga County employers. Employers interviewed for this report mentioned particularly strong applicant pools for open 3C roles - one even called them "application avalanches", a trend that has also been observed at the national level.[10] Several factors contribute to this trend.

First, local education and training completions have increased substantially since 2019. Student completions from accredited programs aligned to 3C roles increased over 70% in Cuyahoga County between 2019 and 2023, the most recent year available.[11] Data also shows that the county's bachelor's+ completions increased by 125% across all Computer and Information Sciences and Support Services instructional programs (which is the bucket for all IT related programs through accredited education providers) since 2019, and includes some programs aligned to 3C jobs. In addition, some employers referenced hiring bachelor's degree holders without a computer related background who used microcredentials or coding bootcamps to upskill technically, in some cases preferring this profile over workers with technical certificates.

In addition to the increase in new graduates locally, competition from outside of the region has become more intense. For one, bachelor's+ completions have ramped up both nationally and in Ohio (+42% and +60%, respectively). For another, Greater Cleveland also has a robust global talent pool seeking job sponsorships and competing for 3C roles to secure their "foot in the door".

Complicating the local hiring landscape further are AI-boosted "agents" that have simplified submitting resumes and job applications, supporting candidates to apply to more roles, more rapidly.

A note on remote work.

While computing occupations tend to have higher rates of remote work generally, local employers of 3C roles typically prefer these staff to work in person, according to interviews. Cuyahoga County's wages are slightly lower than the national averages for the 3Cs, and in some areas higher than Ohio as a whole. Lower wages can be a challenge for employers recruiting experienced talent. On balance, remote work is less of a factor for 3C roles than other parts of the computing talent landscape.

[10]Kessler, Sarah. "Employers Are Buries in A.I.-Generated Resumes." The New York Times. DealBook Newsletter. June 21, 2025.

[11] These figures undercount true training activity, as they only include data from accredited higher education institutions, vocational schools, and career centers. Apprenticeships and other training provider sources (such as small community-based programs and remote programs) are not captured. Ohio Labor Market Information 2024 data from the Department of Job & Family Services do not reflect any active apprentices related to 3C occupations in Cuyahoga County.

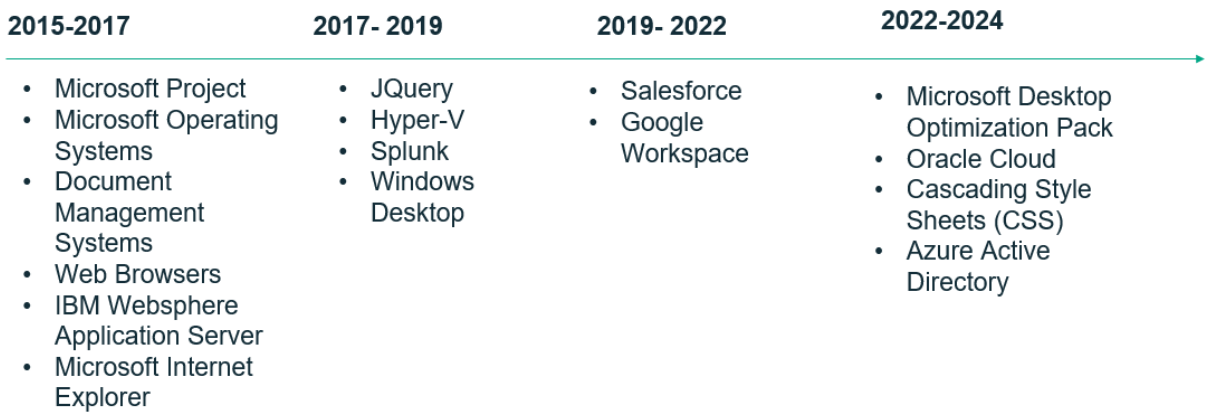
Many interviews with educators and employers elevated the importance of work-based learning and/or applied projects to compete, especially for talent without a bachelor's. Work-based learning refers to integrating real-world work experiences into a student's learning in a structured way, such as through an internship (which are becoming increasingly competitive and can be on par with entry-level jobs[12]), apprenticeship or co-op. Applied projects refer to experiences in which students learn by applying their skills to a real world problem, such as through hackathons and workshops where IT concepts are applied, company-sponsored projects in the classroom or projects through platforms like GitHub. These experiences help students demonstrate a portfolio of applied skills and competencies (technical and soft) and help differentiate them.

Finding 5. Employers demand not only technical skills but also professional, interpersonal, and intrapersonal skills as well as a lifelong commitment to learning. The technology skills and specific software expertise required for the 3C jobs are rapidly evolving.

While 3Cs offer a more accessible entry point than other computing careers, 3Cs are highly skilled roles requiring a robust blend of knowledge, skills and abilities. At the baseline, success in technical training for these careers requires high competency in math, digital fluency and technical aptitude. As such, workers that need to build these baseline skills to enter technical training, often face long, successive training experiences to be ready to compete for 3C roles.

Technical skills required for 3C roles are robust, and have evolved substantially. Figure 6 illustrates a timeline of how the top 50 software skills in demand every other year from Greater Cleveland employers shift markedly over time and in complexity as new technology emerges. Skills also vary widely across industries. AI is also poised to shape employer demand for technological skills across all professions, not only ones in IT[13]. To adapt and stay in tune with the quick pace of change, successful workers in this field must embrace ongoing learning.

Figure 6. Timeline of Highest In-Demand Tech Skills



Source: Lightcast Job Posting Analytics 2024

[12] Cruzvergara, Christine. "Internship Competition Is Fierce. Here's How Colleges Can Help Students Win Them." Forbes. March 17, 2025.
[13] "We're all techies now: Digital skill building for the future." McKinsey & Company. July 14, 2025.

Employers interviewed for this analysis also emphasized that soft skills, like communication, professional etiquette, and project management, were increasingly critical for new hires.

Among the 3Cs, some common skill requirements exist and have been relatively consistent. This may signal that proficiency in key areas is critical to accessing entry-level IT jobs. Figure 7 highlights key skills associated with these roles, which have been in demand fairly consistently over time.

Figure 7. Common Skills & Durable Requirements across 3Cs:

Common Technical Skills

- Clustering software —Ex: VMware
- Communications server software — Ex: IBM Domino
- Enterprise system management software — Ex: IBM Power Systems software
- Internet protocol IP multimedia subsystem software — Ex: Voice over internet protocol VoIP system software
- Office suite software — Ex: Microsoft Office software In-Demand
- Spreadsheet software — Ex: Microsoft Excel In-Demand

Common Soft Skills

- Administration and management
- Asking for Clarity
- Communication
- Critical Thinking
- Customer Service
- De-escalation
- Problem Solving
- Teamwork

Specific technical capabilities consistently advertised for 3C jobs, 2014-2025

- Active Directory
- Apple IOS
- Dashboard
- Dynamic Host Configuration Protocol (DHCP)
- Firewall
- Information Technology Infrastructure Library
- Java/JavaScript (Programming Language)
- Linux
- Microsoft 365 (Microsoft Access, Excel, Outlook, PowerPoint, SharePoint, Visio, Word)
- Operating Systems
- SAP Applications
- SQL (Programming Language) and SQL Servers
- Windows Servers

For a full list of skills associated with 3Cs, see The **Technology, Knowledge, and Other Skills** table, Appendix Figure A-2. For a full list of in-demand certifications (also called qualifications), see the Appendix Figure A-5.

*Sources: O*NET, interviews with employers*

Various certifications support technical skill development for roles in the 3Cs. The most in-demand certifications for these roles in Cuyahoga County and Greater Cleveland are CompTIA A+, Network+, Security+, Microsoft Certified Professional, Certified Information Systems Security Professional, Cisco Certified Network Associate, and Microsoft Certified Systems Engineer.

However, demand for these certifications is not clear cut: companies increasingly indicate the need to stack credentials. IT hiring managers and educators both mentioned that a singular CompTIA certification alone was not enough for candidates to secure employment, contrary to some advertisements by certification providers.[14] A candidate would need CISCO or Microsoft Azure AND CompTIA A+, for example, to make it to the "top of the resume pile". Another company called out a different ideal bundle: Microsoft 365 Administration + Azure + 80 password resets on their resume. Others called out that adding any Project+ certifications would be a valuable signal to the employer that this candidate might be more flexible working across departments.

In addition, new tools and related certifications emerge all the time. Interviews from this analysis elevated numerous technical skills that were not visible in the aggregated analysis (e.g. 5G Tower Work, Cobalt Coders, Endpoint Response Detection Tool, Sentinel One cybersecurity platform).

Finding 6. Advancement opportunities exist for those in 3C roles, but so do barriers.

Advancement opportunities do exist for 3C workers with the appropriate skills, qualifications, and drive. Employers interviewed described two common 3C worker profiles, which inform and support a workers' trajectory:

- Subject Matter Experts (SMEs) focused on specific cyber security, networking, and other IT-related specialties. SMEs still require skills like customer support, project management, and business acumen as they work in teams of various sizes.

- Generalists hired for their soft skill strengths, trained on the technology, and work primarily on sales and project management. Generalists may also be high level subject matter experts on the business side of operations.

These entry points then translate to common trajectories, according to the Atlanta Federal Reserve Bank's Opportunity Mobility Explorer tool:

[14] "How To Become an IT Support Specialist". CompTIA. April 24, 2024.

- Computer User Support Specialists can advance within the occupation (ex. Level 1-3), and also to Computer Network Support Specialist roles and Network/Computer Systems Administrator roles.
- Computer Network Support Specialists can advance to Network/Computer Systems Administrators, Computer Systems Analysts, and Database Architects.
- Computer Systems Analysts can become Database Architects and transition to Manager positions[15].

At the same time, workers' paths are not often linear; it is common for 3C workers to move between jobs and companies frequently, to hone new skills and gain exposure. Candidates with well-rounded experiential backgrounds tend to be more competitive. Multiple interviewees mentioned high competition at the mid- and senior level across IT departments, mentioning the 'industry norm' of poaching candidates from across the nation to find talent with new or desirable expertise. Recent examples of this have been featured in the news as IT talent with AI expertise are coaxed away from major companies[16]. Although these career pathways exist, barriers can hinder upward advancement. Employers interviewed typically agreed that:

> *"Insufficient foundational IT education, inadequate data and analysis, team-playing, and customer service skills…**would limit a candidate's advancement** to the next level."*

- Insufficient foundational IT education, inadequate data and analysis, team-playing, and customer service skills, and high competition for these roles would limit a candidate's advancement to the next level. Often, a bachelor's degree is used as a proxy for these skills. A computer-related bachelor's degree can be required to advance in certain IT pathways anyway, and workers without one can reach a ceiling.
- Personal and professional networks play a significant role in finding and securing IT employment for jobseekers.
- Without a passion for IT as a lifelong career, and the motivation to continue lifelong learning, continuous certification renewal can be a roadblock.
- Social determinants of work can be a significant challenge. 3C roles can sometimes require access to a vehicle, and workers with criminal backgrounds may not be able to obtain security clearance required for the roles.

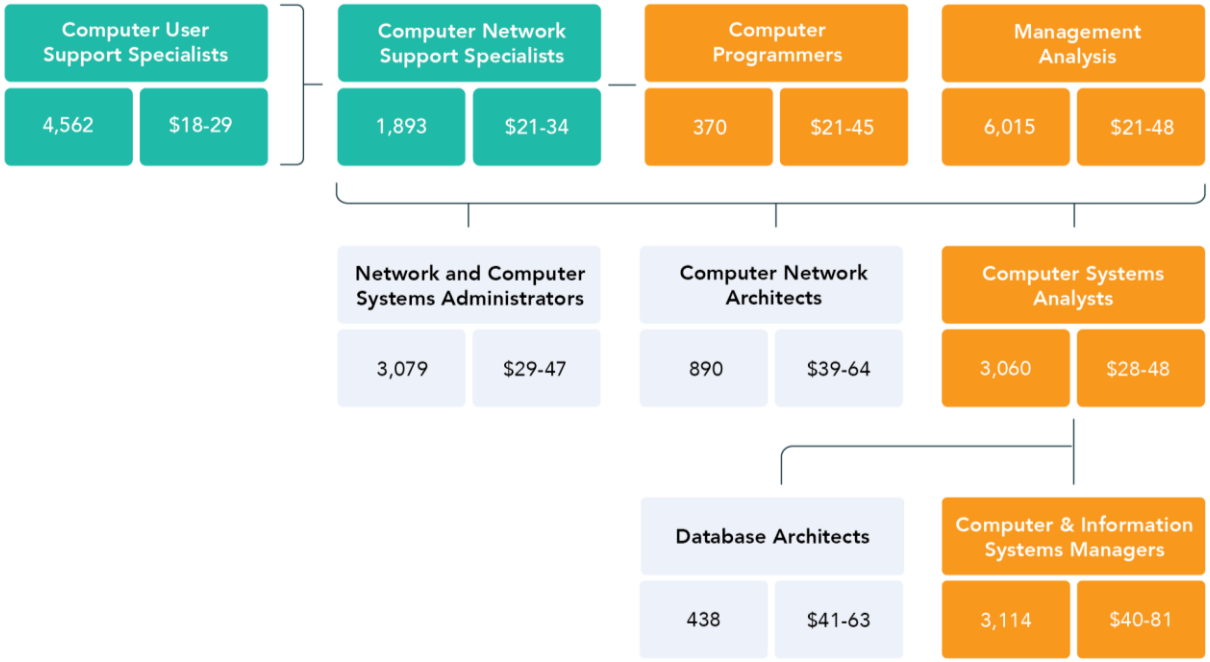
Figure 8 on the next page illustrates the career progression into and out of 3C occupations as well as job numbers and entry to average hourly wage ranges for each. These entry-points aren't always compatible with advanced IT careers, with some requiring additional education or training. See Appendix Figures A-3, A-6 and A-7 for additional context on which programs lead to 3C positions and for qualitative examples of career mobility.

[15] Federal Reserve Bank of Philadelphia Occupational Mobility Explorer
[16] Butts, Dylan. "Sam Altman says Meta offered OpenAI staff $100 million bonuses, as Mark Zuckerberg ramps up AI poaching efforts." CNBC. June 18, 2025.

Figure 6. Team NEO illustration of Career Pathways in 3Cs.

Jobs shown in light grey below have a medium skill similarity with jobs like **Computer User Support Specialists** and others represented in this graphic.

2024 Jobs	Entry-Average Hourly Wage	Entry Level Jobs
16,685	$15-22	Customer Service Representatives
3,067	$16-24	Court, Municipal, and License Clerks
2,171	$18-25	Insurance Claims and Policy Processing Clerks
1,087	$16-25	Dispatchers, Except Police, Fire and Ambulance
920	$19-26	Eligibility Interviewers, Government Programs
294	$19-23	Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators and Tenders
175	$13-18	Switchboard Operators, Including Answering Service
72	$14-16	Concierges



Jobs in **orange** have high skill similarities to each other, signaling an easier transition between jobs. While a **Computer Network Support Specialist** could transition into a **Computer Systems Analyst** role, the medium similarity between jobs could signal more training is needed for the transition.

Finding 7. There is a dense ecosystem around computing education in Cleveland, across the education and training continuum.

An objective of this analysis was to make the ecosystem of providers involved in the IT workforce landscape more visible. Figure 9 highlights many providers of computing and information technology-related training in Cuyahoga County, spanning K12, workforce development and higher education (see Appendix Figure A-4 for details on current providers and their offerings, as of publication). Importantly, program offerings change frequently, and some bootcamp providers have scaled back their local, in-person course offerings in Cleveland in recent years, such as Tech Elevator and Case Western Reserve University.

Figure 7. Key Local IT Education and Training Providers, serving Cuyahoga County residents

K12 & Youth Workforce Development	**Adult Workforce Development**	**Higher Education** (Associates, Bachelor's+)
K12 School districts, especially Cleveland Municipal School District (including CTE and non-CTE offerings in Computer Science & IT)	Cuyahoga Community College (IT Fast Track Career and Technical Training programs, including Cleveland Codes)	Cleveland State University Case Western Reserve University
Mosaic Tech Movement	GCP Apprenticeship Hub	Cuyahoga County Community College (Associate's)
TECH CORPS	Towards Employment	Oberlin College
Y.O.U.	Urban City Codes	Lakeland Community College
	Urban League	Lorain County Community College
	We Can Code It	John Carroll University
		Baldwin Wallace University
		Kent State University at Ashtabula & Geauga

In addition to local providers, workers can also access numerous remote training options, through platforms like Coursera, online programs at universities, etc. Companies also frequently fund or

facilitate access to training, including through programs like Tech Cred, supported by the state of Ohio. Alongside direct education and training, there are also efforts to build leverage, alignment and effectiveness among organizations supporting IT talent development.

- *Center for Computing Education and Instruction (CCEI)*. Led by Cleveland State University (CSU), the CCEI formed in 2024 to expand on a decade of work between Cleveland Municipal School District and CSU to strengthen computer science access and instruction in K12, especially among students historically underrepresented in the IT field. CCEI trains computer science teachers, prepares students for advanced computing college programs and careers (largely focusing on secondary and post-secondary education), advocates for policy and conducts research. CCEI also functions as a hub, coordinator and funding catalyst for organizations supporting students with IT career experiences, including career exposure, mentorships and internships (working closely with Y.O.U., the state of Ohio's Office for Workforce Transformation regional Tech Internship intermediary)
- *Greater Cleveland Career Consortium (GCCC).* GCCC is a collective impact initiative, comprised of public, private, education, and non-profit organizations working together to help every student in the region design a career plan that aligns with their interests and skills. GCCC supports school districts to integrate career counseling, planning and career experiences, and helps students gain access to high quality work-based learning experiences.

Finding 8. While strategic partnerships do exist, there are generally not enough feedback loops between industry and education to keep up with the IT field's rapid pace of change.

Training providers emphasized that it is increasingly difficult to keep up with IT's rapid pace of change. While some successful local partnerships exist between private business and education providers, those same providers can be constrained by curriculum changes incompatible with developments in IT. One employer interviewed stated that educators would need to respond with curriculum updates every 6-12 months, or as warranty stickers on certifications expire (typically 2-3 years), to give students a competitive edge. Providers experience other key challenges as well:

- Low engagement by employer engineers to provide critical curriculum feedback.
- It is difficult to get feedback on student outcomes and participation in post-graduate focus groups.
- Students are ill-equipped to communicate IT skills in practice interviews or real-interviews post-graduation.
- Students can have a difficult time developing unique differentiating skills while learning about general IT.
- No system for IT employers to provide stamps of approval on educational programs

- Employers lack clear incentives to participate in curriculum development
- Engaging IT employers is difficult, with most success in small IT departments of 5 or fewer

*"…locally educated graduates employed in Greater Cleveland, or '**champions**', can be a valuable network for sub-bachelor, entry-IT candidates."*

However, locally educated graduates employed in Greater Cleveland, or 'champions', can be a valuable network for sub-bachelor, entry-IT candidates. Champions allow employers to see the outcome of local training and education firsthand. They can also play a role in creating organic feedback loops and fostering trust between programs or employers. This dynamic ideally leads to effective program development and longer relationships between public and private stakeholders.

Implications & Recommendations

The findings of this landscape analysis demonstrate clearly that workforce development interventions should be the right size (scaled appropriately, for the number of jobs that are accessible to those without Bachelor's degrees) and the right fit (designed for those with both the technical, interpersonal, and intrapersonal skills and distinct mindset to succeed).

Recommendations for educators at the K-12 and post-secondary levels, workforce developers, and funders include the following:

K-12 Education

1. Set realistic expectations for students and families; most IT roles require a bachelor's degree; roles accessible to those with less than a BA are highly competitive and demand both technical and professional skills.
2. Integrate early digital literacy, problem-solving, and foundational math skills into curricula to prepare students for the commitment to education that will make IT careers more accessible.
3. Expand opportunities for work-based learning such as job shadowing, internships, and applied project experiences to help students test their aptitude and interest for the work, build networks, and develop demonstrable skills.

Workforce Development

1. Calibrate participant expectations; even accessible 3C roles are demanding, competitive, and often require ongoing commitment to learning and skill building.
2. Focus on deepening employer partnerships, and anchor training offerings around connected employers that inform curriculum and indicate interest in hiring graduates. Given the rapid pace of change and competitiveness of the hiring landscape, students completing training without strong employer relationships may struggle to secure 3C

employment. Consider downshifting enrollment in programs that do not have strong employer input and partners.

3. Prioritize work-based learning and applied project experiences so that applicants will stand out in a competitive market.
4. Deepen coaching to understand the interviewing, networking, and articulation of skill sets that are likely to resonate with IT hiring managers.

Higher Education

1. Regularly update curricula to keep pace with employer needs; recognize that some skills may expire in short cycles of 6-12 months.
2. Understand that employers may not have significant unmet need for entry level workers at the present time, which may make the development of deeper partnerships more challenging.
3. Integrate work-based learning, applied project experiences as described above, and professional skill development into any technical training.
4. Strengthen pathways (including articulations and recognition of prior learning) from certifications to associate's degrees and then bachelor's programs to give students the best opportunity for career mobility.

Funders

1. Right-size investments. Recognize the limited number of 3C roles available, knowing that not all will be accessible to those with less than a 4-year degree.
2. Prioritize programs and career experiences that include high quality work-based learning, applied projects, strong career coaching and embedded credentials.
3. Fund ongoing employer engagement infrastructure, instructor professional development and externships to enable frequent curricular updates.
4. Invest in mentorship and networking supports to help underrepresented groups strengthen social capital that may increase access to IT roles.

Appendix

Figure A - 1. Common Job Titles for the 3Cs

Computer User Support Specialist	Computer Support Specialist Computer Tech (Computer Technician) Desktop Support Technician (Desktop Support Tech) Help Desk Analyst Help Desk Tech (Help Desk Technician) IS Tech (Information Systems Technician) IT Specialist (Information Technology Specialist) IT Support Specialist (Information Technology Support Specialist) IT Tech (Information Technology Technician) Technical Support Specialist
Computer Network Support Specialists	Computer Network Specialist IT Consultant (Information Technology Consultant) Network Specialist Network Support Specialist Network Technical Analyst Network Technician Personal Computer Network Analyst Systems Specialist
Computer Systems Analysts	Applications Analyst Business Systems Analyst Computer Analyst Computer Systems Analyst Computer Systems Consultant Information Systems Analyst (ISA) IT Analyst (Information Technology Analyst)

	IT Systems Analyst (Information Technology Systems Analyst) Programmer Analyst Systems Analyst

*Source: O*NET Occupational Descriptions*

Figure A - 2. Technology, Knowledge, and Other Skills in 3Cs

The following Technology, Knowledge, and Skills dataset is sourced from O*NET Online analysis of 3C occupations. Click the occupation to see the full O*NET pages for each of the 3Cs: Computer Systems Analysts, Computer Network Support Specialists, Computer User Support Specialists.

Technology Skill	Computer Systems Analyst	Computer Network Support Specialist	Computer User Support Specialist
Access software	✓	✓	✓
Accounting software	✓		✓
Administration software	✓	✓	✓
Analytical or scientific software	✓		✓
Application server software	✓		✓
Authentication server software			✓
Backup or archival software	✓	✓	✓
Business intelligence and data analysis software	✓		✓
Calendar and scheduling software			✓
Cloud-based data access and sharing software	✓		✓
Cloud-based management software	✓	✓	✓
Cloud-based protection or security software		✓	✓
Clustering software	✓	✓	✓
Communications server software	✓	✓	✓
Compiler and decompiler software	✓		

Computer aided design CAD software	✓	✓	✓
Computer based training software			✓
Configuration management software	✓	✓	✓
Content workflow software	✓		✓
Customer relationship management CRM software	✓	✓	✓
Data base management system software	✓	✓	✓
Data base reporting software	✓		✓
Data base user interface and query software	✓	✓	✓
Data conversion software	✓		
Data mining software	✓		
Desktop communications software	✓	✓	✓
Desktop publishing software	✓		✓
Development environment software	✓	✓	✓
Document management software	✓	✓	✓
Electronic mail software	✓	✓	✓
Enterprise application integration software	✓	✓	✓
Enterprise resource planning ERP software	✓	✓	✓
Enterprise system management software	✓	✓	✓
Expert system software	✓		✓
File versioning software	✓		✓
Filesystem software		✓	✓
Financial analysis software	✓		✓
Geographic information system	✓		✓
Graphical user interface development software	✓		✓
Graphics or photo imaging software	✓		✓
Helpdesk or call center software	✓	✓	✓

Human resources software	✓		✓
Industrial control software	✓		✓
Information retrieval or search software	✓		✓
Instant messaging software	✓		✓
Internet browser software			✓
Internet directory services software	✓	✓	✓
Internet protocol IP multimedia subsystem software	✓	✓	✓
License management software			✓
Medical software	✓		✓
Metadata management software	✓		✓
Multi-media educational software			✓
Network conferencing software	✓		✓
Network monitoring software	✓	✓	✓
Network operating system enhancement software		✓	
Network operation system software			✓
Network security **and** virtual private network VPN **equipment software**		✓	✓
Network security **or** virtual private network VPN **management software**	✓	✓	✓
Object or component oriented development software	✓	✓	✓
Object oriented data base management software	✓		✓
Office suite software	✓	✓	✓
Operating system software	✓	✓	✓
Pattern design software	✓		
Platform interconnectivity software		✓	✓
Portal server software	✓		✓
Presentation software	✓	✓	✓
Process mapping and design software	✓		✓

Program testing software	✓	✓	✓
Project management software	✓	✓	✓
Requirements analysis and system architecture software	✓		✓
Sales and marketing software	✓		✓
Spreadsheet software	✓	✓	✓
Storage networking software	✓	✓	✓
Switch or router software		✓	
Transaction security and virus protection software	✓	✓	✓
Transaction server software	✓	✓	✓
Video conferencing software	✓		✓
Video creation and editing software	✓		✓
Web page creation and editing software	✓		✓
Web platform development software	✓	✓	✓
Word processing software	✓	✓	✓
Total Technology Skills	**68**	**41**	**75**

Skills & Knowledge	**Computer Systems Analyst**	**Computer Network Support Specialist**	**Computer User Support Specialist**
Knowledge			
Administration and Management — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.	✓	✓	✓
Administrative — Knowledge of administrative and office procedures and systems such as word processing, managing files and records, stenography and transcription, designing forms, and workplace terminology.			✓
Communications and Media — Knowledge of media production, communication, and dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, and visual media.		✓	✓

Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.	✓	✓	✓
Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.	✓	✓	✓
Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.			✓
Education and Training — Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.	✓		✓
Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.		✓	✓
English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, and rules of composition and grammar.	✓	✓	✓
Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.	✓		
Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.			✓
Telecommunications — Knowledge of transmission, broadcasting, switching, control, and operation of telecommunications systems.		✓	✓
Total Knowledge units	**6**	**14**	**11**
SKILLS			
Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.	✓	✓	✓
Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.	✓	✓	✓
Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.	✓	✓	✓
Coordination — Adjusting actions in relation to others' actions.	✓		
Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions, or approaches to problems.	✓	✓	✓
Instructing — Teaching others how to do something.			✓

Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.	✓	✓	✓
Learning Strategies — Selecting and using training/instructional methods and procedures appropriate for the situation when learning or teaching new things.	✓		✓
Mathematics — Using mathematics to solve problems.	✓		
Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.	✓	✓	✓
Operations Analysis — Analyzing needs and product requirements to create a design.	✓		
Operations Monitoring — Watching gauges, dials, or other indicators to make sure a machine is working properly.	✓	✓	✓
Programming — Writing computer programs for various purposes.	✓		
Quality Control Analysis — Conducting tests and inspections of products, services, or processes to evaluate quality or performance.	✓		
Reading Comprehension — Understanding written sentences and paragraphs in work-related documents.	✓	✓	✓
Service Orientation — Actively looking for ways to help people.	✓		✓
Social Perceptiveness — Being aware of others' reactions and understanding why they react as they do.	✓		✓
Speaking — Talking to others to convey information effectively.	✓	✓	✓
Systems Analysis — Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.	✓	✓	✓
Systems Evaluation — Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system.	✓	✓	
Time Management — Managing one's own time and the time of others.	✓	✓	✓
Troubleshooting — Determining causes of operating errors and deciding what to do about it.	✓	✓	✓
Writing — Communicating effectively in writing as appropriate for the needs of the audience.	✓	✓	✓
Total Skills	**22**	**14**	**17**

Figure A - 3. Computer & IT Programs Leading to 3Cs

Code	Description
11.0101	Computer and Information Sciences, General
11.0102	Artificial Intelligence
11.0103	Information Technology
11.0104	Informatics
11.0199	Computer and Information Sciences, Other
11.0201	Computer Programming/Programmer, General
11.0202	Computer Programming, Specific Applications
11.0203	Computer Programming, Vendor/Product Certification
11.0299	Computer Programming, Other
11.0501	Computer Systems Analysis/Analyst
11.0701	Computer Science
11.0899	Computer Software and Media Applications, Other
11.0901	Computer Systems Networking and Telecommunications
11.0902	Cloud Computing
11.0999	Computer Systems Networking and Telecommunications, Other
11.1001	Network and System Administration/Administrator
11.1002	System, Networking, and LAN/WAN Management/Manager
11.1003	Computer and Information Systems Security/Auditing/Information Assurance
11.1005	Information Technology Project Management
11.1006	Computer Support Specialist
11.1099	Computer/Information Technology Services Administration and Management, Other
11.9999	Computer and Information Sciences and Support Services, Other

Source: Lightcast Education Pipeline for 3C occupations

Figure A - 4. Greater Cleveland Education and Training Provider Offerings

Higher Education in Greater Cleveland

Cleveland State University	Developed a Center for Computer Education and Instruction (CCEI, has enabled more work to be done around computer science advocacy and resource development) and are implementing integrated degrees for BA+ talent, the first public university to do so. Integrated degrees advertised span Computer Science + Design, Electrical Engineering, English, and Physics. Also hosts the Community+Innovation+Technology Hackathon.
Case Western Reserve University	CWRU Department of Computer and Data Sciences and Department of Electrical, Computer and System Engineering offer a variety of BA+ computer education tracts. Research also spans AI, Machine Learning, Robotics, Virtual Reality, Wearable Tech, and more.
Cuyahoga County Community College	Variety of cybersecurity, bootcamp, and other computer science-oriented training for sub-BA talent. Under the School of Advanced Manufacturing, Engineering and Computer Science, Tri-C has also launched an integrated digital manufacturing engineering technology 4-year degree. Tri-C Cyber Defense Center provides hands-on experience in cybersecurity. Dean's Initiative brings industry partners together around work-based learning across colleges.
Oberlin College	The Department of Computer Science integrates CS with liberal arts curriculum for BA+ students.
Lakeland Community College	IT & CS degrees across application programming and web development, Computer IT, CS and software engineering, cybersecurity, data analytics, IT support analyst, and operating systems/networking. Also provides general and industry-specific certificates in computer user, IT foundations, IT specialist, and IT professional areas that

	span coding languages, web concepts, cybersecurity, and more.
Lorain County Community College	Science and Math Programs for sub-BA pathways in Computer Games and Simulation Design and Computer Science. Advertises STEM student support (combo of mentoring and scholarship) for those pursuing computer security, data analytics, hardware maintenance and information system support, interactive and digital media, network systems, software development programs, and web development. Also offers University Partnership for BA of Computer Science and Engineering from University of Toledo
John Carroll University	The Department of Mathematics, Computer Science, and Data Science offers BA+ specializations in Computer Science, Data Science, Mathematics, and Teaching Math. Industry-sponsored projects are also available.
Baldwin Wallace University	The Department of Mathematics, Statistics & Computer Science offers BA+ Computer Science, software engineering, and cyber security analyst majors. Also has a Cyber Defense Team that competes in Collegiate Cyber Defense Competition. ACM Student computer club also sponsors the annual BWU High School Programming competition.
Kent State University at Ashtabula & Geauga	Bachelor's in IT and Information Technology Associate of Applied Business program offered at Ashtabula. Geauga location provides Bachelors of Science in IT.

K-12, Workforce Development & Other Resources of Note

CMSD	CMSD has a Youth + CS Working Group that convenes educators in K-12 under CSU's Continuing Education arm. Also has Industry Advisory Committee infrastructure at some district schools (though participation here is likely limited to Manufacturers or Construction, no IT employers are actively engaging) Career-centered PACE framework through the Greater Cleveland Career Consortium (GCCC)

	CompTIA Tech+ curriculum and $1K incentive to complete were also mentioned by CMSD representatives.
GCP	GCP has developed the Apprenticeship Hub and have implemented tech talent programs which received compliments from a few civic and MSP interviewees, like Tech Elevator.
NEOWIT	Education, resource, and networking group for women and minorities in Northeast Ohio's tech community.
Other Resources FYI	Capture the Flag Cyber Security Consortium Data Palooza Forage (free, short virtual examples of careers) Get wITit. Hack the Box Marketing AI Institute Ohio Cyber Reserve
Towards Employment	Towards Employment provides industry standard IT certifications, soft skill workshops, career readiness training, digital literacy training, personalized career coaching, and supportive services to their clients.
Urban City Codes	Coding Bootcamps for digital skills, cybersecurity (CompTIA Fundamentals, A+), beginner coding, front-end web mobile and developer, full stack web and mobile development,
We Can Code It	Modernized micro credentialing brought in at the back end of IT bootcamps. New focus on AI credentials. Special emphasis on courses allowing students to design and build AI projects and another to strengthen skills in AI development and project management.
Youth Opportunities Unlimited	Youth Opportunities Unlimited (Y.O.U.) was named the State of Ohio's Office for Workforce Transformation Tech Internship intermediary and covers many northeast Ohio counties.

Figure A - 5. 3C In Demand Qualifications for Greater Cleveland

Qualification Description	# Postings with Qualification (May 2023-2025)
CompTIA A+	601
CompTIA Network+	308
CompTIA Security+	239
CompTIA Certification	207
Microsoft Certified Professional	191
Valid Driver's License	149
ITIL Foundation Certification	132
Certified Information Systems Security Professional	129
Cisco Certified Network Associate	119
Certified Ethical Hacker	73
Microsoft Certified Systems Engineer	73
GIAC Certifications	62
Certified Information Security Manager	37
CompTIA Linux+	36
Certified Information System Auditor (CISA)	33
Cisco Certified Network Professional	30
Microsoft Certified Desktop Support Technician	27
Microsoft Certified IT Professional	26
ITIL Certifications	24
NIST Cybersecurity Framework (CSF)	22
CompTIA Server+	22
Secret Clearance	20
CompTIA Advanced Security Practitioner (CASP+)	20
CompTIA Certified Technical Trainer (CTT+)	20
Microsoft Certified Technology Specialist	20
VMware Certified Professional (VCP)	20
GIAC Certified Incident Handler	19
Apple Certified Macintosh Technician	17
GIAC Security Essentials Certification (GSEC)	16
Microsoft Certified Systems Administrator	16
Security Clearance	16
Certified Cloud Security Professional (CCSP)	15
CompTIA Cloud+	15
CompTIA Cybersecurity Analyst (CySA+)	14
Cisco Certified Entry Networking Technician	14
Automotive Service Excellence (ASE) Certification	13
Systems Security Certified Practitioner	12
Microsoft Certified: Azure Administrator Associate	11
Certified In Risk And Information Systems Control	10

Source: Lightcast Job Posting Analytics

Figure A - 6. Demand Deep Dives

Managed Service Providers (MSPs)

5 MSPs were engaged for this project. MSPs typically provide helpdesk, onsite field support, internet, server engineering, network engineering, phone systems, cybersecurity, and IT strategies to their clients. Long-term relationships can drive business in this space over short-term projects. Most MSP staff are typically help desk technicians and field support technicians.

MSP clients can span manufacturing, nonprofits, municipalities, professional services, medical space, and small private colleges, from small to large. MSPs will sometimes work directly with IT professionals at one of these organizations, supplementing IT solutions for a variety of interests. This industry can be a great starting point for someone who is new to IT, may have a couple certificates and strong customer service skills, and is able to use personal and company time to train. However, it can be a very challenging and dynamic workplace with high workloads and consistent problem solving.

- **A+** licensure is needed to advance at one major local IT employer in this industry.
- **AI** Operators in this industry are embracing AI as an augmenting tool, but multiple interviewees highlighted AI as a primary reason for net new hires to slow in the field. Internal AI services are the go-to as they cannot afford data or proprietary information leaks. Some in this space think concerns of AI taking over jobs is unfounded as the technology enables them to perform better, since it is seen as a beneficial tool for critical thinking when solutions aren't immediately available.
- **Certs + Degree Requirement** One MSP remarked that their competitors have flat requirements of a computer engineering degree or 5 IT certifications.
    - This same MSP will offer both company-time training and expect a new technician to pursue a certification on their own time, with a bonus incentive for every certification received. Some certifications are best done at the office when collaborative exercises are part of the curriculum.
    - One MSP commented that their staff was about three-fourths college degree holders and one-third not.
- **Entry-Level Options** One interviewee who often works with government clients described two options for entry-level IT talent in his field: 1. non-technical project coordinator (with pathway to project management positions). This coordinate role must have excellent communication, project management, content knowledge, basic software development or system implementation skills (Azure, Waterfall, Test & Deploy, and IT cycles proficiency needed to advance). 2. Basic Helpdesk position that works with password issues and helps solve issues in real time. Helpdesk will also assist with app installation and getting new hires up and running. AI complicates some parts of the Basic Helpdesk work – for example, AI bots can answer basic questions quickly, however workers will be needed to "back up" the bot and function as a translator between customer and bot. This will eventually require knowledge of basic prompt engineering.
- **ERPs** Some roles require knowledge of complex ERP tools (Enterprise Resource Planning: centralized system for all components of business operations like finance, HR, supply chain, etc. to automate operations). Examples of this are Oracle and Workday FP&A. Often these advanced tools are associated with bachelor's talent.
    - Indian universities have been partnering with Oracle and others, for about 7-12 months of training.

- **Indian & Oracle Partnership** One MSP mentioned that universities in India have enabled their talent to be proficient in some advanced software through partnerships with Oracle and others.[17]
- **Lack of Visibility for MSPs** One MSP interviewee mentioned that it seems like there is a lack of visibility into types of IT employers in local areas. To help connect entry-level talent to jobs, increasing visibility of non-traditional IT companies in our local areas seems like the simplest next step.
- **Low Pass Rate** When using Tech Cred to upskill IT talent, one MSP noted that they had to switch from self-led formats to instructor-led ones as the test passing rate was exponentially lower during the self-led training.
- **MSP Competition** Small IT contractors are typically competition for MSPs since they can provide freelance IT to smaller organizations.
- **No Success** One MSP IT professional cited that employees who need to take frequent, unscheduled time off typically do not succeed in their work environment. This interviewee specifically cited employees in their late 20's struggling with social anxiety as an example. This MSP provides wraparound support to their workers yet expressed fatigue with the situation.
- **Project management** backgrounds are attractive since they allow talent to work in business analysis, project management functions, and alongside subject matter experts. Project managers ensure teams hit milestones, record areas of concern or roadblocks, and adhere to budgeting and timeline constraints. Time management, generic accounting, and organization skills are necessary for these positions.
- **Recruiters** MSPs often rely on internal recruiters, sharing open roles on LinkedIn, and keeping a bank of resumes. Occasionally work with third party recruiters.
- **Standing Out** Talent who like working on documenting plans, procedures, or workflows are attractive to MSPs. Military candidates were also mentioned multiple times for their ability to work on teams and gain access to security clearance for special projects.
- **Training** Some larger MSPs will be able to upskill help desk talent who lack technical experience through developed training programs.

Manufacturing

We engaged five manufacturers for this project and most of them mentioned they go through an MSP for helpdesk and customer IT support as needed, and do not hire these positions directly themselves. The exception to this was manufacturers who produced IT enabled products and automation systems. Manufacturers in that space must provide customer support and troubleshooting to clients and require boots on the ground talent to do so. MSP's can and do bring on IT talent as contractors and full-time employees, but insights on this were limited.

- **AI** Anecdotally, small- and mid-sized manufacturers do not have the data collection or analysis capabilities they may need to be brought up to speed on AI and use it to help work on efficiencies, product development, R&D, etc. Manufacturers expressed AI's rapid pace as a reason to slow adoption. It is always about the bottom-line budget for manufacturers, and until AI has been widely adopted, they don't like the risk. However, some mentioned adopting tools for wordsmithing, reviews, marketing, and generic renderings (like using AI to show examples

[17] Oracle Launches Project Vidya to Train 500,000 Youth and Women in Latest Technologies to Boost India's Knowledge Economy. Oracle Press Release. February 2025.

of testing equipment in one setting or another). At the HR level, adoption examples were related to analyzing salary ranges. The future of using AI for a manufacturer would look like setting procedures and monitoring or comparing latest industry standards for comparisons.

- **CLE Reputation** One manufacturer used a staffing agency for entry-level IT roles - that staffing agency mentioned that Cleveland is not known for good, bad, or otherwise IT talent, calling CLE "reputation-less." This agency representative noted that Cleveland seemed to be hiring more face to face than other markets and lacks 'metropolis style' infrastructure.
- **Critical Skills** Manufacturers expressed that they need talent that can think ahead, on top of scheduling, can quickly pivot and think on their feet. Keeping up to date on industry standards is a must.
- **Entry-level** Associate Engineers and Technicians would be entry-level in this space, interacting with machinery and performing low-mid level configurations. Other titles include Field Service Technician, Line Manufacturer for Sales, Associate Technician. A typical Technician assignment would be to go out to client location, work on a controller, then work on a small frame drive. Entry-level technicians may be split into two buckets: those who work on machinery and those who work on IT functions for the business. Desirable candidates can move between these two buckets of work. 4-year degree holders would perform tasks like designing systems or solutions and configurations of broad or complex systems.
- **ERP in MFG** Supply Chain technology and Enterprise Resource Planning (ERP) tech will continue to be adopted and require talent. This type of tech will fall into network engineering, HR, and Supply Chain teams. Once all these pieces are in place, cloud technology can be implemented. A typical small manufacturer might need 1 or 2 senior workers running this for the business. Newer talent might be able to learn this from large organizations who can afford to take the time to guide them through learning.
- **Example elements of manufacturing IT**: Ethernet, CISCO routing and switching, Cisco stacks, industrial data centers, integrated architecture, processor programming, data/asset/logistics management teams, and data analysis.
- **Industry Drivers** Industrial maintenance and sensor communications are critical for manufacturing industry future and AI development.
- **MFG IT Team Example** One medium-sized manufacturer in Greater Cleveland manages a larger engineering group and an IT Administrator (who is full time on site). They work with a firm to manage infrastructure, troubleshooting, and tech support. This manufacturer mentioned they will lean heavily on external IT for Cybersecurity, as keeping up to date is too burdensome for an IT department of one whose primary job is to troubleshoot IT for day-to-day operations.
- **Moving Up** One IT professional in the manufacturing space mentioned that being a Lab Manager is a good next step for an associate's degree holder with great organizational skills.
- **Not Hiring** one major Cuyahoga County manufacturer declined an interview for this project because they did "not currently have much in terms of entry-level IT opportunities." Small- and mid-sized manufacturers will likely turn to IT talent with 5-10 years of experience who run internal departments, specialize in one area of IT, or else engaged with MSPs to outsource other IT functions.
- **Talent Competition** One Fortune 500 manufacturer that was affiliated with a postsecondary institution's internship program relayed that they do not hire 2-year degree talent for IT positions but will consider it for business-oriented positions, meaning IT associate graduates would be competing with business grads.

- **Trust** The risk associated with a small- or medium-sized manufacturer in trusting IT talent, is a significant barrier.
- **Upgrades** One interviewer discussed the importance of upcoming deadlines to sunset Windows 10 (which many in MFG space are likely to use), which could benefit mid- to senior-level talent and/or MSPs who provide upgrade services to manufacturers.

Fortune 500 Interview + Feedback Deep Dive

One Fortune 500 rarely hires for networking or helpdesk anymore, but focuses on openings in software development, data science, "DevOps" (software development + IT operations) or platform engineering, business analyst, and cyber roles. These roles would require a bachelor's degree, or else bachelor's level talent would be the preferred candidate pool. These Fortune 500's IT teams can range from 200 to 1,000. This same organization saw four hundred applicants in 3 days for an internship program. The interviewee also provided great feedback on their interview processes:

- **Each resume is reviewed**. Resumes that meet qualifications get a virtual interview before a round of cuts, then will face behavioral panel questioning.
- Candidates **may face rejection** from a company like this if they exhibit the following behaviors: preference for only using one technology, resistance to learning new technologies or give off a perception that they are only proficient in some and not willing to learn new ones, or are individually oriented (not a team player).
- This Fortune 500 finds great **entry-pipeline success** with available regional and local colleges that have great retention rates.
- Mid-level positions available at a company like this will also **poach internally** from outside markets, bringing incumbent workers from elsewhere to Greater Cleveland.

Example Fortune 500 Interview Process

- 10 questions + 30-minute phone screen interview focused on interest level and why the interviewee is entering specific job market.
- If passed, the resume goes to HR for another 30–45-minute phone screen. This portion of the interview focuses on "things unsaid," or motivations from candidate for why they want the job. Interviewers here like to see 5–10-year goals from candidates. If the candidate mentions money too early, or the interviewer can see it's their primary motivation for the job, it's "on to the next one". Interviewers also want to hear examples of what the candidate is interested in about the field, or which new developments are most interesting to the candidate.
- After that, it is on to onsite interviews with the larger team. Some do peer interviews in this process, but mostly it is top-down heavy with other department leads.
- The entire process is designed to be streamlined, however others in the space may bring candidates in more than a few times.

Niche Tip: bringing a notebook or other form of material that shows preparation, even if blank, is a good signal to an employer. Showing up with nothing can leave the interviewer with the impression that the candidate may not be prepared or interested enough in the job. It's also a "green flag" to express a candidate's "why", for example that they believe in a certain product or morally want to work for an employer because of a social or other good company initiative.

Civic & Government

- **AI in Gov** Ask Sage is a good example of a successful AI company partnering with government and organizations to provide custom AI.
- **Industry Drivers** Another C-Suite rep in the public works sector mentioned the historic lack of investment in IT systems will likely cause a push for new hardware or software systems in the coming years as AI tech changes all industries.
- **Advancement** One interviewee described that entry-level talent in this space may be employed in a Service Desk position and jump to a position in Infrastructure (networking and servers), Business Intelligence, Oracle Division, or Database Management. Where a jobholder goes hinges on their field of interest.
    - A Service Desk worker could be promoted to a job title like Programmer Analyst or Network Engineer, but it depends on where a vacancy is within the organization.
    - Another interviewee described that IT Applications Management is an additional pathway from helpdesk and other entry-level roles. Titles include technical developers, architects, and database administrators, but all require complex training.
- **Turnover** at government IT jobs is low, but there are opportunities for students as part of internships to advance to other IT departments. Not a lot of talk about job mobility past 1 or 2 jumps from helpdesk positions. One public sector interviewee mentioned that competition is fierce internally at the same time as turnover is low, and another mentioned entry-level talent is likely to face upward barriers due to unionized talent blocks.

Finance & Insurance

- **AI** has augmented, not replaced, the hiring process for one insurance agency IT department. Some are deliberately not using AI in their new hire selection process.
- **Associate Application Engineer** is an entry-level application developer position. For this position, hiring managers would look for candidates with 1-2 years of experience with industry-relevant technology, but it depends on how much a hiring manager wants to take on new-hire training. Majesco, Guidewire, and Snowflake, IBM MQ and Mulesoft are all insurance specific software products, knowledge of which would be a foot in the door.
- **BA Requirements** Most applicants have a bachelor's degree or technical school completion. 4-year degrees are preferred, as are experienced individuals. A Fortune 500 Insurance company interviewed typically takes 4-year degree students but, anecdotally, is slowly coming around to other attainment levels.
- **Dept Size** IT Departments in this industry can be large (400+), but individual teams vary from 5 to 20 individuals. Data and Analytics teams can be eighty strong.
- **Industry Driver** One of the main drivers for IT in Finance & Insurance is cybersecurity adoption – this mainly comes from the insurance industry, who requires more advanced cybersecurity considering hackers increasing ransomware attacks.
- **Internal hiring** for open positions can be common.
- **Interviewing** A typical interview process will incorporate a standard recruiter phone screen, followed by a technical screen, then a panel interview. Technical screens can look like running a report in SQL and analyzing that data in real time. Competency-based interviews and personal motivation questions are also part of the process.
- **Job Title** Technical Support Representatives would be the most relevant position in the industry that does not require a 4-year degree.

- **Tools** Data tools PowerBI and Tableau are both used throughout the industry. While coding languages Python and R are as well, it is debatable which is preferred.

Healthcare

While Healthcare stakeholders were not engaged in a meaningful way for this project, a few IT stakeholder interviewees came from a Health IT background and whose insights may be valuable to stakeholders.

  - Healthcare IT departments are more likely to train from within and go for talent with higher levels of education, potentially due to sensitive patient information and cyber-attacks.
  - Registered apprenticeships can be hired in hospital systems in an earn and learn setting, working in positions unrelated to IT while going through the IT training itself.
- Coursework and faculty availability is a barrier in this space.
- EPIC Applications is one of the most useful technologies to be skilled in for Healthcare IT. Certification in this space may only be possible through employer sponsorship.

Figure A - 7. Upward Mobility Qualitative Example

Qualitative Example in Upward Mobility

One IT hiring interviewee described seeing entry-level help desk talent transition into project management, account management or procurement areas. Helpdesk positions could also move to TSF (Target of Evaluation Security Functions) then to cyber engineers or solutions engineer teams. Typically, openings at this level will be filled by internal candidates (they start to look externally for director or c-suite levels). Infrastructure and Solutions Engineer positions are likely the next rung up for help desk user support/other entry-levels. This occupation most closely matched Computer Systems Engineers/Architects, nested under the "Computer Occupations, All Other" occupation family, and may require certifications like Certified Power Quality Professional or Certified Information Systems Security Professional. Workers in these roles are typically in control of their own work schedule and are not assigned to go onsite or work in help desk shifts.

For those feeling stuck in a Help desk position, Field Support space may be the best second step. Field support work is related to fixing computers by hand or otherwise manually operating them when a remote fix or work performed by bots isn't feasible. These positions require understanding computers, general network issues, and cabling/wireless infrastructure fixes.

Qualitative Public Sector Example | One interviewee described how they saw a few employees advance or hit a wall: Employee #1 started in an entry-level helpdesk position and was able to get training for PC troubleshooting. This training enabled them to transition to an end-user experience group within the department at a slightly higher level.
Employee #2 was succeeding in the engineering/server space at an entry-level salary of $45-55K but did not have supervisory experience. Advancing to the next step was not possible for this individual as the union representing agency workers required supervisory experience to apply.

Figure A-8. 3-5 Community Strategies

(hover over names title names and other underlined text for source links)

(1) Smart Columbus & Digital Skills Hub – Franklin County

Description below taken from Axios Columbus Article Click links for source details.

Smart Columbus wants to give free digital skills training to 10,000 Central Ohioans by the end of 2027 through a new program announced mid-2025. The nonprofit estimates 75% of jobs will require advanced digital skills by 2030. The employment gap is widening for people without them. Around 80,000 households in the region also lack internet access, and thousands more don't have a device beyond a smartphone. To close the digital divide, Smart Columbus is launching the ConnectUs Digital Skills Hub.

- The collaboration is between 16 community partners that will train residents and give them a free large-screen device, such as a laptop or tablet, upon completion.
- Outreach will focus on those facing housing insecurity, older adults, veterans, people with disabilities, students and new Americans.

"This problem became unignorable during the pandemic," Smart Columbus executive director Jordan Davis tells Axios. "So many families weren't able to connect to online learning or telehealth or virtual work." That observation prompted a pilot in 2022 that has since helped 1,000 people with training and free devices.

The full-scale program features courses taught by leaders of the community partners, including Goodwill, Columbus Metropolitan Library, Columbus State Community College, Jewish Family Services and the New Directions Career Center. The hope is to tailor the program to the specific needs of their respective communities. For example, immigrants may have different challenges with tech than a group of older adults. Tech-savvy residents may find tasks like applying for a job or accessing an online benefits portal simple, but Davis emphasizes the difference such skills could make to others.

(2) Code Louisville

Description taken from LouisvilleKY.Gov article from 2022. Click links for source details.

Code Louisville is offered at no cost to residents 18+ in the Louisville region. Participants must complete two 12-week courses in the pathway they select in order to graduate. Code Louisville offers pathways in Web Development with JavaScript, User Experience Design (UX), Data Analysis with Python, Quality Assurance (QA) Testing, and Software Development with C#.

Code Louisville began in 2014 and was expanded in 2015 through a federal grant. Now that the original grant has expired, the program is funded through Louisville Metro Government. The program is run by KentuckianaWorks, the Louisville region's Workforce Development Board. Code Louisville offers students a unique blend of online learning, career readiness training and guidance from experienced software development professionals. Hundreds of industry mentors have now donated a total of 15,000 hours of their time to Code Louisville – including many program

graduates. More than 40% of the 91 mentors who've served in 2022 are former Code Louisville students, for example.

Code Louisville's website highlights 600+ employers who hired their graduates.

(3) Year Up Charlotte, NC (and nationwide)

Description below was taken from EdNC North Carolina Educational News source and Year Up's website. Click links for source details.

Through 4 different Career Pathways, Year Up United offers a variety of skills-based job training offerings tailored to meet the needs of today's job market and of corporate partners. Whether interested in business, customer experience, software, or IT, they provide the training needed to excel.

Year Up Charlotte launched in August 2019, four years after Raj Chetty's research ranked Charlotte dead last for social mobility among the 50 largest metro areas in the country. Erika Potts, Associate Director of Programs at Year Up Charlotte, explained the motivation for launching: "We wanted to connect those young adults who could not find full-time employment. We wanted to train them and get them access to those opportunities."

Year Up's goals are twofold: to connect talented, motivated young adults with meaningful gainful employment and to introduce them or reintroduce them into the educational setting. Potts explained that the team approaches every single student with the understanding that they already have what it takes to be successful in corporate America. "It's our role to really just connect them with those opportunities so that they can soar and be successful," she said.

Year Up Charlotte is one of 26 Year Up sites across the United States and the first one in North Carolina. Year Up began in 2000 with the purpose of providing young adults the skills, experiences, and support needed to empower them so they can reach their potential through corporate careers and higher education. Originally, they worked with adults ages 18 to 24, but since the pandemic, they have increased the age range to 26 years old.

The national board governs the organization as a whole. Locally, every campus counts on a site director who manages the day-to-day operations.

Year Up Charlotte is funded through two avenues. One is through their corporate partnerships, which cover the costs of training and education for the students to become interns. The program also receives philanthropic support.

Year Up Charlotte is a one-year program that is split into two phases. In the first six months, called Learning and Development, students take classes at Central Piedmont Community College. "That's where they're learning the core and technical skills that they're going to need to apply during the internship phase," Potts explained.

Year Up complements these college classes with soft skills courses. As Potts puts it, "We're teaching them how to show up for interviews, how to prepare resumes, how to do elevator pitches — all those soft skills you need to be successful in corporate America."

During this time, Year Up Charlotte assesses their students' personalities and identifies their strength and growth areas, which they use to match students with corporate partners. During the final six months, students begin internships with corporate partners and are able to implement what they've learned. "That's where you really get to see the young adults grow," Potts said. "In one year span, they go from being a student to being an intern in the setting."

(4) Not one strategy, but a Variety of Resources

Found throughout this analysis in other metros/states that saw growing rates of 3C jobs.

10 Texas MSAs (College Station, El Paso, Huntsville, Kerrville, Laredo, Mcallen-Edinburg-Mission, Midland, Texarkana, and Tyler) saw growth in 3C occupations, prompting a deeper look into the state's IT resources:

- Texas A&M (college station) Peer Teachers program in Department of Computer Science & Engineering
- Dallas College's WorkReadyU and free training offers for those without a bachelor's or advanced degree, resident, over 18 years old.
- Texas Internship Challenge *The Texas Internship Challenge is a partnership among the Texas Workforce Commission (TWC), Texas Education Agency (TEA) and The Higher Education Coordinating Board (THECB), who challenge employers to offer paid internships and make it easy for students to search and apply for them.*
- University of Texas at El Paso CREEDS summer program (Cybersecurity Research Experience for Educators through Data Science).
- MyTxCareer app for jobseekers

Nashville, Tennessee MSA: One resource Nashvillians have is the Greater Nashville Technology Council. The council traces their roots back to 1999.

Carbondale, Illinois MSA: Illinois Department of Innovation and Technology as a lynch pin to help facilitate interagency innovation. Illinois Science & Technology Coalition works to connect companies to classrooms, offering programming like the STEM Challenge program, Mentor Matching Engine, The 6x3, and Teacher Externships. (Program Impact: 14K students, 1.6K mentors, 98 teachers, 5K projects.) Illinois Tech (Foundation of Computer Science offered as cert): Venture Capital, Tech Partners, and Global Partners. Momentum Southern Illinois University in Carbondale: supercomputer development funded by Intel ($100M), Google ($50M), and other public sources.