GOVIRGINIA REGION 7: TALENT PIPELINE INITIATIVE REPORT

Center for Regional Economic Competitiveness
& George Mason's Center for Regional Analysis

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CREC
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GO Virginia
Virginia Initiative for Growth & Opportunity in Each Region

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Letter of Introduction

"In Northern Virginia, leading businesses have their pick of highly educated workers and tech-savvy service providers, yet many businesses, large and small, struggle to attract and retain talent. This becomes a regional issue when gaps persistently threaten the resilience of key tech clusters and the critical operations of the federal government. A systematic, sustained, collaborative approach can build support for investments to fill gaps. Support from business and public sector leaders is critical. GoVA Region 7 leaders are looking to co-invest in solutions to expand the talent pool for all."

- ***Susan Baker, Vice President, GoVirginia Region 7***

"GoVA is thrilled to unveil the findings from the TPI report, which provide actionable insights to address the growing challenges of talent acquisition and retention amid regional changes and technological disruptions like AI. It is crucial for us to stay vigilant and proactive, and I am optimistic about the strategic actions we can implement to strengthen our leadership role, not just in Virginia but across the nation."- *Lisa Roger, MTSI*

"This report highlights the critical steps needed to strengthen and make sustainable the tech talent pipeline in northern Virginia. By addressing current gaps in training and career pathway opportunities, we're not only supporting our existing workforce but also creating a highly attractive environment for businesses seeking top-tier talent. We are especially excited to have the Virginia Tech Innovation Campus in Alexandria as a cornerstone of this effort, providing world-class education and research to drive tech innovation in the region. To ensure Virginia remains the #1 State for Business, we must continue building a dynamic tech talent ecosystem that not only meets today's industry demands but solidifies our region as the global leader in tech innovation and opportunity." – *Alex Cooley, Alexandria Economic Development Partnership*

"As the owner of a staffing business in Region 7, I understand firsthand the challenges of identifying the right talent to drive growth—not only for our internal team at FlexProfessionals but also for our small business clients. This report, which uncovers some of the specific skills and expertise organizations need to thrive, offers invaluable insights. It equips us to better understand our client's staffing needs and to provide tailored solutions that help them build the teams essential for their growth and success." - *Ellen Grealish, FlexProfessionals*

"This wholistic analysis is very important for the region and addresses future challenges. The Talent Pipeline Initiative is a critical component for Northern Virginia to continue it trajectory of growth and expansion." – *George Harben, Prince William County Department of Development Services*

"The TPI report takes Region 7–and the Commonwealth—a step further down the path of not just defining the workforce challenges, but providing a critical set of regional data and measurable opportunities. We now have a blueprint through which we can build actionable, outcome driven results." – Laila Salguero, *Peraton*

Acknowledgements

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Executive Summary

This report examines the opportunities and limitations within Region 7's tech talent development pathways. More than 6,000 companies in the region are dependent on tech talent — exploring automation and AI software, maintaining data infrastructure critical to national security, and supporting logistics for the movement of goods and people nationwide — and the employment opportunities are unparalleled. The education and training available are world class as well, but persistent challenges threaten the resilience of the tech sector.

Building on regional competitive advantages, Region 7 leaders have an opportunity to improve on-ramps into IT and emerging technology sectors and broaden the talent pool by focusing on employment pathways that lead to a college degree. Large and small employers need guidance about how to improve their ability to retain and advance local talent into critical job roles. Joint public and private sector commitments are needed to de-risk investments in career pathway development initiatives for individual firms. These actions will improve access to mid-career training opportunities for critical job roles.

We examined five pathway clusters in depth and identified three that, with targeted support to large and small businesses, offer the greatest opportunity for scalability and sustainability – data infrastructure, software development, and cybersecurity. With more than 200 data centers already operational in Northern Virginia and relevant occupational specializations that do not require a bachelor’s degree, we identified the data infrastructure pathway as immediately important to filling a gap in the tech talent development system of the region.

> The Region 7 TPI Research Advisory Board, an industry and government coalition, was formed with key stakeholders to inform and advise Region 7’s TPI process.

Action to strengthen data infrastructure pathways will support a burgeoning ecosystem of data centers, semiconductor facilities, and emerging technology businesses. Multi-skilled trade programs can create on-ramps to maintain world class data storage and connectivity, providing critical infrastructure for the increasingly complex work of software developers, analysts, and tester occupations. These are 26% of computer services and 13% of emerging technology cluster employment in Region 7, a large share compared to the rest of the nation (23% and 6% nationwide). A multi-skilled trades approach has high potential to engage veterans who are 9% of the Region 7 population and fill 12% of the tech jobs examined in this report. Veterans make up 25% of electrical and electronic engineering technologists and technicians in Northern Virginia—an important occupation for the data infrastructure pathway –as well as 25% of information security analysts, another critical job role.

This report challenges our education and business leaders to consider a targeted approach to common regional challenges. There are several players in the region that will be key to sustaining momentum for this work. Collectively, these actors can move the needle in Northern Virginia to build more resilient and representative tech talent pipelines. With strategic investment and decisive action, we have a unique opportunity to empower the next generation of our workforce, turning challenges created by COVID-19 pandemic, tech layoffs, remote work shifts, and job restructuring into catalysts for growth.

Introduction

Digital technologies are transforming every sector of the nation's economy. Large data exchange and storage, networking, cloud connectivity, and new IT platforms built on artificial intelligence are propelling innovation and national economic growth.[1] New ways of collaborating and learning can also disrupt current systems, and it is critical that area businesses and education systems harness innovations to address immediate and future challenges.

These economic transformations are particularly important to Northern Virginia as a national tech and education hub. Northern Virginia played an important role in the early internet and continues to attract major technology companies and workers, including corporate headquarters.[2] It also hosts the campuses of four major public universities (three of which are R1 research institutions), the second largest community college in the country, and multiple private universities. With additional access to colleges and universities in neighboring Washington, D.C. and Maryland, the region offers an abundance of world-class educational opportunities to the region's highly skilled and well-educated workforce.

The arrival of Amazon's HQ2 and the continued growth of government contracting, data centers, and cybersecurity suggest that tech talent will continue to be in demand. In July 2024, for example, Micron announced that it will leverage Federal CHIPS Act and state incentives to build dynamic random-access memory (DRAM) chips for automobiles at a major manufacturing facility in Manassas. Investments such as this will only increase demand in the region for tech talent, including tech-savvy production workers.

Region 7's 2023 *Economic Growth and Diversification Plan Review* identified several industry clusters where Northern Virginia should focus its efforts to address talent and skill gaps, including computer services, cybersecurity, financial services, engineering services, life sciences, research and development, and emerging technologies.[3] Leaders in northern Virginia have harnessed the GO Virginia Talent Pipeline Initiative (GoVA-TPI), launched by the Governor and state legislature in 2022, to examine the workforce needs in these targeted industry clusters and identify equitable pathways for careers in digital technology within Northern Virginia.[4]

This region currently has a competitive advantage in computer services, cybersecurity, and emerging technologies, but these clusters are also losing some ground in comparison to the rest of the nation. By addressing the challenges limiting tech talent pathways, Region 7 leaders can ensure young people and career changers gain the valuable skills needed to succeed in the modern workforce and support more innovative and entrepreneurial industries.

The following sections bring together the perspectives of employers, education providers, and government entities to outline tangible career pathways and provide actionable recommendations to support the continued development of the tech sector across the region.

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[1] Henry-Nickie, M., Frimpong, K., & Hao, S. (2019). *Trends in the information technology sector*. Brookings Institution. https://www.brookings.edu/articles/trends-in-the-information-technology-sector/.

[2] Derek Thompson (2011). "'The Silicon Valley of the East' is Washington, D.C.," *The Atlantic*. *https://www.theatlantic.com/business/archive/2011/06/the-silicon-valley-of-the-east-is-washington-dc/240055/*

[3] Go Northern Virginia Region 7, "2023 Growth & Diversification Plan Review, " October 2023, https://www.gonorthernva.com/_files/ugd/ce78fa_86092f036f82447dbd8614678711181f.pdf.

[4] V.A. Legis. Session 2020-2022. Budget Amendments – HB29 Conference Report. https://budget.lis.virginia.gov/amendment/2022/2/HB29/Introduced/CR/114/1c/.

Background: Region 7's Tech Talent Context

Region 7's unique population and labor market dynamics present both opportunities and challenges for tech talent attraction, development, and retention. The region has a highly educated workforce, extensive public-private partnerships, and a high concentration of military personnel and veterans–all of which are strengths for building better education and career pathways. However, a high cost of living limits recruitment and retention of young people and young families and may limit mid-career changes.

Northern Virginia's reliance on federal employment and government contracting also creates opportunities and obstacles for employers looking to quickly hire or skill-up technology employees. The federal government provides a large and reliable source of contracting and employment opportunities. This helps the region better weather cyclical economic downturns but may limit entrepreneurship and innovation, and constrains talent development, especially from entry to mid-level. The frequent requirement of security clearances, higher education, and work experience for entry-level jobs restricts the labor pool available to meet regional demand.

> Northern Virginia's labor market has many strengths. Yet without investment and action to support tech talent and employers, Region 7 will miss opportunities for industrial diversification, technology development and deployment, and the restructuring of jobs and career pathways to address new technological challenges.

This section addresses these known challenges. The next sections of the report provide insights from original research and recommendations for action to strengthen tech talent pipelines.

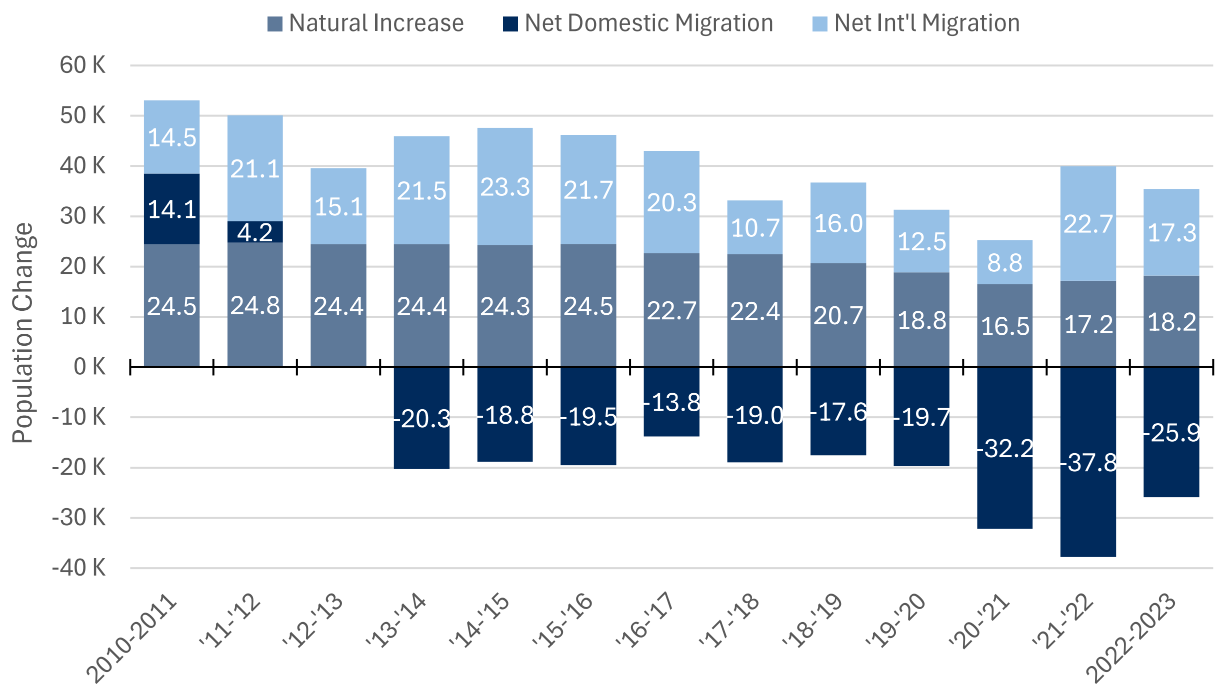
Region 7 Population Growth and Change

Region 7 encompasses nine jurisdictions (Arlington County, City of Alexandria, Fairfax County, Fairfax City County, City of Falls Church, Loudoun County, City of Manassas, City of Manassas Park, and Prince William County). In 2023, the region had a total population of 2.55 million and a median household income of $140,511.[5] Region 7's population continues to grow faster than the nation. Between 2010 and 2023, Region 7 grew by 14%, outpacing national growth by over 5 percentage points. Domestic out-migration has been consistent in Region 7 since 2013, although international in-migration and natural increases continue to contribute to high overall growth. That overall growth, however, has shrunk since 2010. During the pandemic, out-migration peaked (2021-2022) and population in the region declined (2020-2021) for the first time in 10 years (see *Figure 1*). **Overall, Northern Virginia enjoyed faster-than-average population growth for several decades, and that growth rate is expected to continue rebounding from pandemic lows, especially in the outer suburbs. Demographers project the population of Region 7 to**

[5] U.S. Census Bureau, *Population and Housing Unit Estimates* (2023), https://www.census.gov/programs-surveys/popest.html; Northern Virginia Regional Commission, *NOVA Region Dashboard* (2023), https://www.novaregiondashboard.com/median-household-income.

grow by 11% between 2020 and 2030, almost twice as fast as the rest of the state (6%) and more than twice as fast as the country (4-5%).[6]

Figure 1. Region 7 Cumulative Components of Population Change, 2010-2023 (in thousands)



Source: U.S. Census Bureau, County Population Totals and Components of Change 2010-2019, 2020-2023

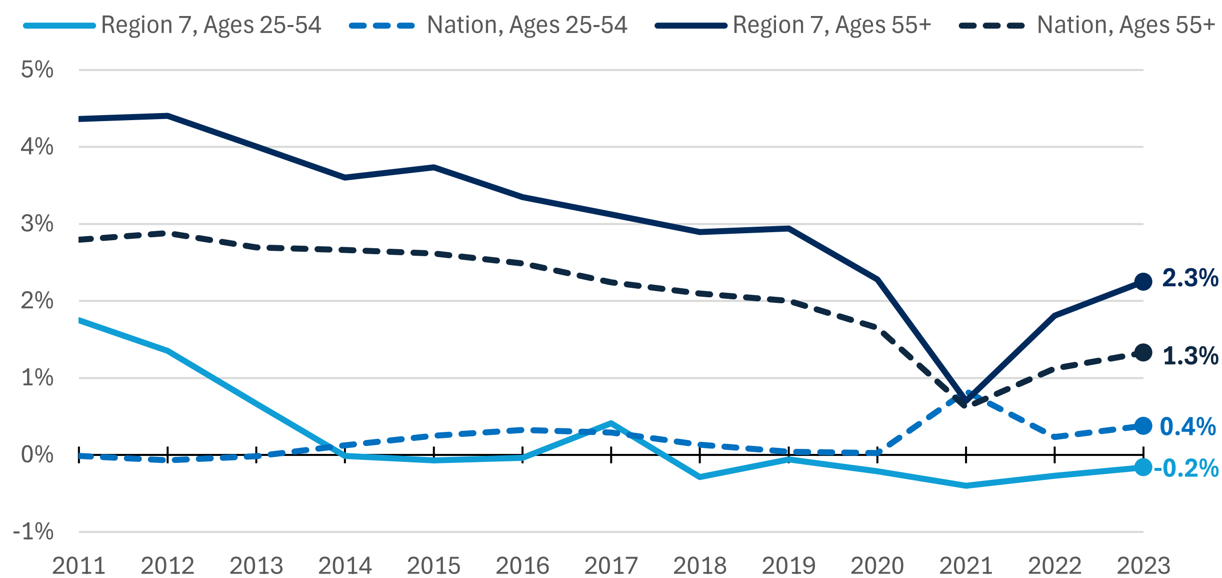
Demographic change is one of the major factors affecting the talent ecosystem in Region 7. **While the region has been growing faster than average, the population is also aging, with fewer 'prime age workers' (those aged 25-54) available to be employed in needed tech jobs (see *Figure 2*).** The fastest growing age group in the region is those aged 55 and up, while the number of residents aged 25-54 has been declining slightly in recent years. The population of those aged 15-24—older teens and college-aged adults, as well as traditional college graduates important to filling entry-level jobs—has been growing, but only slightly.

According to the most recently available migration data from the U.S. Census Bureau's American Community Survey (ACS), from 2016 to 2020, much of the migration in Region 7 was internal (i.e., movement between counties within the region). However, when individuals move out of Region 7, they are primarily moving to adjacent counties within Virginia, such as Stafford and Fauquier, or other areas of the state such as Frederick and Harrisonburg counties. One possible reason for this flow of residents from

[6] U.S. Census Bureau, *Projected Population by Single Year of Age, Sex, Race, and Hispanic Origin for the United States: 2022 to 2100* (November 2023), https://www.census.gov/data/datasets/2023/demo/popproj/2023-popproj.html; University of Virginia Weldon Cooper Center for Public Service, *Virginia Population Projections* (July 2022), https://www.coopercenter.org/virginia-population-projections; Metropolitan Washington Council of Governments, *Round 10.0 Cooperative Forecasting Summary Tables (July 14, 2023*), https://www.mwcog.org/documents/2023/11/03/cooperative-forecasts-employment-population-and-household-forecasts-by-transportation-analysis-zone-cooperative-forecast-demographics-housing-population/.

Region 7 to outlying counties within the Washington, D.C. metropolitan area and other parts of the state is the lower cost of living. According to the most recent annual Cost of Living Index data published by the Council for Community and Economic Research (C2ER), Arlington County's cost of living is 37% higher than the national average, while Stafford and Fauquier are just 5-10% higher, and other Virginia counties are slightly above or below average.[7]

Figure 2. Year-over-Year % Change in Population by Age Group



Source: U.S. Census Bureau, County Population Totals and Components of Change 2010-2019, 2020-2023.

As noted in *Figure 1*, international migration has helped sustain overall population growth in the region despite a decrease in domestic migration. In 2019, immigrants represented 22.8% of the STEM workforce in the state of Virginia.[8] In Northern Virgina, about 20% of foreign-born immigrants worked in traditional "blue-collar" occupations, while 18% worked in management, business, and financial occupations, 12% in computer, engineering, and science occupations, and 9% in education, arts, and media occupations.[9] **Additionally, a large majority of the foreign-born population in Northern Virginia speaks English and approximately 45% hold a bachelor's degree or above.[10]** While obtaining security clearances remains an issue for this population, these dynamics indicate that international migrants represent a substantial talent pool for key technology occupations in Region 7.

[7] Council for Community and Economic Research (C2ER), "Cost of Living by County," Cost of Living Index, May 2024, https://www.coli.org/. Accessed 15 August 2024.

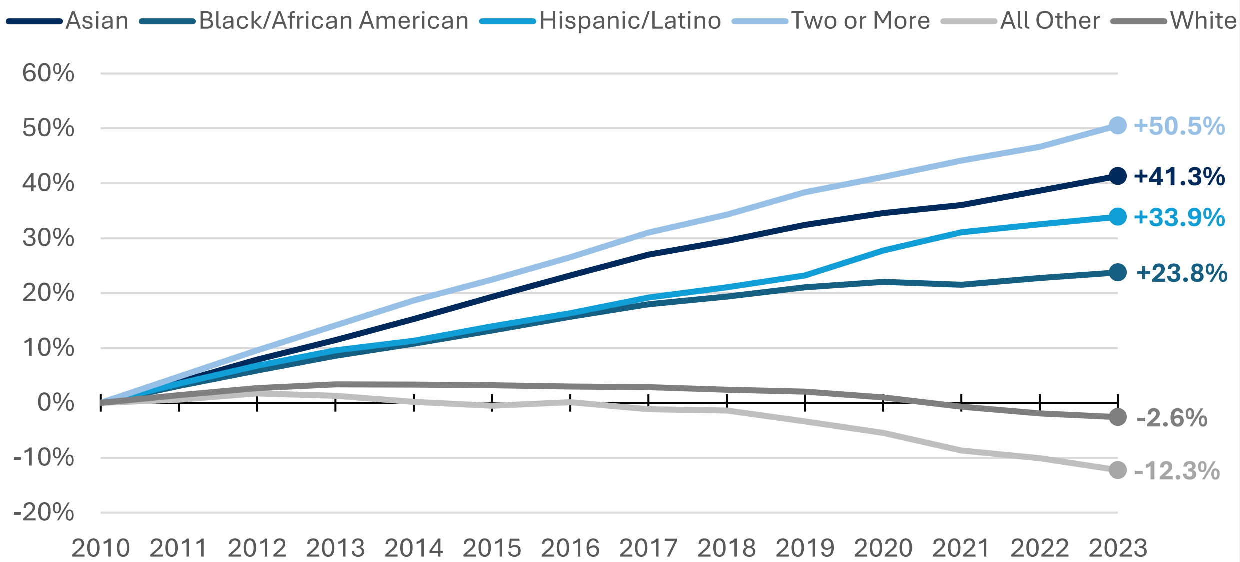
[8] VCU School of Government and Public Affairs, "Barriers to Integration of Virginia's Immigrants: Challenges and Opportunities Identified through a Needs Assessment," July 2022, https://www.dss.virginia.gov/files/division/cvs/ona/immigrant_services/2022-vcu_ona-study/ONA-Barriers_to_Integration_final_report_Sept_2022.pdf/

[9] The Commonwealth Institute, "Pillars of the Northern Virgina Community: A Profile of Our Immigrant Neighbors," July 2020, https://www.thecommonwealthinstitute.org/wp-content/uploads/2020/09/Pillars-of-the-Northern-Virginia-Community-A-Profile-of-Our-Immigrant-Neighbors.pdf.

[10] New American Economy, "One Region: Welcoming New Americans to Northern Virginia," March 2020, https://research.newamericaneconomy.org/wp-content/uploads/sites/2/2020/03/NAE_NorthernVA_V6.pdf.

In large part, Region 7's racial and ethnic makeup is like the rest of the country, with similar shares of the population identified as Black/African American and Hispanic/Latino. By contrast, 17% of the region's population is identified as Asian, compared to 6% nationally, while 48% of the region's population is identified as White compared to 58% nationally (see *Figure 3*). This is after over a decade of the region's Asian population growing more rapidly than any other group except those who identify in more than one race/ethnicity group (a trend that is also occurring nationally). **At the same time, the region's White population has been declining, even more rapidly than nationwide, since 2014. In recent years (since 2019) the region's Hispanic/Latino population has also experienced an uptick in growth.**

Figure 3. Percentage Change in Region 7 Population from 2010 by Race/Ethnicity



Source: U.S. Census Bureau, County Population Totals and Components of Change 2010-2019, 2020-2023.

Finally, Region 7 also has a higher-than-average population of veterans. **While veterans comprise 7% of the US civilian population over 18 years old, veterans account for 9% of the same population in Region 7, a higher share than around three-quarters of other metropolitan areas and higher than in any other peer technology industry-heavy metropolitan area (see *Table 1* below for a list of these regions).** Veteran shares of the population in Seattle and Denver are similar to the nation (7% apiece), while other tech hubs like Boston and San Francisco have much smaller veteran populations (4% of total).

Region 7 Industrial Employment

As of 2023, total employment in Region 7 was 1.28 million, or around a third (32%) of statewide employment, and 40% of all employment in the Washington, D.C. metropolitan region. Between 2010 and 2023, regional employment grew by 14%. While this was faster than the Washington, D.C. metro area (11%), it was about the same rate as the rest of the state (14.5%) but lower than national employment growth over the same period (20%). **According to the most recent employment projections available from Virginia Works, employment in Region 7 is projected to grow 14% between 2020 and 2030, faster than national projections of 8% employment growth over the same period.**

Top private employers in the region include large businesses such as Amazon, the Aerospace Corporation, CACI International, and Capital One; medium-sized businesses such as Deloitte, Accenture, Northstrat Incorporated, Cortex; and smaller businesses such as Chenega Corporation, Tenica and Associates, Mymic.[11] Many of these employers are government contractors in the defense and professional services sectors.

The fastest growing sub-sector within the professional and technical services sector is Computer Design Services, which is projected to grow by 20% in Region 7 between 2020 and 2030, much faster than regional employment on average. The regional data processing, hosting, and related services sub-sector is projected to grow even more significantly (35%).

Comparing employment in these industry clusters between Region 7 and other tech-heavy metropolitan areas nationally helps to reinforce the unique qualities of the region's technology workforce. Eight metropolitan statistical areas (MSAs), including the larger Washington, D.C. metropolitan area, were identified as peer technology hubs based on the size and concentration of technology employment. *Table 1* compares employment metrics by MSA across the two industry-based technology clusters targeted as priorities in Region 7's *Growth and Diversification Plan*, computer services and emerging technologies (see the Methodology section for definitions of each).

*Table 1. Priority Cluster Employment in Comparison MSAs (2023)**

Metropolitan Area	Total Employment	Location Quotient [12]	Avg. Employment per Establishment
Washington, D.C.	239,199	3.0	11.5
Northern Virginia (Region 7)	144,653	4.5	14.5
D.C.-Suburban Maryland	83,917	2.1	9.1
New York City	236,867	1.0	12.8
San Francisco	209,570	3.4	22.9
Boston	174,454	2.6	17.3
Dallas-Fort Worth	142,404	1.4	12.2
San Jose (Silicon Valley)	119,351	4.2	24.9
Seattle	100,660	1.9	10.5
Denver	72,367	1.8	6.0

Sources: U.S. Bureau of Labor Statists, Quarterly Census of Employment and Wages (QCEW), https://www.bls.gov/cew/. Virginia Works Economic Information & Analytics Division, Quarterly Census of Employment and Wages (QCEW), https://virginiaworks.com/.

**Comparable tech hubs (metropolitan areas) were selected by total employment and location quotient (employment concentration) for priority clusters and are listed here in descending order by total employment. Region 7 and D.C.-*

[11] Data Axle, *U.S. and Canadian Verified Business Database*, retrieved 1 August 2024, https://www.referenceusagov.com/.

[12] LQ is defined as an occupation's share of regional employment divided by the occupation's share of national employment. An LQ of 1 indicates that an occupation makes up the same proportion of total regional employment as it does nationally, while an LQ higher than around 1.2 means that the occupation makes up a greater share of the regional labor market than it does at a national level (and vice-versa for an LQ below 0.8).

Suburban Maryland sub-region employment will not sum to the total for the Washington D.C. MSA due to exclusion of outlying MSA/non-Region 7 counties in Virginia (Rappahannock, Stafford, etc.), as well as Jefferson County, WV.

While total employment in the selected technology clusters is lower in Region 7 than in other metros, it makes up a much more significant share of the labor force in Region 7, where tech employment is 4.5 times more concentrated (11% of total Region 7 employment) than the national average (2.5% of total US employment). The size of technology establishments in Region 7 is close to the national average size of 13, smaller than establishments in Silicon Valley and San Francisco (23-25 employees on average) and larger than those in Denver (6 employees on average).

Indeed, Region 7 has a higher concentration of mid-sized technology businesses, (those that have 50-250 employees) compared to other tech-heavy metro areas (those listed in *Table 1*). This is especially true in the computer systems design industry group where 8% of establishments in Region 7 are mid-sized, twice the share as at the national level and in other tech-heavy metropolitan areas (around 4% in both cases). While emerging technologies[13] establishments tend to be larger overall, Region 7 has a higher-than-average concentration of medium and large business establishments in this industry area as well (18% compared to 12% nationally, and 14% across tech-heavy metros).[14]

In the emerging technologies cluster, Region 7 also has a higher concentration of businesses focused on electronic research and development, technology assistance programs, and artificial intelligence research and development (including companies focused on cyber and physical security AI) than the rest of the Washington D.C. metropolitan area and the country. Other areas of emerging technology specialization in the region include physical engineering and life sciences/environmental research and development.[15]

The significant increase in remote and hybrid positions following the COVID-19 pandemic, especially in the technology sector, will likely impact employment at these businesses well into the future. The demand for remote jobs, however, has slowly declined since the beginning of 2023. **Employers in the area, including the federal and state government and contractors, are now making the move back to the office either part- or full-time.[16]** This brings cost of living back to the forefront as a talent attraction issue, particularly for federal agencies that are finding it challenging to attract skilled workers to the region at

[13] Defined as business establishments categorized under the NAICS codes 541713, 541714, and 541715, which are those involved in research and development in the physical, engineering, and life sciences, including nano- and biotechnology. See Table 3 below.

[14] U.S. Census Bureau, *County Business Patterns: 2022*, June 2024, https://www.census.gov/data/datasets/2022/econ/cbp/2022-cbp.html.

[15] Data Axle, *U.S. and Canadian Verified Business Database*, retrieved 15 July 2024, https://www.referenceusagov.com/.

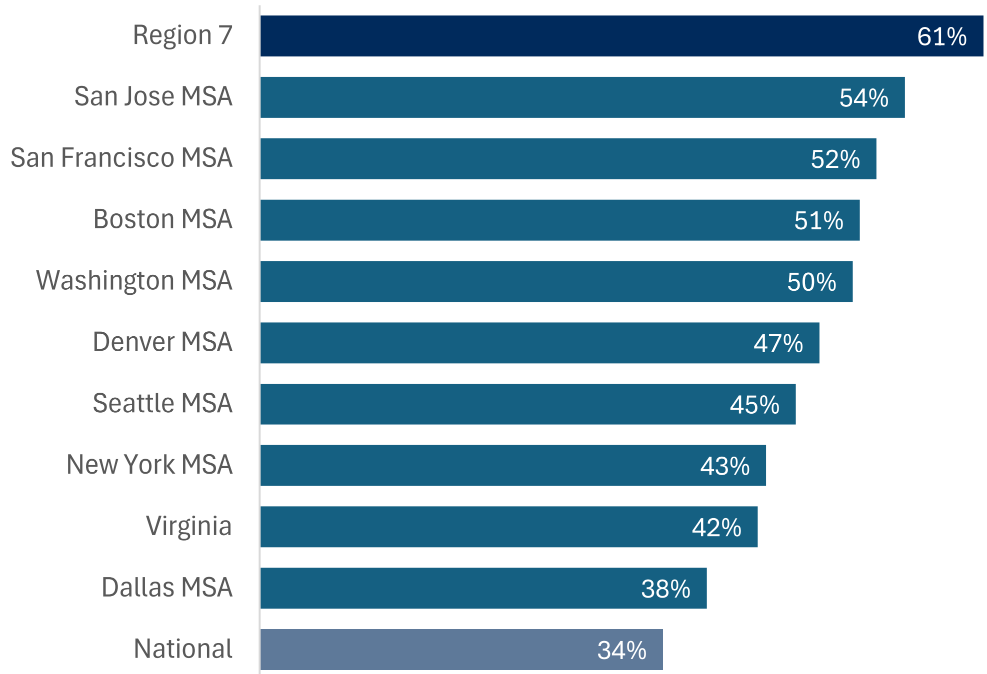
[16] Governor of Virginia, "Governor Glenn Youngkin Announces New Telework Policy Focused on Innovation and Teamwork", Office of the Governor, May 2022, https://www.governor.virginia.gov/newsroom/news-releases/2022/may/name-932062-en.html; Axios Richmond, "Capital One wants workers back in the office," April 2023, https://www.axios.com/local/richmond/2023/04/04/capital-one-in-person-workers-hybrid; Federal News Network, "A running list of agencies' return-to-office plans," December 2023, https://federalnewsnetwork.com/workforce/2023/12/heres-what-we-know-so-far-about-agencies-return-to-office-plans/.

their scheduled salary rates.[17] That said, the percentage of regional job postings that are remote or hybrid remained at about 9% of total jobs in the first half of 2024, significantly higher than pre-pandemic.

Region 7 Educational Attainment

Region 7 is one of the most well-educated regions in the nation, with 61.1% of the population holding at least a bachelor's degree or higher. Region 7's bachelor's attainment is almost 20 percentage points higher than the rest of the state, and 7 points higher than the next closest MSA (see *Figure 4*).

Figure 4. Share of Population Aged 25+ with a Bachelor's Degree or Higher



Source: U.S. Census Bureau, American Community Survey 5-year Estimates, 2018-2022.

According to the Virginia Department of Education, in 2022-2023, 60.4% of Region 7 public high school completers attended four-year colleges, and 21.2% attended two-year colleges. Another 4.5% continued with other education plans, 7.6% went directly into employment, 1.5% joined military services, and the remaining 4.8% had no plan after high school graduation.[18] This is a high rate of college-going compared to the rest of the state. However, these college-going rates can vary significantly by school, ranging from 26% to 99%. County-level differences in high school graduation and college-going across Region 7 will be important to consider when crafting targeted solutions for broader economic opportunity.

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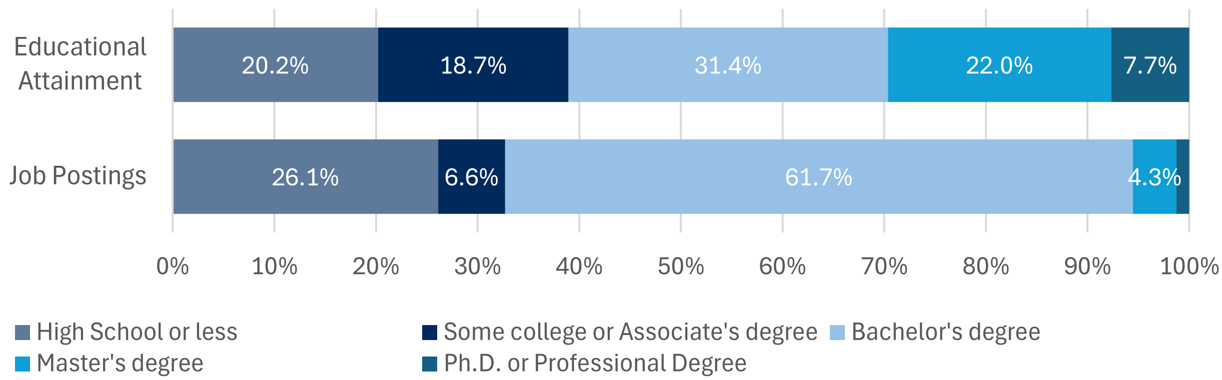
[17] Deloitte, "Government can win the talent race – Here's how," May 2022, https://www2.deloitte.com/us/en/insights/industry/public-sector/talent-war-government.html.

[18] Virginia Department of Education, "Annual Reports of Graduates & Completers 2022-2023," https://www.doe.virginia.gov/data-policy-funding/data-reports/statistics-reports/graduation-completion-dropout-postsecondary-data/high-school-graduates-completers/high-school-graduates-completers-archive-data.

Even with the high regional attainment of bachelor's degrees in Region 7, the percentage of job postings requesting a bachelor's in the region is even higher (see *Figure 5*). This dynamic is similar in other tech hubs, indicating a common issue that bachelor's degrees may be utilized as a filter to weed out candidates even when the credential is not strictly needed. The issue is most prominent in Region 7 and the broader Washington, D.C. MSA, however. **The difference in the share of regional job postings requiring a bachelor's compared to the share of workers with bachelor's degrees is 30 percentage points in Region 7, a full 4 to 15 percentage points higher than other prominent tech metros.** One likely reason for disproportionate bachelor's degree requirements in Region 7 is that federal contracts often mandate bachelor's degrees for many billable activities, potentially inflating educational requirements beyond what would typically be seen elsewhere.

Figure 5. Share of Region 7 Population Aged 25+ by Level of Education versus Share of All Region 7 Job Postings by Minimum Education Required



Sources: U.S. Census Bureau, American Community Survey 5-year Estimates, 2018-2022; Lightcast.

Region 7 Education and Training Providers

There are a significant number of education and training providers in Region 7 offering bachelor's and associate's degrees. In total, there are 30 training providers in Region 7 offering programs related to the three targeted industry clusters, 9 of which are postsecondary institutions. **A comparison of degree completions across selected tech hubs illustrates that the Washington D.C. MSA is #1 in computer and information sciences as a percentage of total completions and #6 in mathematics and statistics.[19]**

Region 7 also has many existing resources for workforce development. The area contains two workforce development boards, the Virigina Career Works, Alexandria Arlington Region and the Northern Virginia Region, each with their own talent initiatives such as TalentUP Fairfax, which connects jobseekers with employer-sponsored, paid work-based learning (WBL) opportunities. These WBL programs provide critical education and training to residents in Region 7. **Apprenticeships are one form of a WBL model; as of 2022 there were 324 unique, federally registered apprenticeship programs in Region 7 with nearly 2,000 participants, but only 13 of these were related to technology occupations.[20]**

[19] Integrated Postsecondary Education Data System, *2021-2022 Completions*, retrieved 30 April 2024, https://nces.ed.gov/ipeds/.

[20] Registered Apprenticeship Partners Information Database System, FY 2022, https://www.apprenticeship.gov/data-and-statistics/apprentices-by-state-dashboard.

There are also many opportunities for tech talent development available in Region 7's K-12 space. Many middle and high schools in the area have career and technical education (CTE) courses available that can prep students for careers in a variety of tech fields. For example, Fairfax County Public Schools' relevant program areas include Business and Information Technology, Technology Education and Engineering, and Trade and Industrial Education. Within those program areas students can take a range of courses such as cloud computing, cybersecurity basics, and engineering systems. Several middle schools in Region 7 also offer related programming, ranging from data literacy to introduction to technology and engineering. Many of these courses are also aligned with both student and industry needs as well in addition to offering WBL opportunities. In this space, WBL ranges from guest speakers and career fairs to internships and youth registered apprenticeships.

Region 7 high schools also offer a range of specialized STEM opportunities. Examples include Alexandria City Public Schools' STEM Academy which provides a smaller collaborative environment for students and teachers to go deeper into STEM topics, and the Governor's Career and Technical Academy at the Arlington Career Center which is a program that integrates STEM CTE and academic classes to make better connections with real-world employment. Dual enrollment also allows high school students to earn credit towards their high school diploma while earning college credit, thus giving them a head start with a two- or four-year degree. Northern Virginia Community College is a key partner here and offers many dual enrollment opportunities in Region 7.

There are also several external talent readiness programs that target different populations in Region 7 to build up talent pipelines in tech industries. For example, Genesys Works is working to provide pathways to career success in tech-related fields for high school students in underserved communities through employer-sponsored WBL initiatives. This innovative program partners with school districts and employers across the Capital region to help fill entry-level business technology positions, while supporting students with the foundational skills needed to excel in their field. Students at Genesys Works undergo 8 weeks of intensive training in both professional and technical skills and receive consistent support from experienced mentors in their field. *Table 2* below provides examples of this and other programs in Region 7 that provide opportunities for WBL in this space.

Table 2. Talent Development Programs in Region 7 (non-exhaustive)

Program	Provider	Targeted Industry	Targeted Population	Length	Service Provided
Talent Ready Program	Greater Washington Partnership	IT	High school	4 years	Training, work-based learning opportunities
TalentUP	Fairfax County	High-demand industries (e.g., IT, Healthcare, Finance, Sales)	Fairfax County residents who are 18 years or older	N/A	Paid internship, career guidance, job placement assistance, entry to mid-level career opportunities in high demand fields
Genysys Works Internship Program	Genysys Works	IT, Businesses Operations	High school senior students in	8-week training,	Training, internship

Program	Provider	Targeted Industry	Targeted Population	Length	Service Provided
			underserved communities	12-month internship	
Opportunity Scholars	Opportunity Scholars	Healthcare, Education, Accounting, IT, Building Trades and Construction	Low- and middle-income young adults	N/A	Career readiness training, financial support, program coach/liaison
Arlington Talent Program	Exeleration	Tech	Early career developers who live in Arlington or Alexandria, VA	12 weeks	Paid, full-time software developer role for 12 weeks
DoD Skillbridge	Department of Defense	All career fields	Service members during the last 180 days of service	Up to 180 days	Specific industry training, apprenticeships, or internship
NS2 Serves Program	SAP National Security Services	High-tech, in-demand careers	Veterans	8-12 week	Intensive training and employment assistance
Aim High	NVTC	In-demand jobs	High school students	Varies by employers	Internship opportunity
Cybersecurity Traineeship Program	Commonwealth Cyber Initiative	Cybersecurity	U.S. citizens in Virginia	7 weeks	Full-time traineeship program

Tech Talent Pathway Assessment Methodology

In anticipation of further investment by GoVirginia Region 7 leaders, CREC and GMU conducted a comprehensive analysis of three targeted technology industry clusters to better understand the challenges and opportunities facing tech talent pipelines in the region. This report focuses on three industry clusters identified as priorities in Region 7's 2023 *Economic Growth and Diversification Plan Review*: computer services, emerging technologies, and cybersecurity. These clusters were selected for attention due to their diminishing competitive advantage (cluster growth in Region 7, although substantial, is slower than in other regions) or because they provide significant new opportunities for high value-added growth. We define these clusters using standardized NAICS and SOC codes to identify the universe of businesses and relevant training programs (*Table 3*).

Table 3. Priority Technology Industry Clusters for Region 7

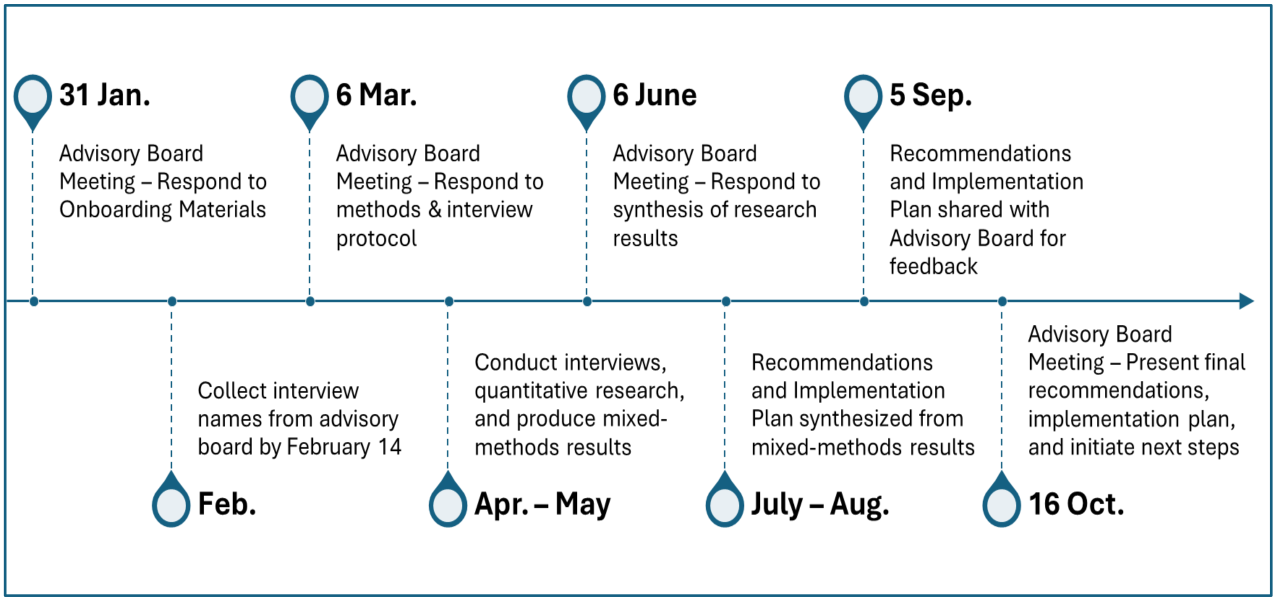
Computer Services (Industry-based)	Emerging Technologies (Industry-based)	Cybersecurity (Occupation-based)
Data Processing, Hosting, & Related Services (*NAICS 518210*)	Research & Development (R&D) in Nanotechnology (*NAICS 541713*)	Computer Systems Analysts (*SOC 15-1211*)
Custom Computer Programming Services (*NAICS 541511*)	R&D in Biotechnology (*NAICS 541714*)	Information Security Analysts (*SOC 15-1212*)
Computer Systems Design Services (*NAICS 541512*)	R&D in Physical, Engineering, and Life Sciences (*NAICS 541715*)	Computer Network Architects (*SOC 15-1241*)
Computer Facilities Management Services (*NAICS 541513*)		Network & Computer Systems Administrators (*SOC 15-1244*)
Other Computer Related Services (*NAICS 541519*)		Database Administrators /Architects (*SOC 15-1242/15-1243*)

The research for this report was conducted in several stages to better articulate viable career pathways and training opportunities in the region. CREC and GMU established four research questions in the initial stages of the project to guide the research and analysis. Those questions were:

- What are priority jobs, career pathways, and recognized labor supply-demand gaps?
- Which industry-related training, recruitment, hiring, and retention programs are the largest in the region and which are the most impactful?
- What changes are needed for employers to recruit and retain critical talent? Which pathways should be expanded/fortified or refined and how?
- How will the region measure progress and evaluate investments to ensure ROI for businesses and economic mobility for residents?

This report utilized a mixed methods approach to analyze viable pathways. An industry and government coalition, known as the Region 7 TPI Research Advisory Board, was formed with key stakeholders to inform and advise Region 7's TPI process. Due to GoVirginia's TPI requirements, the Research Advisory Board was comprised of a broad array of stakeholders that represented various sectors across the technology landscape in Region 7 (see the Acknowledgements section for a list of individuals). The Research Advisory Board met five times throughout the course of the project to guide the research process from initial exploratory phases to reviewing draft material. *Figure 6* below shows the timeline of advisory board engagement.

Figure 6. Region 7 TPI Research Advisory Board Project Milestones



The CREC-GMU research team reviewed a range of public and proprietary sources of quantitative data and conducted a comprehensive qualitative analysis. Interviews and focus groups engaged employers, education and training providers, and government entities to validate and provide context for the numbers. **CREC and GMU conducted 35 individual interviews and 2 focus groups, speaking with 55 individuals across 45 different organizations in the region**. Employers were classified into small (10-50 employees), medium (50-250 employees), and large (250+ employees) groups for analysis. Research Advisory Board members were instrumental in helping identify interview contacts and convening focus groups to aid in the qualitative research process. Please refer to Appendix A for a detailed description of data sources and interview participant categories. Appendix B offers details on how the team utilized previous research to inform interview conversations, as well as dive deeper into the dynamics of specific talent pipelines in the analysis below.

Selecting Key Jobs for Pathway Analysis

Region 7 faces a unique set of opportunities and challenges when it comes to building and enhancing technology talent in priority industry clusters. The region's unique mix of government contractors, defense, cybersecurity, and data/internet infrastructure sets it apart from other tech hubs like Silicon Valley/San Francisco and the Bay Area, Seattle, or New York. While the region is home to many high-quality institutions of higher education, both in Northern Virginia and nearby, the high cost of living can make it difficult for students and residents to stay in the area and for employers to retain entry-level and experienced workers. Additionally, artificial intelligence (AI) tools threaten to weaken demand for the few accessible jobs that are advertised in the region, even as they may expand or enhance job opportunities in other technology areas and businesses. Without action, AI solutions could further weaken access and talent development opportunities.

> Northern Virginia's strategic advantage comes with constraints as jobs here are more likely to require a bachelor's degree and security clearance than nationwide, prohibiting entry for those without college degrees.

To more effectively develop technology talent that meet the needs of both employers and workers alike, as well as answer the research questions posed in this report, it is essential to develop a detailed understanding of the labor market dynamics impacting Region 7's unique tech talent pool. To inform the career pathway development options described in the next section of the report, this section describes overall technology occupation trends in the region, connecting these to demographic, employment, and programmatic issues.

Occupational Demand

To understand which tech talent career pathways are viable in Region 7, we examined the technology occupations, as well as non-technology occupations, that make up the largest shares of employment across our priority industry clusters.

Data from the state's labor market information office, Virginia Works, indicates that software developers – the largest occupation in the region, employing over 50,000 jobs – make up the largest share of employment in both the computer services and emerging technologies clusters. The occupation makes up a larger share of regional employment in priority industry clusters than it does nationwide, indicating its particularly strong relevance for Region 7. **Stakeholders, especially medium and small businesses, also identified software developers as a key occupation.** Networking/systems administrators and information security analysts also make up larger shares of employment in Region 7's priority technology clusters than nationally (see

> Software developers, analysts, and tester occupations make up a significant share of both the computer services (26%) and emerging technology (13%) clusters compared to the rest of the nation (23% and 6%, respectively).

Table 4), while computer research scientists make up a larger regional share of employment in the emerging technologies cluster than nationally (*Table C3*). These patterns reinforce Region 7's unique strength in networking/systems, cybersecurity, and high-skilled computer/electronics research.

Table 4. Top 10 Occupations Across Priority Industry Clusters by Regional Share of Employment

Occupation	Share of Cluster Employment, Region 7	Share of Cluster Employment, National
Software Developers and Software Quality Assurance Analysts and Testers	24.6%	22.8%
Computer Systems Analysts	5.2%	5.0%
Information Security Analysts	4.4%	1.6%
Network and Computer Systems Administrators	4.2%	2.3%
Management Analysts	3.9%	2.3%
Computer User Support Specialists	3.6%	6.2%
General and Operations Managers	3.1%	3.6%
Computer and Information Systems Managers	3.1%	4.8%
Sales Representatives of Services, Except Advertising, Insurance, Financial Services, and Travel	2.7%	4.7%
Project Management Specialists and Business Operations Specialists, All Other	2.6%	3.8%

Source: Virginia Works Economic Information & Analytics Division, Long Term Workforce Area Projections, https://virginiaworks.com/.

Staffing patterns – or the occupational makeup of an industry - also reveal several important operational roles that may not be traditionally thought of strictly as technology occupations, but that are still critical to business in technology sectors like computer services. These include management analysts, sales representatives, and project managers. **Project managers were also identified across stakeholder groups as in demand in the region, with a strong need for individuals who can translate technical language and concepts for a broader set of stakeholders within an organization (e.g., sales, executive management, etc.).**

Finally, there are other technology occupations that are important to consider when looking at relevant pathways, but that may not make up significant shares of combined industry employment due to their relatively small size, or the unique specialization of the occupations. **Examples include computer hardware engineers, which still make up the second largest share of employment within the data processing and web hosting industry at approximately 5%** (a critical component of the computer services cluster due to the continued growth of data centers in the region). **From this analysis, we selected a list of *key, target occupations* to further evaluate as potential targets for our pathway and demand/requirements gap analyses (see *Table 1* in Appendix C).**

Talent pathways of value, however, should focus specifically on those occupations that are most in-demand by employers, which requires considering a few other regional factors, specifically projected growth, employment concentration (or LQ), and volume of current/future job openings. ***Table 5* illustrates that information security analysts have the highest projected growth rate across priority industry clusters, followed by statisticians and operations research analysts.** Data scientists also have a high projected growth rate and were mentioned frequently in our interviews as some of the most in-demand jobs. Growth rates can be misleading when the actual employment is low, however, as is the case with statisticians, which employed 520 jobs in Region 7 in 2022. Thus, we also need to consider overall employment as factor when looking at growth rates in determining the most in-demand occupations.

Table 5. Top 10 Occupations Across Priority Industry Clusters in Region 7 by Projected Growth Rate

Occupation	Projected Growth Rate (2020-2030)	Employment (2022)
Information Security Analysts	38.6%	12,160
Statisticians	38.0%	520
Operations Research Analysts	28.7%	4,460
Market Research Analysts and Marketing Specialists	23.8%	9,860
Software Quality Assurance Analysts and Testers	23.5%	4,890
Software Developers	23.5%	50,500
Data Scientists	20.2%	2,670
Computer Occupations, All Other	20.2%	7,290
Management Analysts	17.7%	41,140
Computer User Support Specialists	15.5%	9,430

Source: Virginia Works Economic Information & Analytics Division, Occupational Employment and Wage Statistics (OEWS), Long Term Workforce Area Projections, https://virginiaworks.com/.

Employment concentration is another way to look at in-demand or “top” occupations. Occupations that are more “concentrated” in the region (i.e., those with a high “location quotient”) indicate regional specialization and competitive advantage. An LQ of 1.0 indicates that the occupation makes up the same share of jobs in a region as its share of jobs nationally; a higher LQ indicates that an occupation makes up a larger share of jobs in a region than nationally. **As shown in *Table 6*, information security analysts rank near the top of target occupations, with an LQ of 8.97, indicating employment in this occupation is almost nine times more concentrated in Region 7 as at the national level.** We also see overlap with high-growth occupations from the previous table, including management analysts, operations research analysts, and software developers.

Table 6. Top 10 Occupations Across Priority Industry Clusters in Region 7 by Location Quotient (Employment Concentration)

Occupation	Location Quotient (2022)
Database Architects	9.44
Information Security Analysts	8.97
Management Analysts	6.14
Operations Research Analysts	5.13
Database Administrators	4.79
Physical scientists, all other	4.57
Computer and Information Research Scientists	4.22
Computer Network Architects	4.05
Software Developers	3.97
Web Developers	3.84

Source: Virginia Works Economic Information & Analytics Division, Occupational Employment and Wage Statistics (OEWS), https://virginiaworks.com/.

The third primary factor we considered when determining which technology cluster target occupations are most in-demand is the projected number of average annual job openings, which includes openings resulting both from new job growth and from separations or exits (i.e., individuals moving to jobs in other occupations, or exiting the labor force). Despite information security analysts being near the top of the previous two tables, when looking at average annual job openings it is ranked eighth, though it is still projected to have a respectable 1,481 annual openings (see *Table 7*). Meanwhile, software developers (combined with software quality assurance analysts and testers) are projected to have the highest average annual openings at 7,299, followed by management analysts at 4,223.

Software developers and information security analysts are top in-demand occupations in the region. Trend analysis and interview feedback across stakeholder groups support this finding.

Table 7. Top 10 Occupations Across Priority Industry Clusters in Region 7 by Avg. Annual Job Openings

Occupation	Average Annual Job Openings
Software Developers, Quality Assurance Analysts and Testers	7,299
Management Analysts	4,223
Customer Service Representatives	2,902
General and Operations Managers	2,594
Sales Representatives of Services, Except Advertising, Insurance, Financial Services, and Travel	2,473
Project Management Specialists and Business Operations Specialists, All Other	2,229
Market Research Analysts and Marketing Specialists	1,571
Information Security Analysts	1,481
Computer Systems Analysts	1,172
Data Scientists	1,000

Source: Virginia Works Economic Information & Analytics Division, Occupational Employment and Wage Statistics (OEWS), https://virginiaworks.com/.

There are also a handful of technology occupations that are projected to continue declining in demand. This includes computer programmers and data entry roles, for which employment in Region 7 is projected to decline by 15% and 10%, respectively, over the next ten years. This overall decline reflects national trends and may be due to several factors, including increased automation of programming as well as other occupations (e.g., software developers) absorbing more overlapping tasks. **The degree to which currently in-demand technology occupations may be impacted by AI is still unknown, however, and there is still a lot to learn regarding its industry- and occupation-specific applications. Some employers are expecting job decline due to AI, and others are expecting job growth.**[21] Overall, this analysis helped identify which of the target occupations in *Table C1* should be further explored through the detailed pathway analysis in the following Career Pathways section of the report. **Region 7 is projected to add over 48,000 new jobs in these selected target occupations by 2032, indicating substantial opportunities for additional tech talent development efforts.**

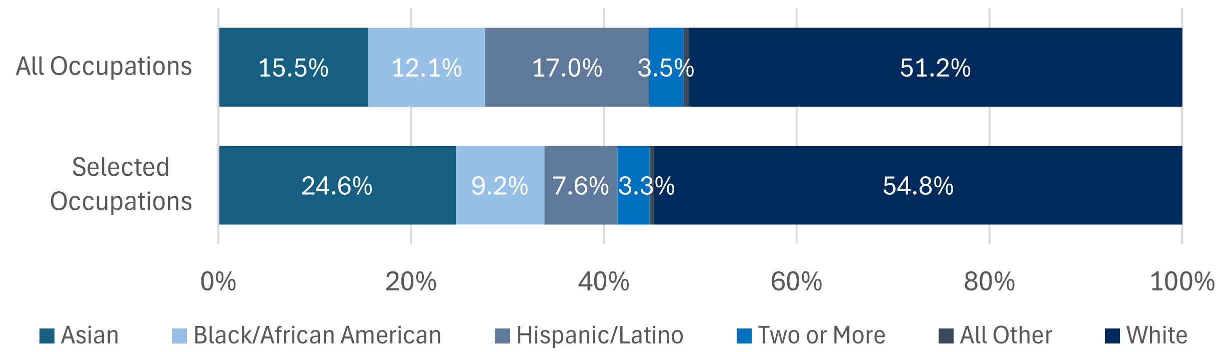
Demographics

Regardless of occupation, a major challenge in developing talent pipelines concerns diversity, equity, and inclusion across the region's technology workforce, particularly given the demographic trends highlighted above. Some populations are persistently underrepresented in these jobs and may need better access to opportunities that foster skills development and lifelong career mobility via these occupations. **Specifically, African American, Hispanic/Latino workers are underrepresented in the technology industry occupations selected for analysis, especially when compared with the region's overall workforce: these groups make up 29% of workers across all occupations but just 17% of employment in**

[21] NC Department of Commerce, "Insights on Generative AI and the Future of Work," February 29, 2024, https://www.commerce.nc.gov/news/the-lead-feed/generative-ai-and-future-work.

technology occupations (*Figure 6*). This imbalance carries over to gender as well. **While women make up half of the Region 7 workforce, they make up only 33% of selected technology occupations, only three of which are majority female (software quality assurance analysts and testers, market research analysts, and technical writers).**

Figure 7. Share of Region 7 Workers by Race/Ethnicity



Source: U.S. Census Bureau, American Community Survey 5-year Estimates Public Use Microdata, 2017-2021.

Diversity in this field will continue to be an issue, especially as women entering the data, analytics, and AI field are at a national 16-year low relative to men.[22] This lack of diversity may be further compounded by traditional recruitment practices among regional employers (such as word of mouth, online job boards, and internal hiring) that are more likely to reinforce existing disparities and provide fewer opportunities to non-traditional job candidates.[23]

The age distribution for technical occupations is concentrated in the 25-54 age range—with slightly younger workers in web development, computer and information research scientists. Looking at the working population of Region 7, 15% are between 15 and 24, 55% are between 25 and 54, and 30% are 55 and older. Ninety percent of web and digital interface designers and 83% of software quality assurance analysts and testers are aged 25 to 54. Electrical and electronics is more representative of workers 55 and older. Web developers and computer and information research scientists are more representative of workers 15 to 24 years old.

Women and people of color are under-represented in advanced technical and management roles. There are more women and people of color in entry-level roles, suggesting barriers that could be addressed to expand the talent pool for management and leadership positions (see Career Pathways section).

Given the region's strength in cybersecurity and the prevalence of government contractors, it is also worth considering the concentration of veterans in the selected occupations. While veterans make up 9% of the

[22] KPMG, Wilda Tech, & Revelio Labs, "Career outlook for women in D&A and AI," September 2024, https://kpmg.com/kpmg-us/content/dam/kpmg/corporate-communications/pdf/2024/CareerOutlookforWomeninDataAnalyticsandAI_20240925_final.pdf.

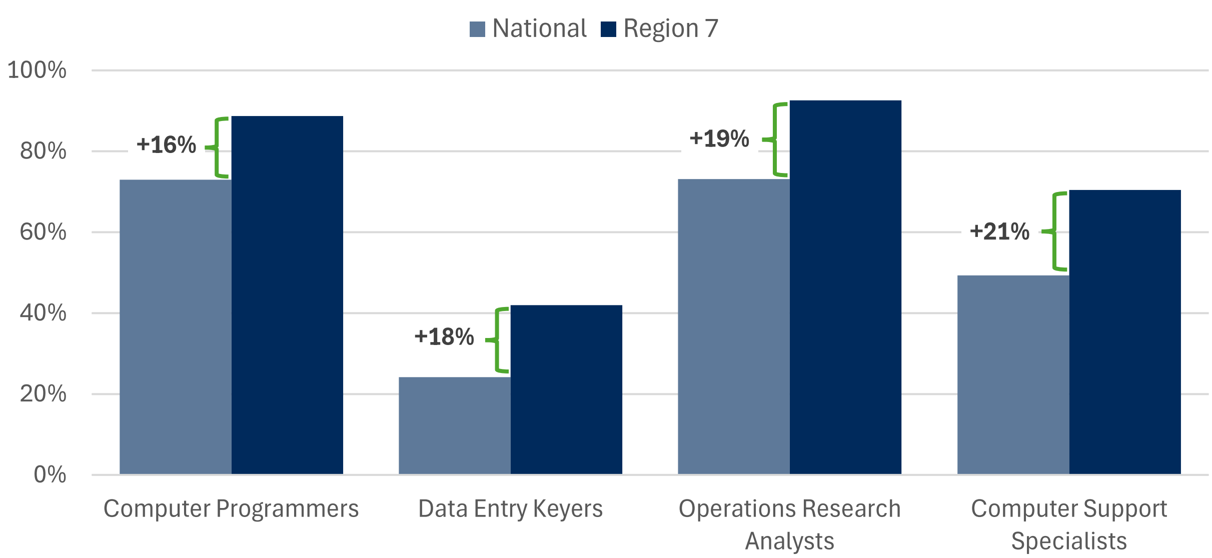
[23] Northern Virginia Community College, & Northern Virginia Chamber of Commerce. (2023). *2022 Northern Virginia Workforce Index.* https://novachamber.org/wp-content/uploads/2023/01/23-001-IndexSurveyReport2022-final-web.pdf

Region 7 population, they make up 12% of the workers in these occupations. Yet these workers are not evenly distributed across these occupations. Only 2% of data entry keyers and web developers are veterans. **Veterans make up 25% of information security analysts and electrical and electronic engineering technologists and technicians, more than any of the other occupations.** An additional 3% of the information security analyst workforce is on active duty for the national guard and military reserves.

Education and Experience Requirements

As previously highlighted, residents of Region 7 have much higher levels of educational attainment than most other areas of the country, including other technology-heavy MSAs (see "Region 7 Educational Attainment" above). **In the selected technology cluster occupations, 84% of Region 7 workers have a bachelor's degree or above, compared to 66% of workers in these same occupations nationally. Looking at individual technology occupations, this difference tends to be larger for those occupations typically requiring less education at the national level.** For example, 70% of computer support specialists in Region 7 have a bachelor's degree or above, compared with around half of similar workers nationwide – a 21-percentage point difference (*Figure 7*). By contrast, similar shares of computer research scientists have a bachelor's or above in Region 7 compared to nationally (94% vs. 95%, respectively).

Figure 8. Comparison of Region 7 to National Attainment Rates of Bachelor's Degree or Higher for Selected Technology Occupations (and Percentage Point Differences)



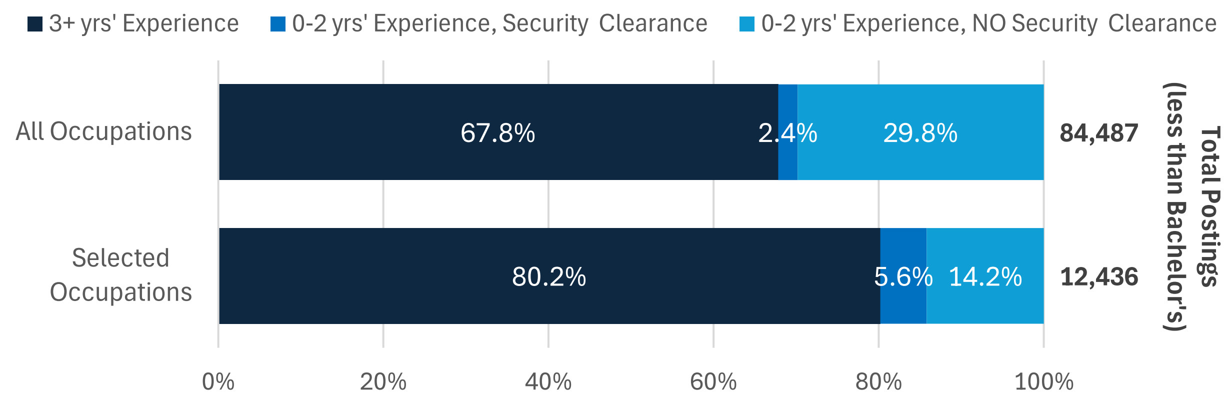
Source: U.S. Census Bureau, American Community Survey 5-year Estimates Public Use Microdata, 2017-2021.

Not only is educational attainment among technology occupations higher in Region 7 compared to the nation, those technology occupations requiring higher levels of education and experience are also projected to grow faster than other tech occupations in the region. On average, technology occupations typically requiring at least a bachelor's degree or above are projected to grow by at least 17% over the next 10 years, compared to 15% among those requiring some college but no degree, or 12% among those requiring an associate's degree. This means that, absent any intervention, regional demand for technology workers will continue to skew more heavily to the highly educated over time.

Strong demand for technology roles that require at least a bachelor's degree in Region 7 is further reinforced when looking at job postings data. **While 67% of all 2023 job postings in the region required minimum education of a bachelor's degree or greater, 87% of postings for technology occupations required the same. Even among those technology occupation job postings requesting less than a bachelor's degree, however, the vast majority (80%) also require three or more years of work experience** (*Figure 8*). This significantly limits the number of potential entry-level job opportunities available to those without at least a four-year degree. Moreover, 5% of these sub-baccalaureate job postings also require a security clearance, leaving around 1,700 annual technology postings (or 1.5% of the total 125,000) available to be filled by those without significant education, experience, or security clearance.

> Bachelor's degree requirements are prevalent even for "entry-level" positions, and many workers in "entry-level" roles have a bachelor's or above. To compete for entry-level jobs and promotions, area employees frequently possess even higher levels of education than job postings require.

Figure 9. Share of 2023 Job Postings Requiring Less than a Bachelor's by Years of Experience, Security Clearance Requirement



Source: Lightcast.

All this suggests that demand for technology roles in Region 7 tends to be highest, therefore, among those that may be defined as "mid-level" as opposed "entry-level."[24] Interviews with employers reinforced this finding. They frequently described the challenges they encountered with hiring for mid-level roles. That said, smaller businesses emphasized an even more critical need for senior level talent, more so than medium or large businesses.

[24] "Mid-level" may be confused here for "middle-skill," which is typically defined in the broader workforce development literature as those occupations requiring more than a high school diploma (or equivalent) but less than a bachelor's degree for entry. For example, see: Joseph B. Fuller, et al., (November 2014). *Bridge the Gap: Rebuilding America's Middle Skills*, published by Accenture, Grads of Life, and Harvard Business School, https://www.hbs.edu/competitiveness/Documents/bridge-the-gap.pdf. Given Region 7's higher than average education requirements and levels of attainment for technology occupations, it is necessary to loosen this definition of "middle level" occupations to include those that may typically require a bachelor's degree. By contrast, entry-level roles in Region 7 may be better defined as those where some college less than a bachelor's degree, or a bachelor's degree and minimal experience are required.

Skills Requirements

While formal education and work experience play an important role in understanding the talent needs and potential pathways for technology occupations, individual skills requirements are equally important, particularly given the pace at which technology needs continue to change. The top three skills requested across 2023 job postings in Region 7 for the set of technology cluster target occupations are broad, professional skills (or what might be typically referred to as "soft" skills) including communication, management, and operations. **However, this is common regardless of occupation, with "communication" showing up as the most frequently requested skill across all occupations, both for Region 7 and nationwide.[25]**

> **Professional skills** in demand among the selected technical occupations are:
> - Communication
> - Management
> - Operations

The most frequently requested "specialized" skill (i.e., those skills that are often unique to specific job areas) for our target occupations in Region 7 during 2023 was "computer science." Similarly broad functional skill areas (including "software development" or "software engineering") also show up frequently. More usefully, project management-related capabilities are also among the most requested specialized skills. Agile methodology, a project management framework, is the second most-requested specialized skill, identified in nearly a quarter of postings. Other in-demand specialized skills include core programming/scripting languages such as Python, SQL, and Java (requested in 19%, 15%, and 14% of postings respectively). Finally, networking and cloud systems-related skills are also prominent—Amazon Web Services is the third most-in-demand skill across selected occupation postings (required by 19%) while "automation" and "Linux" are also in the top 10-15 identified skills.

> **Specialized skills** in demand among the selected technical occupations are:
> - Computer Science
> - Agile Methodology (Project Management)
> - AWS

Employer interviews validated that while in-demand technical skills such as coding and targeted programming are important, oftentimes those skills are viewed as teachable; professional skills, on the other hand, such as communication, teamwork, work ethic, and initiative, were thought of as equally important for key tech roles. Yet the hiring process often provides a different picture. There seems to be a big disconnect between job descriptions in online job postings and what employers are looking for according to our interviews with various stakeholders in Region 7. There is an ongoing challenge with the availability of trained talent, as companies often struggle to find the required skillsets at a mutually agreed price. **As a result, bachelor's degrees are often used as a proxy for experience and professional skills in the job market. There are some medium and big businesses, however, that are increasingly integrating behavioral interviewing techniques and questions to screen candidates more thoroughly for these professional skills.**

Skill and familiarity with AI is also becoming important in the region. **Amongst the selected technical occupations, the portion of the job postings requiring any AI skill is 2 percentage points higher in Region 7 than for the nation at large, with machine learning, artificial intelligence, and natural language**

[25] Occupational skills data is sourced from online job postings, reflecting a measure of the extent to which skills are in demand among employers.

AI skills in demand among the selected technical occupations are:

- Machine Learning
- Artificial Intelligence
- Natural Language Processing

processing as the most sought-after AI skills. The biggest differences between Region 7 and the national average are in the computer and information research scientist and data scientist occupations which require AI skills in a share of job postings 14 and 13 percentage points higher (respectively) than job posting shares at the national level.

These AI skill requirements are roughly average in comparison to other tech hub metropolitan areas, however. The San Jose Metro Area (i.e., Silicon Valley) has the highest portion of job postings that require any AI skill at 17%, and the Denver- Metro Area has the lowest at 4%. Meanwhile, 9% of Region 7's job postings and 8% of the Washington, D.C. Metro Area's require any AI skill, placing them in the middle of this group. It is important to note that there is always a spike in job posting skill requirements when new technologies are released but this may die down as the "hype" declines. This can be seen in the decline in AI requirements between 2022 and 2023.[26]

Credentials

Security clearances are the top in-demand certification across all the selected target occupations. **Nearly half of all job postings for target occupations in Region 7 request security clearances, significantly higher than other major tech metros and 10 percentage points higher than the broader Washington D.C. MSA.** On average, 3 of the 5 top credentials requested in job postings for our target tech occupations are different types of security clearances. Cybersecurity occupation job postings require security clearances more frequently than tech occupations in other identified pathways (see Pathways section below for more detail). This stems from one of the defining characteristics of Region 7's workforce: federal and government contract technology work frequently requires some form of security clearance.

Security clearances are the most in-demand credential in the region, regardless of occupation. CompTIA Security+ is the top industry certification, although Project Management Professional certification is also in-demand, consistent with stakeholder interview findings.

Security clearances are unique from other in-demand credentials as they are not available from any non-government source. Security clearances can only be obtained through a position that requires it, meaning they cannot be acquired in advance of obtaining a job. Clearances are also lost in between jobs, necessitating reactivation if an individual changes agencies or contractors. The national Background Investigation Services seeks to unify the various agency processes under the Trusted Workforce 2.0 initiative; however, there is currently no project timeline for this effort. The current average time to acquire a clearance is three to four months, though

[26] Lightcast. (2024). *The Lightcast Global AI Skills Outlook*. https://lightcast.io/resources/research/the-lightcast-global-ai-skills-outlook.

some applications can take more than a year. Interim clearances can be awarded as early as one month into the process.[27,28]

If we consider non-security clearance in-demand credentials, a valid driver's license and CompTIA Security+ are the most common credentials requested in job postings for target occupations. There is some nuance to this as a valid driver's license is the top credential for less technically specialized occupations such as general operations managers and sales representatives, whereas CompTIA Security+ is the top credential requested for more specialized occupations such as data scientists, information security analysts, and software developers. CompTIA Security+ also appears as one of the top three most in-demand credentials for an additional nine occupations**.** **Notably, the Project Management Professional (PMP) certification is also one of the most in-demand credentials, not only for occupations like project management specialists and management analysts, but also for technology roles. This lines up with employers we interviewed who listed credentials like CompTIA Security+ and PMP as being the most in-demand.**

> Training for industry credentials helps employers upskill their existing workforce and allows employees to gain portable credentials, such as a PMP or CompTIA certification.

Other top credentials identified as in-demand based on stakeholder feedback include AWS, Certified Information Systems Security Professional (CISSP), CompTIA Network+, and Scrum Master certifications. Both medium and large businesses identified these credentials as particularly valuable, though these groups differed as to when the credential must be acquired: medium-sized businesses often require these certifications as an entrance ticket, whereas large businesses focus more on skill sets and job performance at hire rather than certifications (some may require the certification be completed within a certain time period following hire).

Higher Education Providers

Identifying potential sources of talent for specific occupations requires mapping postsecondary and non-degree training programs to occupations based on the field of study, credential level, and/or certification awarded. This was done primarily using a standard program-to-occupation crosswalk from the National Center for Education Statistics (see Appendix A for more details). However, the main program categories linked to our target occupations using this crosswalk also align with those representing the largest shares of Region 7 graduates entering computer occupations following graduation, based on recently released data from the Virginia Office of Education Economics (specifically, Computer and Information Sciences, Engineering, Business Management/Marketing, and Mathematics/Statistics).[29]

Looking at the 2021-22 academic year, *Table 8* depicts the top postsecondary institutions located in the DC MSA by completions from these relevant programs. **The top three are University of Maryland Global**

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[27] United States Department of Homeland Security. "DHS I&A Security Clearance Process." *Intelligencecareers.gov*, U.S. Intelligence Community careers, www.intelligencecareers.gov/dhsia/security-clearance-process#:~:text=The%20security%20clearance%20process%20takes. Accessed 8 Aug. 2024.

[28] United States General Services Administration. "Top Secret / Sensitive Compartmented Information (TS/SCI) Clearance." Handbook.tts.gsa.gov, handbook.tts.gsa.gov/general-information-and-resources/business-and-ops-policies/top-secret/#:~:text=Below%20are%20approximate%20timelines%20for. Accessed 8 Aug. 2024.

[29] Virginia Office of Education Economics, *Virginia College and Career Outcomes Explorer*, 8 July 2024, https://www.voee.org/virginia-college-and-career-outcomes-explorer/.

Campus with 8,465 completions, University of Maryland-College Park with 4,741, and American Public University System with 4,412.

Table 8. Top 10 Washington D.C. MSA Postsecondary Institutions by GoVA-related Program Completions (2022-2023)

Institution	State	Completions
University of Maryland Global Campus	MD	8,465
University of Maryland-College Park	MD	4,741
American Public University System	WV	4,412
Northern Virginia Community College	VA	2,841
George Mason University	VA	2,750
Strayer University-Global Region	DC	2,189
Georgetown University	DC	1,987
George Washington University	DC	1,965
Montgomery College	MD	992
American University	DC	872

Source: National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), https://nces.ed.gov/ipeds/.

Of the 32 occupations targeted for this report, 15 have University of Maryland Global Campus as their top provider, 11 have University of Maryland-College Park, two have the American Public University System, and the remaining three have George Mason University, Career Technical Institute, and Montgomery College. For 27 of these occupations, the top training provider is in Maryland. **Only two occupations have their top training provider located in Virginia: computer systems analysts, for which the top training provider is George Mason University, and electrical and electronic engineering technologists and technicians, for which the top provider is Northern Virginia Community College (NOVA).**

Higher education program completions, however, provide only part of the picture. **Notably, internships were identified as the main sources of entry-level talent in many employer interviews, particularly for medium and larger employers. Companies often draw from higher education institutions for this entry-level internship talent – George Mason University, Virgina Tech, University of Virgina, and NOVA were all cited as key sources for the region.** Large employers often have stronger connections with these educational institutions, whereas medium-sized employers frequently do not have proper connections to fully leverage these same sources. Smaller employers cited their use of IT staffing firms as key sources of talent given their specific needs and limited resources to onboard interns or train employees on-the-job.

Transitioning military members are also a key talent source in the region given their security clearance status and experience. While military security clearances are inactivated when the veteran leaves the service, they can be reactivated within two years, unless their Periodic Reinvestigation to maintain the clearance was due during that time. Employers such as CACI International have specific programs to recruit transitioning military personnel and veterans, who make up roughly 40% of their workforce in the region.

Training Providers

Postsecondary credentials play a significant role in signaling job readiness for technology roles in Region 7. Developing technology talent in the region relies heavily on postsecondary educational institutions; however, non-postsecondary training—including certification training classes offered by private training providers, as well as non-credit/non-degree credentials offered by accredited postsecondary institutions—is another critical component of the talent ecosystem.

Virginia Career Works Northern Region offers incumbent worker training grants to help employers re-train their existing workforce and support employees in gaining new skills. This grant program requires employees gain a portable credential from the training, such as a PMP or CompTIA certification.

Out of the 157 providers eligible to receive federally funded training money (through the Workforce Innovation and Opportunity Act, or WIOA) in the Washington D.C. metro area, 51 (or around a third) provide training programs directly related to technology careers and pathways; however, of these, only 30 have recently active programs (i.e., programs with participants at any point between 2019 and 2022). As indicated, there is some overlap here with the postsecondary institutions examined in the previous section – among the five providers offering the greatest number of related programs are NOVA and Frederick Community College. Private providers Security University, ASM Educational Center, and Intellectual Point also offer at least 10 or more related programs apiece (*Table 9*). While these five providers also produced the largest number of program completers between 2019 and 2022, ASM Educational Center has produced the most (992) followed by Security University (722) and NOVA (618).

Table 9. Top Eligible Training Providers by Number of Technology-Related Programs

Training Provider	Number of Related Programs	Total Program Completers (2019-2022)
Security University	19	722
ASM Educational Center	14	992
Intellectual Point	10	540
Northern Virginia Community College	7	618
VETSGroup Training Academy	5	152
George Mason University Continuing and Professional Education	4	45
Frederick Community College	4	15
Per Scholas, Inc.	3	380
Cybersecurity Training Center	3	138
Lord Fairfax Community College	3	91
Prince George's Community College	3	64

Source: U.S. Department of Labor Employment and Training Administration, TrainingProviderResults.gov, retrieved 7 May 2024, https://www.trainingproviderresults.gov/.

Like postsecondary programs, eligible training provider list (ETPL) programs are also categorized by Classification of Instructional Programs (CIP) code. The most common CIP program type associated with recently active programs in the Washington D.C. metropolitan area is computer and information systems security/auditing/information assurance (11.1003) followed by computer support specialist (11.1006). Programs in these two categories also had the highest number of completions over the reporting period, 1,463 and 666, respectively, followed in third by computer systems networking and telecommunications programs (548). Combined, programs in these three categories represent over half of related training programs (63%) as well as total completions from related programs (54%). **As a result, it seems that most technology-related training programs in the Washington D.C. metropolitan areas are well-aligned to key regional skill needs in cybersecurity, computer support, and networking and systems administration.**

Public postsecondary providers in Maryland, as well as private institutions in Washington D.C., heavily supplement the tech talent pool available to Region 7 employers. Private training providers also offer a significant number of programs focused on relevant industry credentials, particularly those in-demand for entry- and mid-level roles like CompTIA A+, Network+, and Security+.

There are opportunities, however, to further align regional skills needs in Region 7's K-12 system. Currently, there are several CTE courses in the region that focus on programming, cloud computing, and engineering – areas of expansion could include machine learning/AI, project management, and other specialized languages such as Python or SQL. Dual enrollment courses could also be expanded in these areas and connected to specific industry credentials such as AWS. The National Career Clusters Framework by Advance CTE serves as the foundation for designing high quality CTE pathways and highlights the need for digital technology across all career clusters.[30] Region 7's K-12 system has an opportunity to build out this framework and critically think how students can gain exposure and skills beginning at the middle school and high school level.

Lastly, registered apprenticeships are also an important part of the education and training ecosystem. **While there were over 300 federally registered apprenticeship programs in 2022 in Region 7, only 13 of those were related to GoVirginia's targeted technology clusters.** One of these programs is housed at Micron, a large employer in the region, which provides apprenticeship opportunities for process, equipment, or lab technicians. In total, these 13 programs had 106 participants in 2022; roughly half of the participants were for application developers, and another quarter were for electrical/electronic technicians (*see Table C6*). These numbers reflect the relatively new interest in leveraging the apprenticeship model for IT, a trend which began in 2014 with USDOL apprenticeship expansion grants. There is likely room to increase apprenticeships in the region and align these with higher education to enhance completion rates.

[30] Advance CTE, "The National Career Clusters Framework," accessed January 3, 2025, https://careertech.org/career-clusters/.

The Northern Virgina Virginia Talent + Opportunity Partnership (V-TOP), housed at NOVA, is promoting work-based learning expansion through working with agencies such as iQuasar to help Virgina employers with less than 250 employees expand their internship opportunities through marketing openings, screening candidates, and onboarding interns. See *Appendix D* for more information on education and training resources in the region.

Optimistically, evidence suggests that many employers in the region are providing training and upskilling opportunities for their employees. According to NOVA's 2023 Workforce Index, 70% of employers surveyed offer in-house training and roughly half offer tuition reimbursement.[31] This was validated in our interviews with Region 7 talent ecosystem stakeholders, as many employers referenced providing education stipends and professional development opportunities. Large businesses also are moving to better map opportunities and pathways for people to grow and advance within the company. At the same time, interviews also indicated that internal company trainings are more frequently utilized than external trainings. Moreover, structured internal training opportunities and partnerships with external providers tend to be more prevalent in larger companies, which have greater resources to invest into training, while medium-sized and small companies tend to rely more on LinkedIn Learning and similar asynchronous, low-cost programs for employee professional development.

[31] Northern Virginia Community College & Northern Virginia Chamber of Commerce, *2023 Northern Virginia Workforce Index Executive Summary*, https://www.nvcc.edu/dist/files/sites/about/offices/strategic-insights/lmi/research-insights/24-001-IndexSurveyReport23.pdf.

Findings: Career Pathways

Overview

Given the high levels of educational attainment and the plethora of education and training opportunities in the region, why do tech companies persistently report difficulty attracting and retaining talent? Labor market analysis suggests this is due, in part, to a stagnation in the growth of the region's prime working age population resulting from domestic out-migration. Persistent challenges resulting from bachelor's degree and security clearance requirements remain unanswered. This has led to a slight decline in the region's dominant position in IT. For the region to remain competitive as a tech hub, it is important for stakeholders to invest in priority actions that will have a substantial effect on regional employment dynamics, creating new opportunities and motivating continued improvement.

The pathway assessment of Region 7's three key technology clusters in the previous section led to the selection of five tech talent career pathways for closer consideration. Each pathway includes a key occupation that is critical to the region's technology workforce, either due to high regional demand/specialization, or significance to a particular technology industry. Aligned with employer-reported pain points around recruitment and hiring, these key focus occupations are largely "mid-level" roles—that is, roles typically requiring a college degree and/or non-entry-levels of work experience. They also represent critical career pathway "destination points" for new-to-career workers in key regional economic clusters. These five key occupations are: software developers, data scientists, information security analysts, project management specialists, and computer hardware engineers.

For each of these critical occupations, we identified the most relevant "feeder" jobs. These are roles that generally require less education and/or work experience but share valuable skills with the key occupation where modest upskilling or reskilling would allow individuals to advance into targeted occupations. Finally, we have also identified relevant "next step" jobs for each pathway to assess long-term opportunities for workers entering the pathway.

1. **Software Development** – Software developer is the largest technology occupation in Region 7 by employment. Consequently, it makes up the largest share of cluster employment and is expected to result in the largest number of job openings over the next 10 years. Identifying and improving opportunities for entry into these jobs will be critical to sustaining the region's tech workforce.

2. **Data Infrastructure –** Recognizing the continued growth of data centers and associated hardware and systems infrastructure in the region, there is a strong need to design effective talent pathways for the skilled technicians and engineers required to build and maintain this infrastructure. Aside from software developers, computer hardware engineers make up the largest share of employment in the data processing and web hosting industry (which encompasses data centers). While filling the pipeline for these roles is important, employer-reported demand may be even more substantial (and immediate) for entry-level technicians within this pathway. These entry-level technician roles can also translate to other emerging talent needs in the region, such as the semiconductor industry.

3. **Cybersecurity –** As highlighted earlier, cybersecurity firms and workers are a substantial component of regional technology employment as well as an area of strong regional

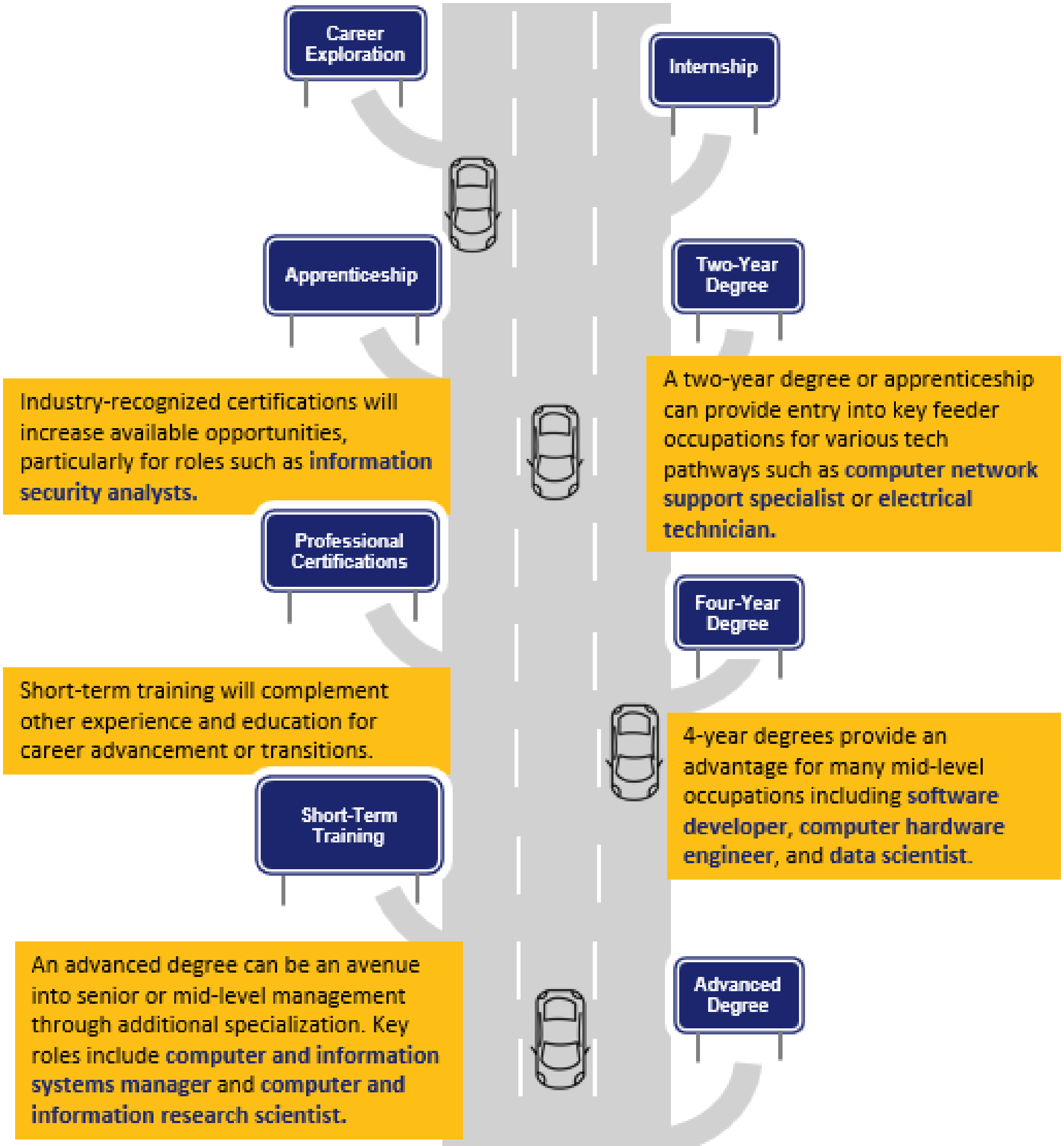
specialization. Information security analyst is the field's workhorse occupation, as well as the region's fastest-growing and second-most regionally concentrated technology occupation. However, despite a wealth of cyber-related non-degree/industry certification training in the region, these roles often require a degree and/or related work experience. Identifying entry points into these roles that are appropriate for those without a degree or experience will be necessary to meet growing demand.

4. **Data Science –** Data scientists (as well as related statisticians) are projected to be among the fastest growing occupations in Region 7 over the next 10 years. With the increasing prevalence of methods such as machine learning, the region stands to be at the forefront of related research and development by government as well as private firms. Region 7 has a comparatively high concentration of AI/machine learning R&D firms, particularly those focused on security applications. Continued growth will require a strong pathway for data science practitioners and researchers.

5. **IT Management –** Through interviews and focus groups, technology employers consistently identified project managers as a significant need, particularly those with foundational technical knowledge. While these employers also indicated that project management is an important skill for those in technical occupations as well, it is also worth considering other technology-adjacent/operational roles that may build both the management skills and technical awareness to succeed in specialized project management jobs.

These five pathways are explored in detail below followed by a summary section with key takeaways across pathways. These entry-, mid-, and advanced-level roles across the pathways will be key to filling the 48,000 projected new tech jobs in the priority industry clusters by 2032. *Figure 9* below serves as an illustration of the tech talent development opportunities to help individuals in Region 7 access and advance through these roles. Effective tech talent development will ensure education and training opportunities are available for both career joiners and changers. Region 7 stakeholders can make strategic investments to ensure these options are available to everyone.

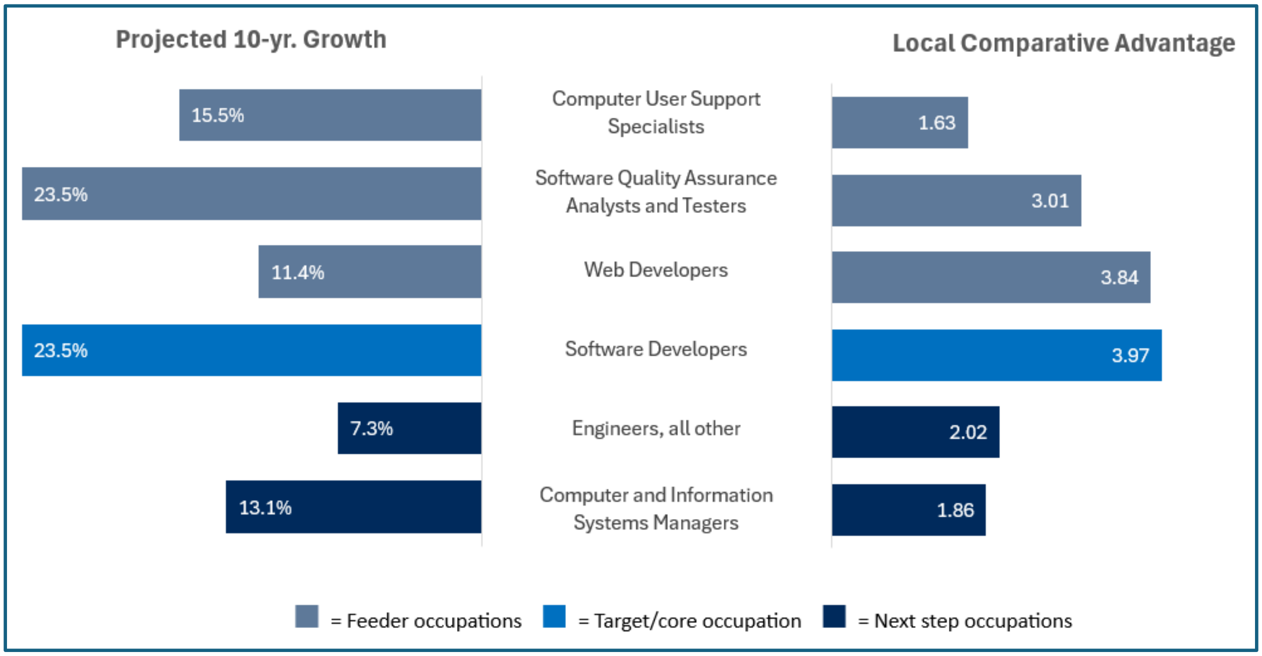
Figure 10. On the Road to Tech Talent Development: Adding 48,000 **New Jobs** in Region 7 by 2032



Software Development

Software developers are a major element of the technology workforce in Region 7, making up a quarter (24.6%) of employment across the region's priority technology clusters. The share of software developers (as a percentage of the region's workforce) is four times greater than the nation. Employment for software developers is also projected to grow at a much faster rate than overall regional employment growth over the next 10 years (23% vs. 13%). As a result, the career pathways associated with these roles provide a vital opportunity for future Region 7 workers and will require a sizeable pipeline of future talent. Employers and stakeholders interviewed for this report reinforced this finding, with software developers mentioned most frequently when asked about in-demand job roles.

Figure 11. Software Development Pathway Occupation Demand



A wide range of roles could be potential feeder occupations for software development. However, **we have focused on two occupations that have the greatest degree of skill overlap based on job postings data: web developer and software quality assurance analyst/tester.** Demand for both roles is significant, with employment three to four times more concentrated regionally than nationally. Despite a lower degree of skill overlap with software developers, we have also chosen to focus on computer user support specialists as potential feeder roles for software development. **As one of the few technology occupations traditionally requiring less than bachelor's degree for entry, the user support specialist is frequently held up as a strong entry point for technology careers in general, and often for software development in particular.**[32] This was again reinforced through our interviews with regional employers and domain experts who consistently cited help desk roles to be "standout" entry-level roles that can transition into a number of other mid-level jobs.

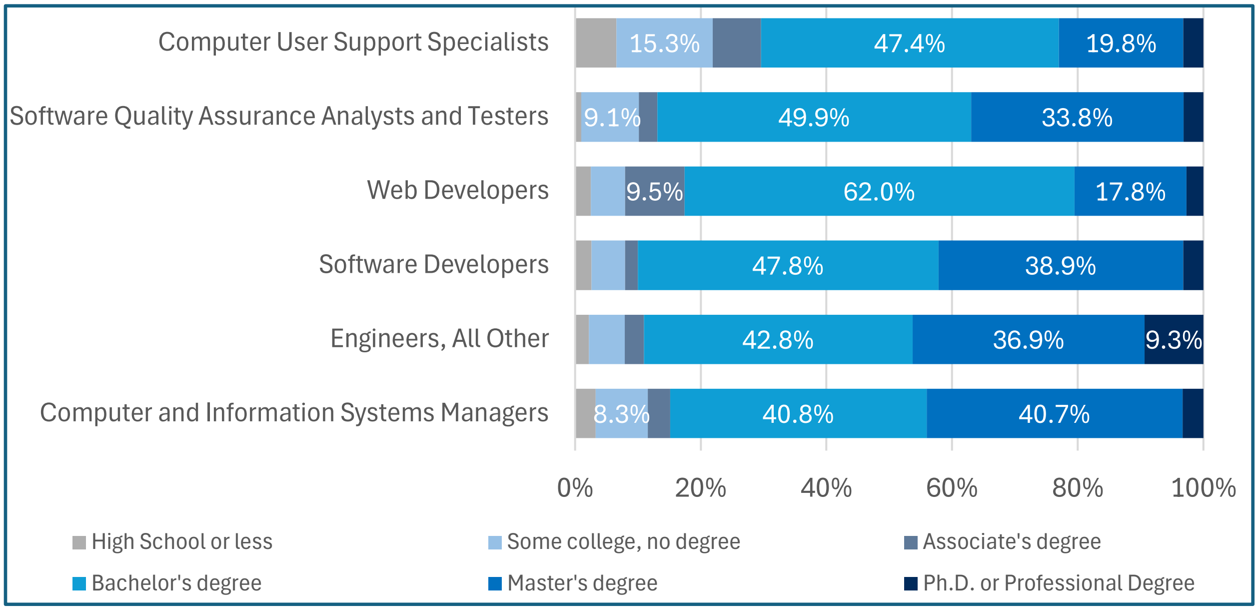
When advancing beyond senior levels of the occupation, software developers may typically move into broader management roles with responsibilities over multiple development teams or domain areas. While

[32] Herzing University, "How to Go from Help Desk/Tech Support to Software Developer." https://www.herzing.edu/pathway/it-support-to-software-developer. Accessed 14 Aug. 2024.

the occupation "Engineers, All Other" can encompass a wide range of specialized engineering titles and disciplines, those heavily utilizing artificial intelligence and low-level software systems—such as microsystems, robotics, and nanosystems engineers—are natural extensions for software developers/engineers. Projected employment growth across "all other" engineers is lower than average; however, this likely encompasses slower growth in roles less relevant to software development.

Formal educational requirements for user support roles are lower than for other feeder occupations identified for this pathway: nearly a third of those employed in the region (30%) have less than a bachelor's degree and 16% of occupation job postings required less than a bachelor's, at minimum, for employment. By contrast, just 17% of web developers and 13% of software quality testers in the region have less than a bachelor's degree. In both cases, less than 10% of postings required the same.

Figure 12. Share of Region 7 Software Development Workers by Highest Level of Education Attained



So, while most user support specialists in the region are still more likely to require a bachelor's degree than in other areas, there are greater opportunities for non-degree holders to enter the pathway here than via other routes/occupations. In fact, only network and systems administrators and "computer occupations, all other" (which, again, can encompass a wide range of roles with varying hiring standards/requirements) had higher shares of workers without a bachelor's among technology occupations in the region (32% and 31%, respectively). However, options are potentially more limited for jobseekers with less than a bachelor's and fewer than three years of experience, and especially those without a security clearance. Of the nearly 1,500 job user support specialist job postings in 2023 requiring less than a bachelor's degree, around a third required fewer than three years of experience, and a third of those (11% of all sub-baccalaureate postings) requested that candidates have a security clearance, leaving around 350 truly "entry-level" postings.

Besides security clearances, industry certifications appear to be most important for user support specialists, with ten different certifications requested in over 3% of occupation postings apiece, compared with just one or two certifications requested at the same levels for other occupations in the pathway. By far, the most uniquely in-demand certification for user support specialists is CompTIA A+ (requested in 11.5% of occupation postings), which is designed specifically for those in IT support roles. Microsoft Certified Professional and CompTIA Network+ are also in-demand for these roles, although somewhat less prevalent (4-5% of postings). **Otherwise, general IT security-related certifications like CompTIA Security+ and others listed under the Information Assurance Technical (IAT) Level II of Department of Defense approved 8750 baseline certifications[33] tend to be commonly requested across the pathway.** Next to user support specialists, IT managers have the second-highest number of non-clearance certifications requested, mostly consisting of higher-level information/cybersecurity credentials like Certified Information Systems Security Professional (CISSP), Certified Information Systems Auditor (CISA), and Certified Ethical Hacker (CEH).

AI adoption is having a large impact on the software development pathway. Research shows AI can improve productivity on a variety of tasks like programming and may lessen the demand for more entry-level positions. Yet AI is projected to also create new jobs in this pathway, such as AI engineers. Upskilling opportunities may be even more needed, then, for mid-level roles in this pathway.

Based on their comparative presence in online job postings, all three feeder occupations for software developer jobs generally share many of the professional skills that tend to be most in-demand across occupations. These include common skills needed for technical work (e.g., critical thinking, analytical skills, and creativity) as well as those required for collaborative work on teams (e.g., collaboration, teamwork, and leadership). *Table 10* illustrates some of these dynamics by identifying common transferable skills across occupations broken out by entry- to mid-level crossover and mid-level to advanced crossover.

Table 10. Common Transferable Skills Across Occupations in the Software Development Pathway

Entry-Level to Mid-Level	Mid-Level to Advanced
Customer Service	Amazon Web Services
JIRA	Automation
Team Leadership	Computer Science
Teamwork	Java
Timelines	Python

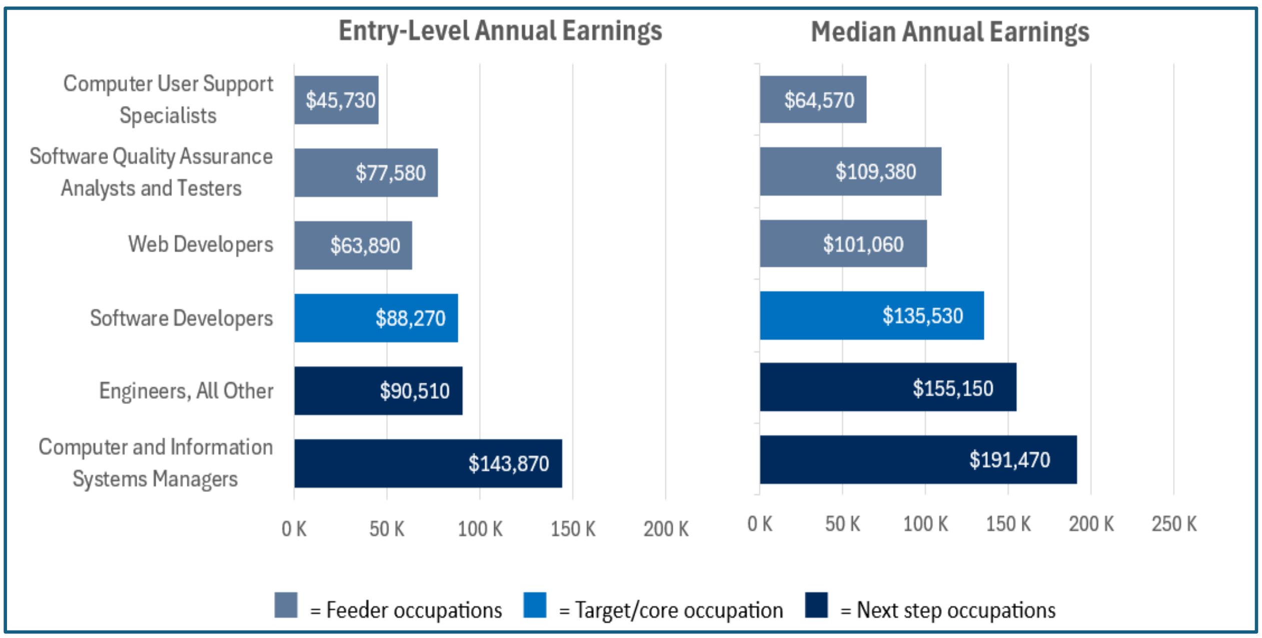
Note: The skills in this table were identified as those with similar levels of demand across entry-to mid-level and mid-level to advanced roles based on job postings data. The skills listed here represent a snapshot of possible transferable skills in this pathway. Source: Lightcast.

[33] These are industry certifications that are approved to fulfill different levels of requirements under the Department of Defense (DoD) Information Assurance Technical (IAT) career pathways, as outlined in the DoD 8570.1-Manual. These requirements are established to ensure that IT professionals filling certain military positions have the requisite level of training and expertise. See: Defense Information Systems Agency. “DoD Approved 8570 Baseline Certification.” DoD Cyber Exchange, https://public.cyber.mil/wid/dod8140/dod-approved-8570-baseline-certifications/. Accessed 15 Aug. 2024.

In the case of feeder occupations for software developers, however, potential skill gaps/needs are mostly focused on specialized/technical skills. This indicates that, **while feeder occupations may help workers develop many of the professional skills needed to succeed as software developers, some amount of technical upskilling or reskilling is necessary for advancement**. In the case of user support specialists, this includes heavily utilized/core programming languages for software development (e.g., Java, Python, JavaScript, and SQL) as well as key software development methods (e.g., Agile methodology), tools (Git, Docker, and Kubernetes), concepts (automation, scripting, and scalability), and environments (e.g., Amazon Web Services, Linux, and Azure).

Given the region's high cost of living, even entry-level salaries for web developers, software testers, and software developers may provide living wages, on average, for only dual-income households and single-income households with no children.[34] While annual entry-level wages for web developers and software testers in the region are around $64,000 and $77,000 per year, respectively, entry-level user support specialists may typically make around $45,000, with median wages closer to the entry-level for web developers. **As a result, entry-level wages for user support specialists only meet the average Region 7 living wage threshold for workers in dual-income households with no children.** While this does not necessarily mean that these are low-quality or unsustainable jobs, it does emphasize the importance of creating opportunities for user support specialists to advance into higher paying, more family-sustaining, roles through skill development and additional education/training.

Figure 13. Software Development Pathway Wages and Wage Growth

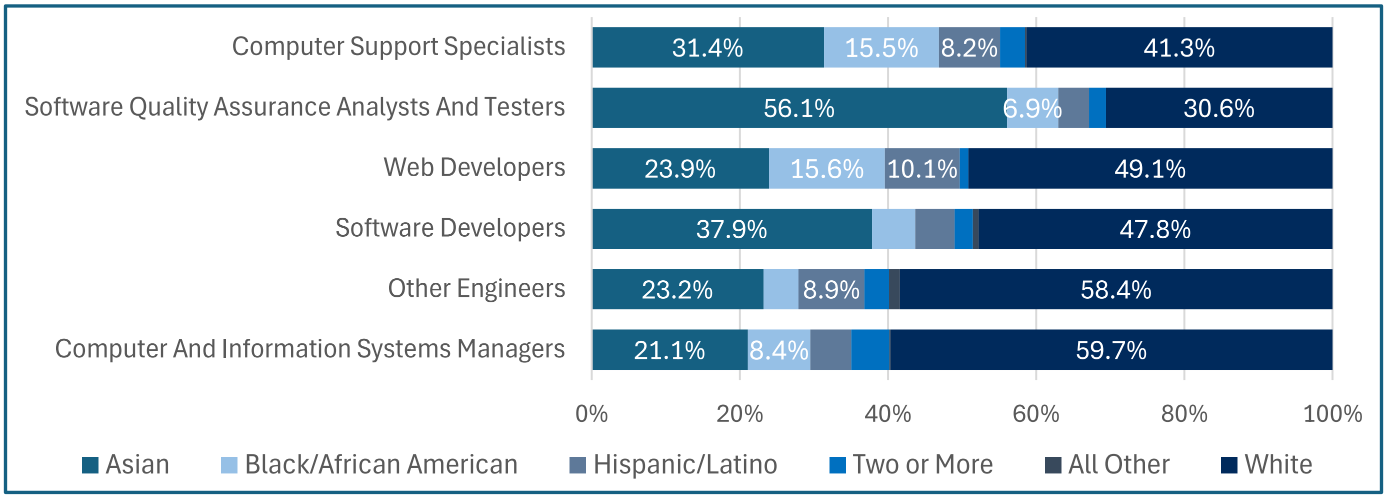


When considering issues of social equity across the software development pathway, feeder occupations tend to have a more diverse distribution of workers by race and ethnicity in the region than software developers and senior level engineers/managers. Less than half of user support specialists and software testers identify as White (whereas this group makes up roughly 50% of the region's total population) and

[34] Living wage thresholds used in this report are based on those set by the MIT Living Wage Calculator. See Amy K. Glasmeier (2024) "Living Wage Calculator," Massachusetts Institute of Technology. Updated on February 15, 2024. https://livingwage.mit.edu/.

Black/African American workers make up larger shares of both support specialists and web developers than the region's population (around 15-16% compared to 12% overall). With no more than 10% of any one occupation's workers identifying as Hispanic/Latino, this group is underrepresented across the board, especially when compared to the region's younger population.

Figure 14. Share of Region 7 Software Development Workers by Race/Ethnicity



In terms of gender, a larger share of the region's software testers are women than for any other occupation in the pathway. **In fact, it is the only technology-specific occupation in the region that is majority-female (63%).** By contrast, just a third of workers across all the occupations selected for analysis in the region are female, and only one other occupation in the software development pathway, web developers, has a share higher than this average (38%). Software developers and specialized/ "other" engineers have the lowest representation among pathway occupations (just over a fifth of workers in the region are female) while user support specialists and IT managers are somewhat higher (27% and 30% respectively). **Taken together this suggests that opportunities for underrepresented groups are more prevalent at the entry-level (i.e., across feeder occupations), with fewer opportunities among highly specialized engineers and senior level management.**

The high demand in software development makes this a key pathway for improvement, offering potential for more readily accessible entry-points, including user support specialist as an entry job. It will be important, however, to track the effects of AI on these entry-level roles, while focusing on upskilling and preparing mid-level roles for changing skill requirements.

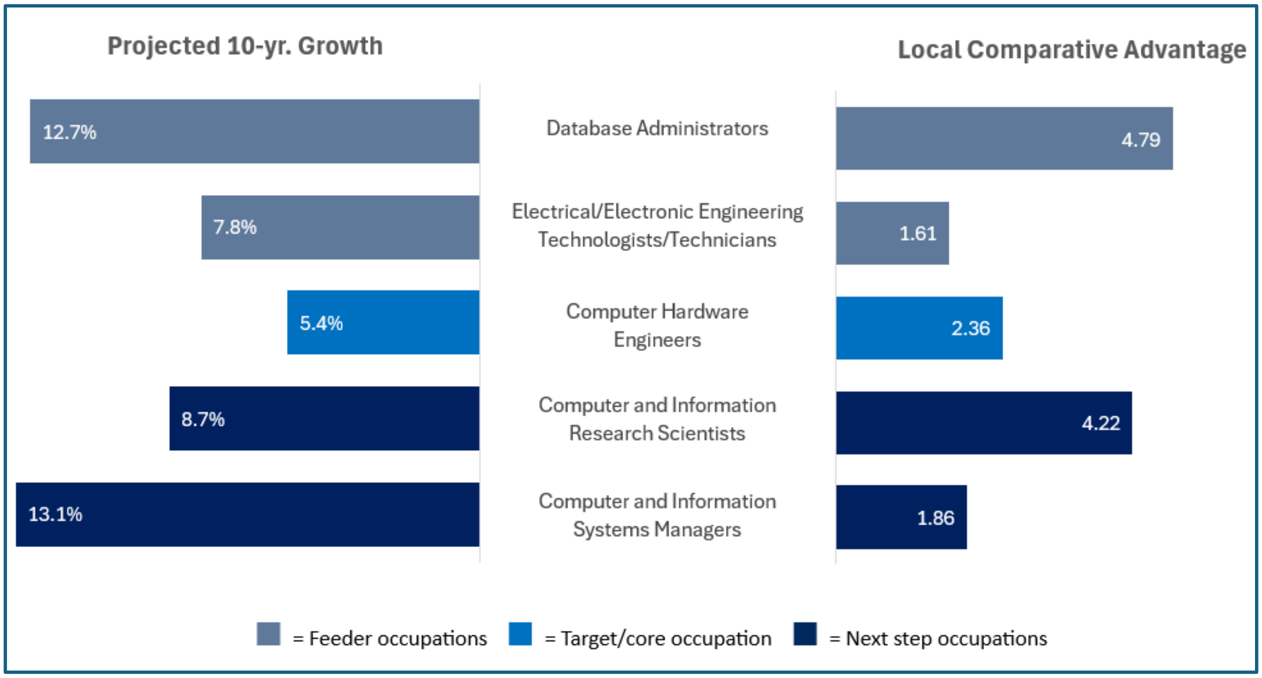
Data Infrastructure

There are other technology occupations that are important to consider when looking at relevant pathways that may not make up significant shares of combined industry cluster employment due to their relatively small size, or the unique specialization of the occupations. **One of those occupations is computer hardware engineers, which makes up the second largest share of employment within the data processing and web hosting industry** (but less than 1% of employment across Region 7's priority industry clusters). According to Virgina Works, computer hardware engineers are estimated to grow by 5.4% by

2032, surpassing the national projected growth rate at 4.6%. As such, computer hardware engineers were chosen as the target occupation for this pathway based on both the occupation's outlook and the need to focus on more of the physical infrastructure pieces that are crucial to data operations in the region.

Data infrastructure encompasses a range of existing and emerging companies in the region, including data centers, semiconductor manufacturing, quantum computing, and fiber optics, to name a few. Data centers, in particular, are an increasingly critical piece of Virginia's economy. In 2023 alone, data centers provided $47 billion in economic output and over 26,000 jobs for the state.[35] The state – and specifically Region 7 – has the largest data center market in the world.[36]

Figure 15. Data Infrastructure Pathway Occupation Demand



While hardware engineers often need to be familiar with computer software systems and programming, there is also a significant need for foundational skills in technical design, basic circuitry, and electrical system maintenance and installation. According to job postings, data infrastructure roles more focused on frontline installation and maintenance of data infrastructure like fiber optics lines, cabling, and servers (i.e., "data center technicians") are often categorized under the database administrator occupation. **Database administrators have a high projected growth rate in the region at 12.7% over the next 10 years, as well as a high employment concentration (4.79), indicating a sizable presence and potential for growth.** Despite a lower degree of overall skill overlap with hardware engineers based on job postings data, this occupation is important to include in the pathway as it was validated as a key in-demand occupation during interviews with data center companies in the region.

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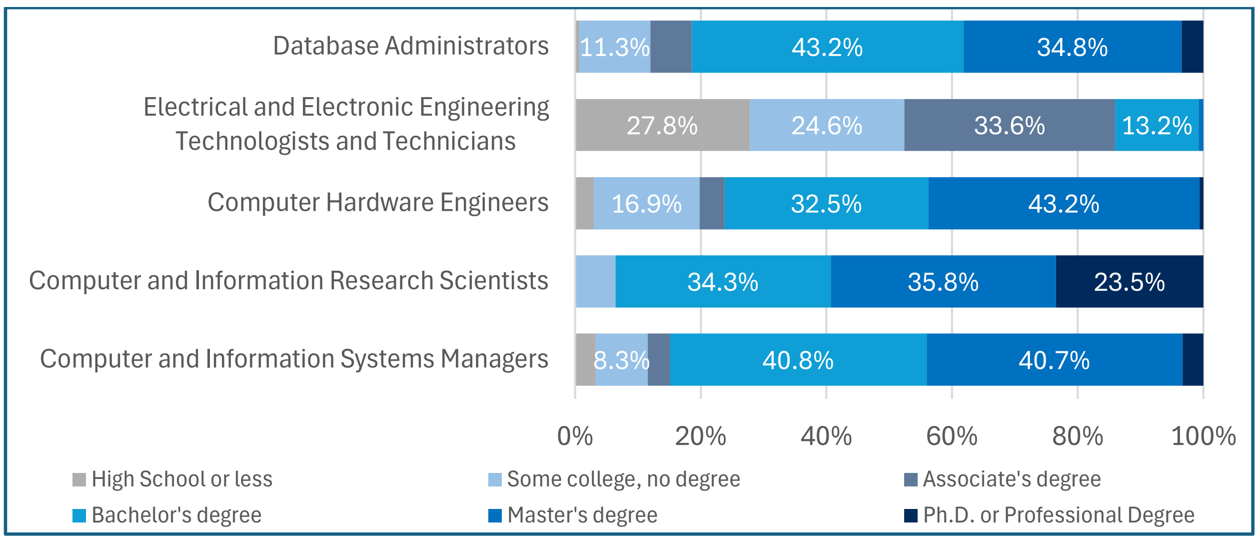
[35] Northern Virginia Technology Council, "The Impact of Data Center on Virginia's State and Local Economies: 5th Biennial Report," April 2024, https://www.nvtc.org/topics/data-center-and-cloud/report/.
[36] Virginia Economic Development Partnership, *Information Technology: Data Centers*, accessed 1 July 2024, https://www.vedp.org/industry/data-centers.

It is important to note, however, that the database administrator occupation also includes a broad range of titles and roles that are not applicable to data center operations. To help address this gap, we also consider the electrical and electronic engineering technologists and technician occupation as a supplement. While the regional employment concentration for this occupation is lower than database administrators, this role is more traditionally trade-focused and typically offer lower barriers to entry in terms of education and training requirements.

Like many other occupations, advancement for hardware engineers generally leads to either increased management responsibilities or additional specialization. According to job postings data, computer and information research scientists have the greatest amount of overlap and focus more heavily on developing new data infrastructure theories and solutions, as well as designing and conducting experiments. On the other hand, computer and information systems managers offer an alternative avenue of advancement focused more on project management and organization-wide technology deployment.

While the two identified feeder occupations provide promising points of entry into this field, only one of these occupations is realistically attainable for those without a bachelor's degree. Formal education requirements are lowest for technicians in this pathway; approximately 84% of technicians in Region 7 have an associate's degree or less.

Figure 16. Share of Region 7 Data Infrastructure Workers by Highest Level of Education Attained



Regional job postings data also reflects this low barrier to entry, as 68% of technician postings only require a high school degree or less and another 15% require some college or an associate's degree. In contrast, 82% of job postings for database administrators have a bachelor's degree requirement, with only 15% requiring an associate's degree or less. Regional data shows a much higher educational attainment level for database administrators as well, as roughly a third have a master's degree. **Database administrators, therefore, have both a higher barrier to entry and may be more competitive given the presence of a highly educated workforce in the region.**

Most hardware engineer postings also require a bachelor's degree or higher (90%+), although regional data indicates a slightly lower percentage of attainment (75%+ have a bachelor's or graduate degree). **It is interesting to note, however, that about 20% of hardware engineers in the region possess an associate's degree or less, indicating that some of the education requirements in job postings may be inflated.** Computer systems managers also have a similar breakdown to hardware engineers with a slightly higher percentage of job postings requiring master's degrees.

AI is expected to have less impact on physical occupations; as such, the data infrastructure pathway is likely to be more resilient to AI disruptions. In fact, AI is more likely to increase demand for infrastructure and the associated labor needed to store and manage large quantities of data.

The skills needed to advance through this pathway start out more specialized and slowly expand to more common skills as management and public speaking become increasingly relevant (see *Table 11* for transferrable skills across these roles). Pathway feeder occupations already share some basic soft skills (e.g., time management, reliability, professionalism) with hardware engineers, but present more gaps when it comes to technical skills (e.g., electrical engineering, debugging, and computer science). For the advanced occupations, more common skills are needed such as leadership, in addition to advanced technical skills with algorithms and programming, illustrating the need for individuals who can translate more internal technical skills to an external facing audience.

Table 11. Common Transferable Skills Across Occupations in the Data Infrastructure Pathway

Entry-Level to Mid-Level	Mid-Level to Advanced
Decision Making	Algorithm Design
Microsoft Excel	Mentorship
Multitasking	Microsoft PowerPoint
Planning	Operating Systems
Project/Program Management	Procedure Development

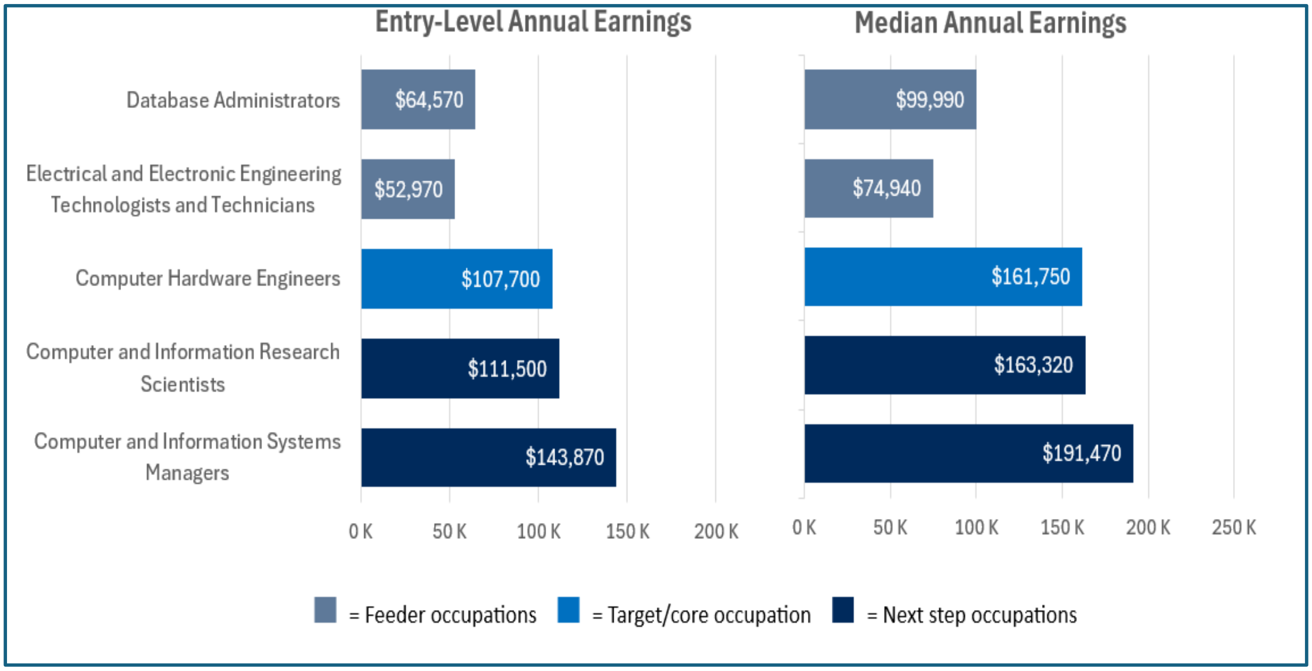
Note: The skills in this table were identified as those with similar levels of demand across entry-to mid-level and mid-level to advanced roles based on job postings data. The skills listed here represent a snapshot of possible transferable skills in this pathway.
Source: Lightcast.

The largest skill gap between database administrators and hardware engineers tends to be very specialized engineering skills including field-programmable gate array (FPGA), computer engineering, simulations, and hardware design and architecture. For technicians, there is a gap in skills related to electrical engineering and debugging, as well as some computer programming languages such as C++ and Python. Research scientists have more of a need for continued specialized skills than do systems managers.

As is consistent with many of the other pathways, security clearances are the top requested credential across most occupations in data infrastructure. **Looking beyond clearances, an IAT Level II certification is requested in 6% of job postings for database administrators, which is 1.5 percentage points higher than the rest of our selected occupations.** Some CompTIA certifications are also requested for these roles, with the top four listed here in order of demand– including Security+, Security+ CE, A+, and Network+. By contrast, the top listed credential for technicians is a valid driver's license. **While the second most requested credential for technicians is a security clearance, job postings data indicate that there is not a high need for having one upon entry.** Therefore, this occupation provides a promising opportunity to gain industry experience without strict education or security requirements, both of which can be gained on the job as needed for further advancement.

Wages in this career pathway are promising. **Median annual earnings for technicians and database administrators are roughly $75,000 and $100,000, respectively; however, it is important to note that entry-level wages are about $20,000-30,000 lower.** Consequently, only database administrators meet the entry-level living wage threshold for a single adult in the region.

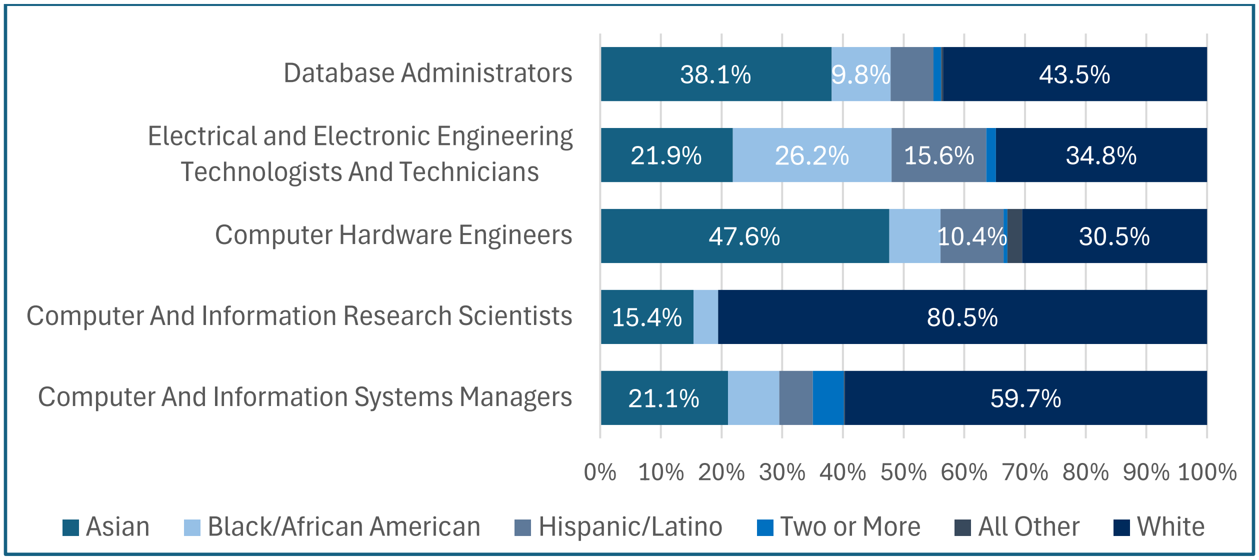
Figure 17. Data Infrastructure Pathway Wages and Wage Growth



The difference in these two feeder occupations can likely be attributed to the advanced education often requested for database administrators. **Entry-level and median wages for hardware engineers are much higher, indicating strong opportunities for individuals to access family-sustaining jobs in this pathway through advancement.** Entry-level and median wages for this role are both above six figures and can sustain a single parent household with one child, as well as a two-parent household with two or three children depending on how many working adults are present. Research scientists and systems managers provide even more security, with higher entry-level wages; in particular, systems managers offer the largest wage growth potential in the pathway beyond the hardware engineer role.

Overall, the data infrastructure pathway has limited, but promising, avenues to strengthen diversity and representation within key occupations. Both database administrators and technicians are majority-minority occupations; that is, most workers in these occupations are Asian, Black/African American, Hispanic/Latino, or another race/ethnicity. Hardware engineers are also majority-minority, although there is less representation among Black and Hispanic workers in this occupation versus the region as a whole (8.4% vs. 12.3% for Black/African Americans, 10.4% vs. 18.3% for Hispanic/Latinos). This representation begins to drop off in the more advanced levels of this pathway, with White workers significantly overrepresented compared to the region, with 80% of research scientists and 60% of systems managers identified as White.

Figure 18. Share of Region 7 Data Infrastructure Workers by Race/Ethnicity



Another promising indication of this pathway's diversity is the presence of veterans in key entry-level roles; **veterans make up 25% of electrical and electronic engineering technologists and technicians.** Representation of women in these roles, however, is less robust compared to the overall population. **Database administrators have the highest portion of female workers in the pathway at 35%, followed by systems managers at 30%, and technicians at 23%.** Both hardware engineers and research scientists, on the other hand, have less than a quarter of workers in Region 7 who identify as female. These numbers indicate there is room to grow diverse entry-level talent to ensure those individuals are being tapped for advancement opportunities and further upskilling.

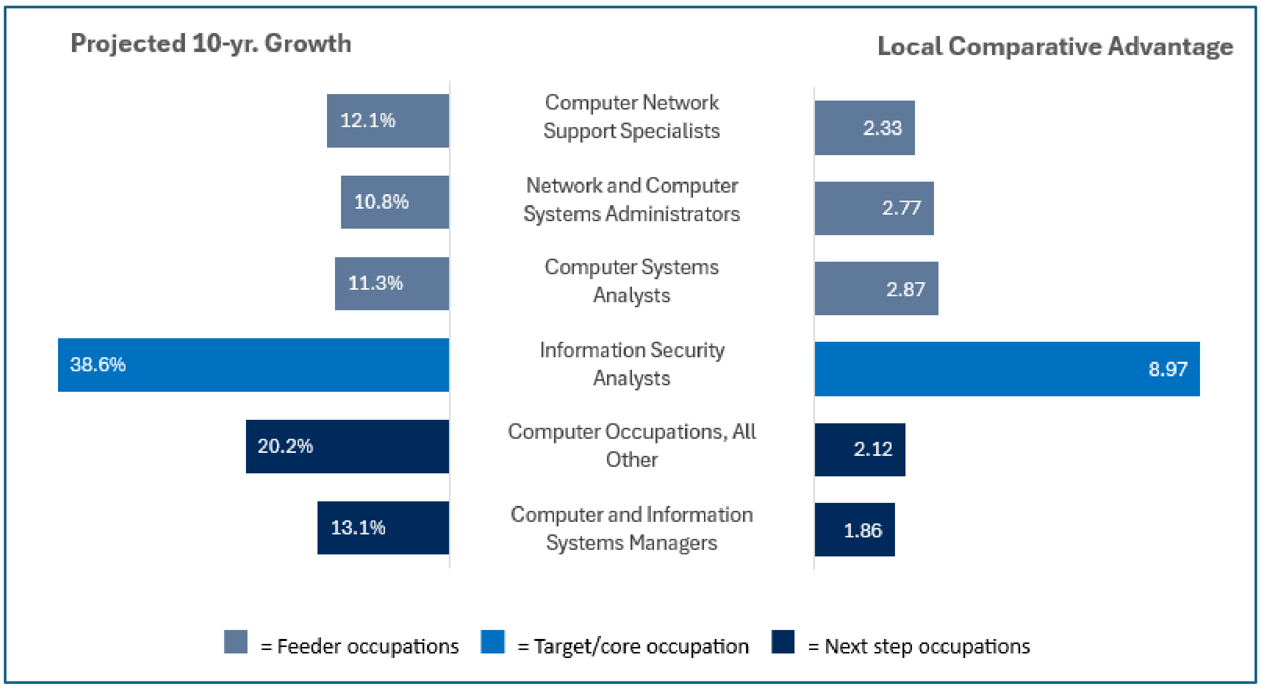
> The data infrastructure pathway offers strong opportunities for workers looking to enter the technology sector in Region 7. Although newer titles such as "data center technician" can be difficult to capture utilizing standard occupational taxonomies, data suggests a larger share of opportunities for workers with less than a bachelor's degree, as well as more sustainable wages for a broader portion of the region's workforce.

There are already pathway-related opportunities in the region, such as Micron's Registered Apprenticeship Program or NOVA's Data Center Operations Career Studies Certificate, which can offer avenues for this increased representation through non-degree training and education. Micron's earn-and-learn model offers a competitive wage for process, equipment, or lab technicians while covering tuition for a related certificate or associate degree. Zooming out, 5 out of the 13 technology-related apprenticeships in Region 7 offered training targeted to electrical and electronic engineering technicians (see *Table C6*). It is important to consider these sorts of opportunities as this pathway continues to grow in the region, ensuring equitable opportunities for all Region 7 residents regardless of background.

Cybersecurity

Information Security analysts make up 4.4% of employment across the region's computer services and emerging technologies industry clusters, the third largest occupation by share of cluster employment behind software developers and computer systems analysts. **Employment for information security analysts is projected to grow at a much faster pace in Region 7 than nationally, with a growth rate of 38.6% over the next ten years (7% higher than national growth)**. Information security analysts have the second highest local comparative advantage across all technology occupations (8.97), indicating an extremely high regional concentration. Information security analysts also use job titles like information security officers, information security specialists, information systems security officers (ISSO), information technology security analysts, or network security analysts. These roles are responsible for protecting information or computer networks and monitoring security measures.

Figure 19. Cybersecurity Pathway Occupation Demand

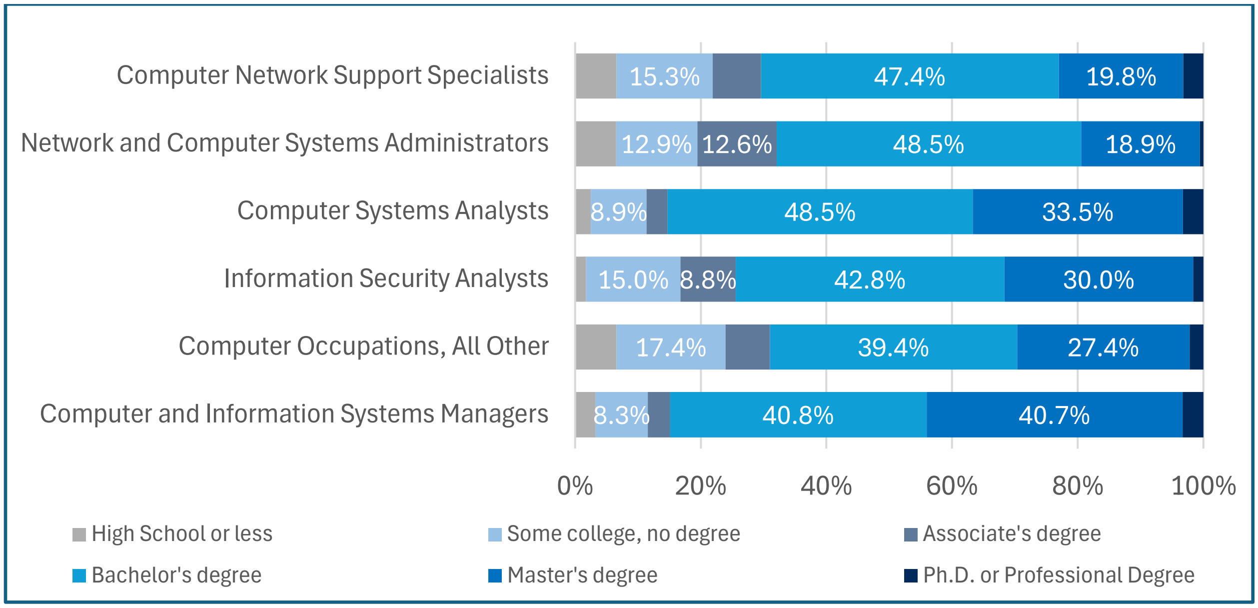


Information security analysts' major responsibilities such as network infrastructure monitoring and maintenance, system evaluation, and troubleshooting, resemble several occupations that constitute feeder occupations. **We selected three occupations that have the greatest degree of overlap based on job postings data: network and computer systems administrators, computer network support specialists, and computer system analysts. All of them have a larger than expected concentration of local employment and are in high demand, with projected growth rates that exceed 10% in Region 7 by 2032.** Computer network specialists have the highest projected growth rate among them, making it the most in-demand feeder occupation.

When advancing, information security analysts typically move into "Computer Occupations, All Other," which contains a wide range of specialized options such as penetration testers, digital forensics analysts, and computer and information systems managers. Both "Computer, All other" and computer and information systems managers have high growth prospects with 20.2% and 13.1% growth rate, respectively.

Computer network support specialists have the lowest formal educational requirements compared to other feeder occupations identified for this pathway. Only 60.6% of job postings require at least bachelor's degree, while other feeder occupations are 20 percentage points above this measure. Yet regional attainment data provided by the BLS note that computer network support specialists typically require an associate's degree, indicating a higher education requirement in Region 7 than the national average**. Even so, computer network support specialist is the most new-grad-friendly occupation in this pathway, with 17.6% of its job postings requiring 0-2 years of experience and no security clearance – the highest among all feeder occupations in the cybersecurity pathway – followed by computer systems analysts with 14.2%.**

Figure 20. Share of Region 7 Cybersecurity Workers by Highest Level of Education Attained



There is a steady increase in education requirements as the pathway progresses, with a bachelor's degree required in over 80% of job postings for the target and next step occupations. Likewise, work experience also increases as individuals advance in the career pathway. **It is important to note that despite being a mid-level occupation, information security analysts have the highest share of such requirements with 92.6% requiring a minimum of three years of experience.** Both "Computer Occupations, All Other" and computer and information systems managers have over 85% of job postings that require at least three years of experience.

Due to Region 7's proximity to the nation's capital, security clearances play a critical role in the career pathway progression, particularly, a TS/SCI (Top secret-sensitive compartmented information) clearance. 46.63% of job postings for information security analysts require a TS/SCI Clearance, one of the highest levels of security clearance requirement. Feeder occupations also have this requirement; 50.33% for network and computer systems administrator and 34.5% for computer network support specialists. Job postings for computer systems analysts also frequently request IAT Level II Certifications (22%). When advancing beyond information security analyst, the percentage of TS/SCI clearance requirement from job postings is about 5% lower for "Computer Occupation, All Other", which indicates a potentially relatively smoother change in career trajectory. TS/SCI Clearance remains the top certification requirement for computer and information systems managers, with 26.62% job postings contain such a requirement.

AI is more likely to enhance, rather than replace, occupations in the cybersecurity pathway. AI technologies help security analysts better identify threats; any increased efficiency generated through these technologies is not likely to reduce the number of roles required. Additional upskilling in these technologies, however, may be necessary.

Acquiring essential skills is also critical for career advancement. **Based on online job postings comparison, all three feeder occupations require an understanding of the domain knowledge for cybersecurity to proceed to information security analyst.** Vulnerability and incident response, two skills that require keen insights, are also important skills to obtain, though the degree of importance varies across three feeder occupations. **Moving forward, the skill gap tends to diversify. Both technical and management skills are needed to become a computer and information system manager.** Specifically, technology solutions require proficiency in software and management skills, which entail project management and IT service management. IT service management, in turn, requires a certain degree of professional skills to master. *Table 13* illustrates some of the commonly needed skills as an individual advances from entry- to mid-level and beyond.

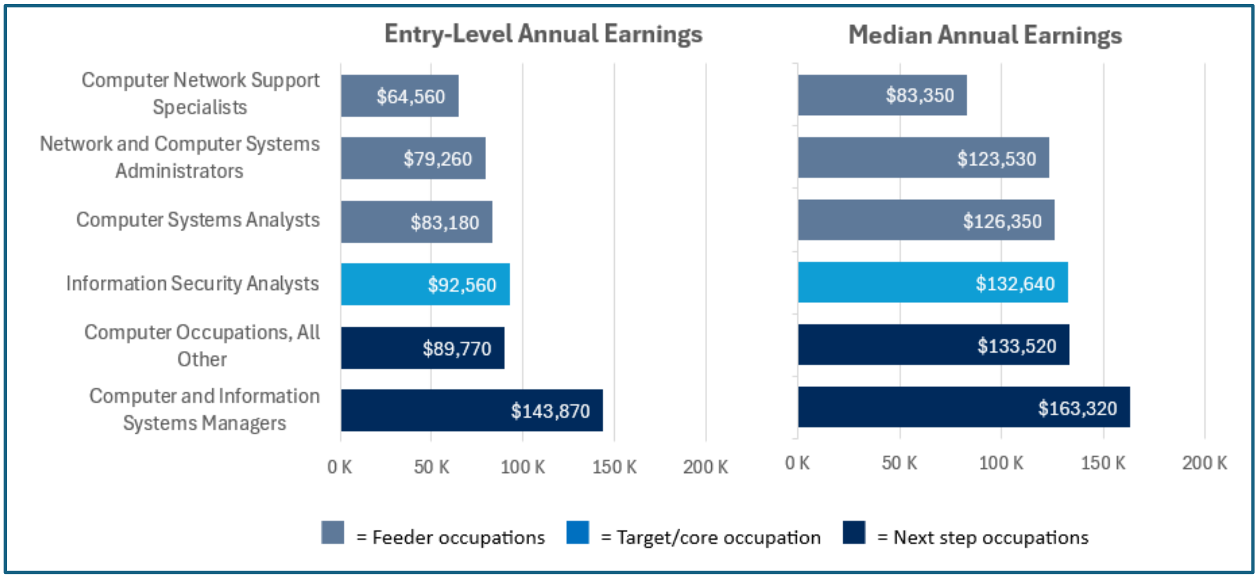
Table 12. Common Transferable Skills Across Occupations in the Cybersecurity Pathway

Entry-Level to Mid-Level	Mid-Level to Advanced
Collaboration	Data Analysis
Critical Thinking	Linux
Decision Making	Operations
Project/Program Management	Presentations
Team Leadership	Writing

Note: The skills in this table were identified as those with similar levels of demand across entry-to mid-level and mid-level to advanced roles based on job postings data. The skills listed here represent a snapshot of possible transferable skills in this pathway.
Source: Lightcast.

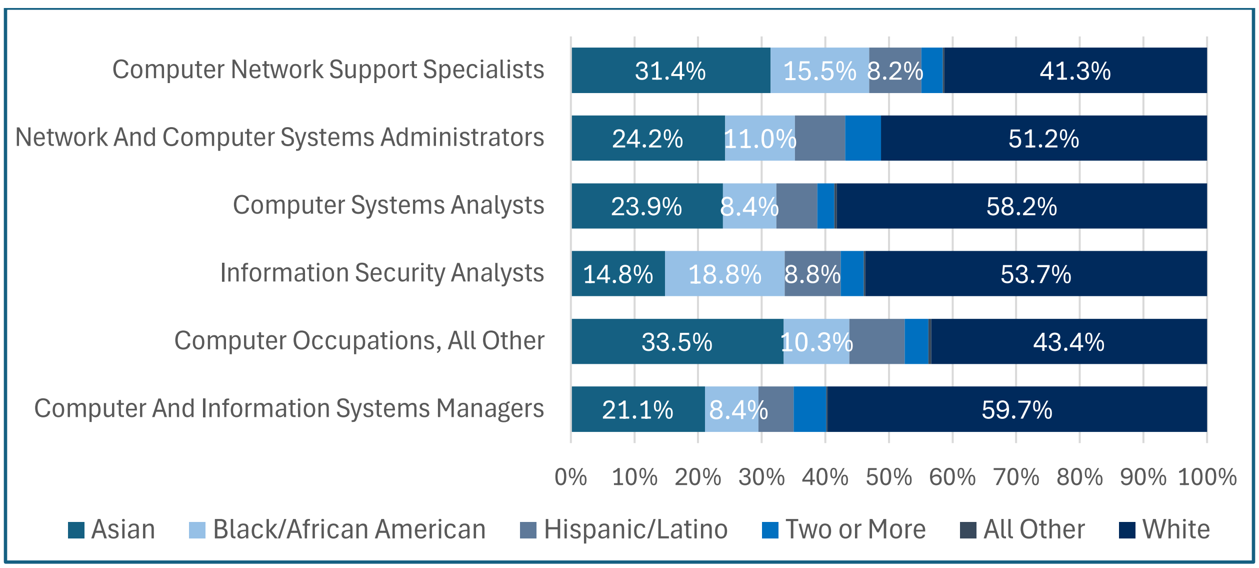
The cybersecurity pathway demonstrates a steady increase in wage growth. Computer network support specialists earn the lowest entry-level wage compared to other feeder occupations in the identified pathway, making $64,560 annually. This wage level would only support a dual-income household with up to two children or a single working adult with no children. Moving forward, entry-level information security analysts earn $92,560 annually, which would offer a dual-income household earnings above the living wage threshold even if their family includes up to three children. Progressing beyond information security analysts, working as computer and information systems managers experience a significant boost in wage growth, earning $191,470 annually.

Figure 21. Cybersecurity Pathway Wages and Wage Growth



Across the cybersecurity pathway occupations, the demographic distribution shares the same pattern: workers who identified as White constitute the largest share of workers in Region 7, followed by Asian, Black/African American, and Hispanic/Latino. The discrepancies between White and Asian workers are smaller than the ones between Asian workers and Black/African American workers. **When comparing the distribution of cybersecurity workers in Region 7 to the distribution of the total population, Hispanic/Latino workers in the cybersecurity sector are underrepresented.**

Figure 22. Share of Region 7 Cybersecurity Workers by Race/Ethnicity



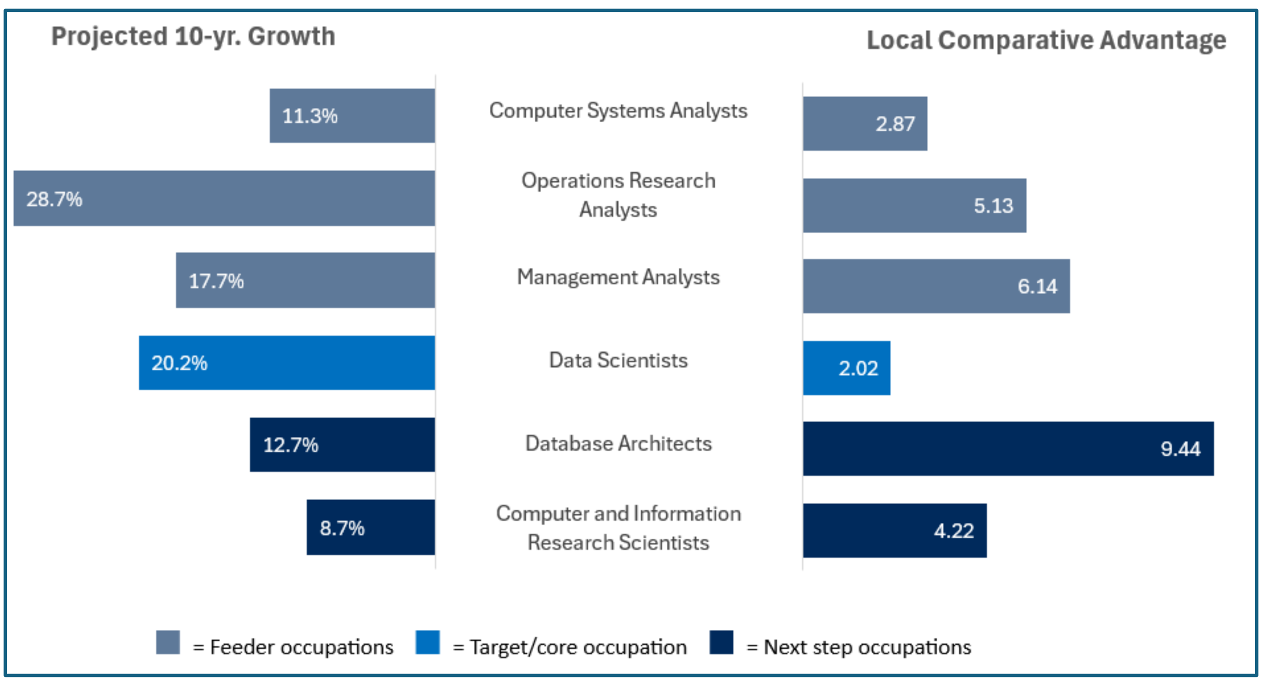
The high demand for security analysts and critical nature of cybersecurity skills make this a key pathway for improvement. Pathways to cybersecurity analyst jobs also offer potential for more readily accessible entry-points, like software developers.

When looking at gender distribution, all five occupations across the cybersecurity pathway are male dominated. Females only constitute less than 40% of the workers in all five occupations. **Computer systems analysts have the smallest gender gap among all target occupations identified in this report.** This occupation is the only one with a female representation equal to the average share of female workers in Region 7. In contrast, all other occupations show a male workforce that is at least twice the size of the female workforce. **Overall, these trends suggest many opportunities to advance representation in the cybersecurity sector and encourage more women to pursue STEM education, training, and careers, especially in cybersecurity.**

Data Science

Among the target occupations, data scientists are the fastest growing occupation nationally (35%), as well as among the top five fastest growing occupations regionally (20%). In 2023, there were 7,872 job postings for data scientists, the third highest amount among key occupations and roughly 3,000 postings above average for selected occupations in Region 7. Employer interviews also indicated a broad need for data analytics and core scientists, which further indicates continued growth in the region. Alternative titles also include Business Intelligence Analyst, Competitive Intelligence Analyst, Data Analyst, Market Intelligence Analyst, and Market Intelligence Consultant.

Figure 23. Data Science Pathway Occupation Demand



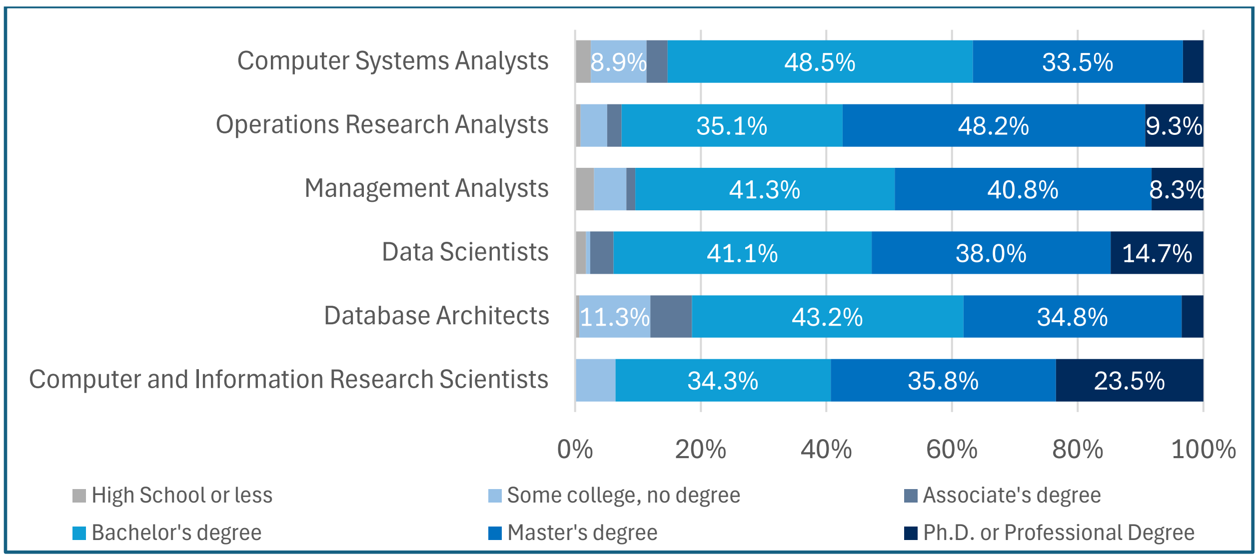
There are three feeder occupations of note: management analysts, computer systems analysts, and operations research analysts. Each of these occupations is projected to grow by at least 11% over the

next 10 years, increasing by roughly 9,900 jobs between them over that same time frame. Operation research analysts and management analysts also have high employment concentrations in the region. These occupations often work alongside data scientists in varying capacities. As a result, these occupations are often not only familiar with the data scientist role, but also represent skill-based steppingstones to the data scientist role. **Overall, each feeder occupation shares certain similarities with the data scientist role, while also presenting distinct skill gaps that can be bridged through targeted upskilling, enabling a smoother transition into data science.**

There are two next step occupations identified in this pathway for data scientists which are database architects and computer and information research scientists. **These next step occupations have a high degree of skill overlap with data scientists and are projected to grow by at least 9%, adding around 720 jobs (including 617 expected database architects).** The main difference between these two roles is that while computer and information scientists create new methods, data scientists are more focused on applying existing methodology and technology.

All three feeder occupations require a minimum education of a bachelor's degree for the majority of their respective job postings, ranging from 65% to 70%. Data scientist job postings have similar educational requirement requirements – with 68% of postings that require a bachelor's degree as compared to database architects in which 60% of postings require a four-year postsecondary degree. While only around 42% of job postings for computer and information research scientists require a bachelor's degree, an additional 29% of those postings require a master's, posing an additional barrier for advancement.

Figure 24. Share of Region 7 Data Science Workers by Highest Level of Education Attained



Given that many job postings for every occupation in this pathway require at least a bachelor's degree or 3+ years of experience, it is difficult to consider even the feeder occupations to be entry-level jobs. Only a small portion of each occupation (ranging from 8.7% - 14.2% of jobs postings that require less than a bachelor's, 0-2 years of work experience, and no security clearance) could be considered entry-level jobs.

Like many occupations in the region, security clearances make up one of the top three credentials required for all occupations in the pathway. Management analysts have the fewest proportion of job postings that require some type of security clearance (17.5%), while roughly a quarter of job postings for data scientists require a top security clearance. Other top credentials for these pathway occupations include PMP certifications, CISSP, and CompTIA+. Feeder occupations tend to have more postings requiring the PMP certification (4-5%) compared to data scientists (1.5%) and next step occupations (0-2%). CompTIA Security+ requirements also range from 1.5% - 4% of job postings for feeder occupations, 2.6% for data scientists, and 4.5% for database architects.

The data science pathway will likely be significantly impacted by AI adoption. The prominence of AI skills in data scientist job postings indicates the field is only likely to increase as AI technologies becomes more commonplace.

Regarding skills, the biggest gap between the feeder and target occupations are technical data skills related to programming languages, data analysis, machine learning, and computer science. Professional skill gaps include communication and more analytical professional skills such as critical thinking, decision making, governance, and strategic planning. **A particularly important skill gap is in artificial intelligence; 22% of job postings for data scientists require AI as a skill, whereas only 4-5% of management and operation research analyst postings required this skill.** *Table 12* illustrates some of the common transferable skills across roles, illustrating the need for professional skills across roles even as more technical skills are introduced.

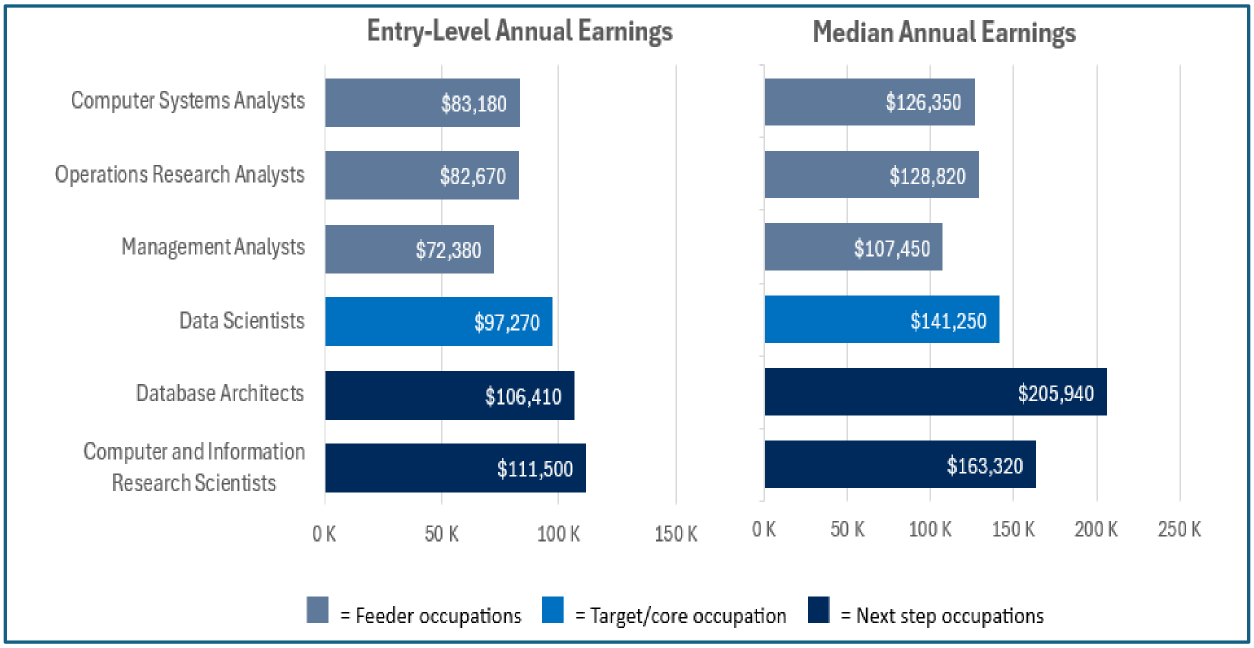
Table 13. Common Transferable Skills Across Occupations in the Data Science Pathway

Entry-Level to Mid-Level	Mid-Level to Advanced
Collaboration	Application Programming Interface (API)
Mentorship	Automation
Research	Critical Thinking
Strategic Planning	Scripting
Teamwork	Writing

Note: The skills in this table were identified as those with similar levels of demand across entry-to mid-level and mid-level to advanced roles based on job postings data. The skills listed here represent a snapshot of possible transferable skills in this pathway.
Source: Lightcast.

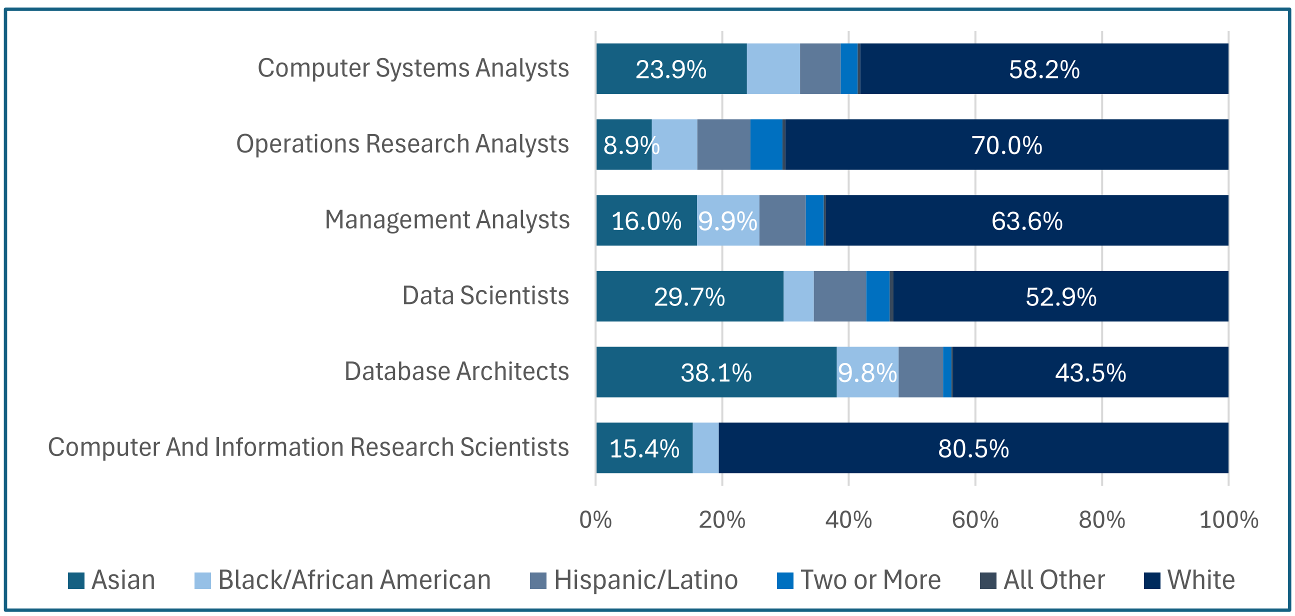
Each occupation in the data analytics pathway provides a living wage at both entry and median earning levels. On average, the median annual wage for a data scientist is around $20,000 more per year than the feeder occupations at $141,250, with the next step occupations ranging from $20,000 - $60,000 more per year. Compared to computer systems analysts and management analysts, the higher median wage for operations research analysts suggests that there could be greater upward mobility in wage growth over time than the other two feeder occupations.

Figure 25. Data Science Pathway Wages and Wage Growth



Examining the demographics of these pathway occupations, database architects stand out as the most racially and ethnically diverse at only 43.5% White. The feeder occupations are less diverse than data scientists and database architects, ranging from 58.2% to 70% White, and computer and information research scientists has the least racial/ethnic diversity of all occupations in this pathway.

Figure 26. Share of Region 7 Data Science Workers by Race/Ethnicity



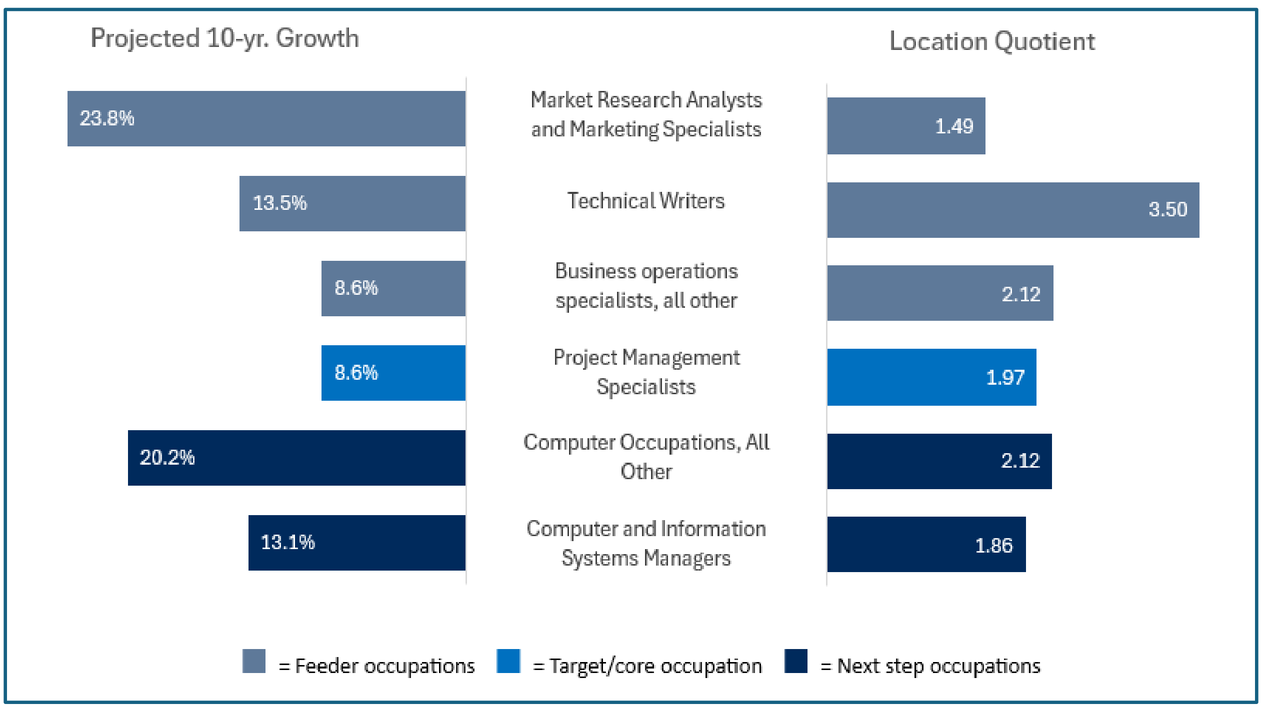
All occupations in this pathway are also male dominated, although 5 out of the 6 pathway occupations have more female representation when compared overall to all target occupations. The one occupation that does not meet this threshold is computer and information research scientists at 80% male. The remaining occupations range from 54% to 65% male. **The target occupation, data scientists, have the largest proportion of female workers in Region 7 of all occupations in this pathway (46.2%).** Taken together, this suggests that gender representation is stronger in this pathway than some of the others, yet there is still room for improvement and additional representation moving forward.

> While data analytics is the highest paying pathway and offers significant opportunities for wage growth, there are fewer entry points available to those without a bachelor's and related work experience, and many entry-level roles require graduate degrees.

IT Management

According to staffing patterns data from Virginia Works, project management specialists make up the 10th largest share of employment among occupations in the region's computer services and emerging technology clusters. **In 2023 there were over 6,000 job postings for project management specialists, making it the 4th most advertised among occupations selected for analysis.** Virginia Works projects that it will grow 8.6% in Region 7 over the next 10 years with more than 2,000 annual openings. **Employer interviews also consistently elevated the need for technical project managers regardless of company size, thus solidifying project management specialist as one of our key occupations.**

Figure 27. IT Management Pathway Occupation Demand



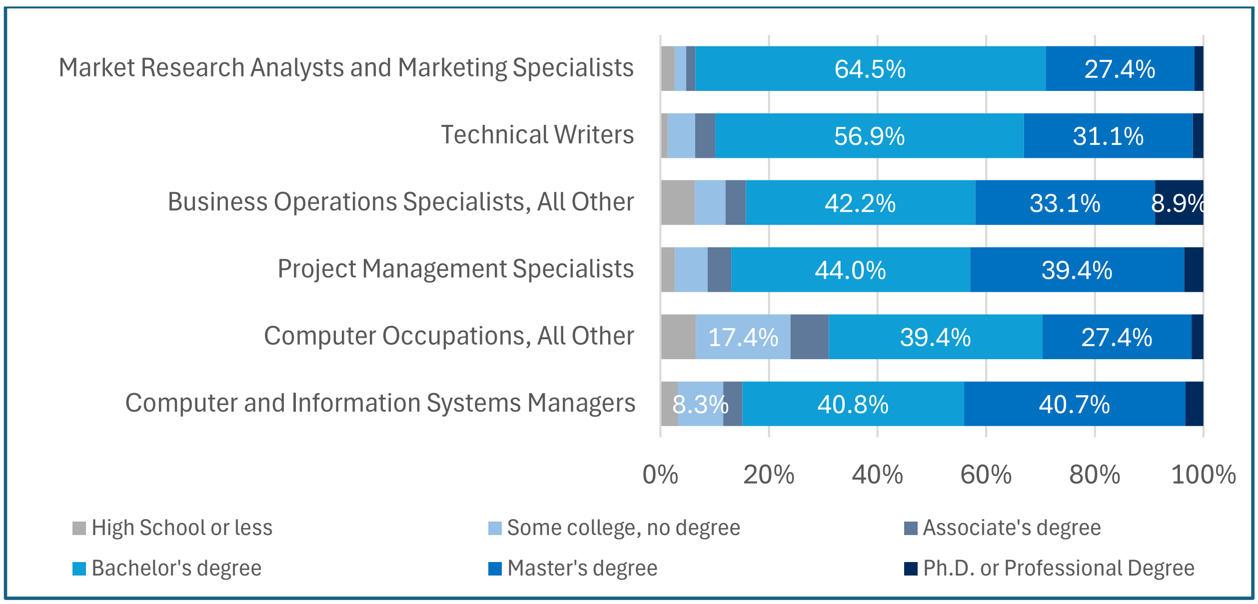
The three feeder occupations are market research analysts and marketing specialists, technical writers, and business operations specialists, all others. **Of these three feeder occupations, marketing research analysts are expected to grow the fastest at 24%, yet business operations specialists will offer the**

greatest number of new job opportunities. Technical writers are projected to have the fewest annual openings at only 205 per year. Market research analysts and marketing specialists research conditions in various markets and gather information to project potential sales of a product or plan a marketing campaign. Technical writers have more experience on the back end of projects, such as writing equipment manuals, appendices, or operating instructions. Business operations specialists include job titles such as business continuity planners, sustainability specialists, and security management specialists, all of which have strong skill overlap with project management specialists.

The two next step occupations are computer and information systems managers and computer occupations, all others. Each of the two occupations is projected to keep growing and offer more than 900 annual openings for the next 10 years. Computer and information system managers plan, direct, or coordinate activities in the IT field. They can manage either day-to-day operations or longer-term planning. The computer occupations, all other category represents a catch all for several occupations including information technology project managers. This is the more specialized and advanced occupation for project management specialists making it a natural next step occupation.

Every job in the IT Management pathway has over 85% of job postings requiring a bachelor's degree or higher, showing there is not much deviation among education requirements along this pathway. Computer occupations have the greatest discrepancy between job posting requirements and in-practice hiring with 90% of the job postings requiring a bachelor's or higher, but over 30% of workers with less than a bachelor's degree.

Figure 28. Share of Region 7 IT Management Workers by Highest Level of Education Attained



When looking specifically at job postings that do not require a bachelor's, the only occupation that does not have over 80% of the remaining postings requiring 3+ years of experience is business operations specialists. Given that only 33 of the 402 unique postings do not require a bachelor's, this means that 14 postings can truly be considered 'entry-level', or roughly 3% of all postings for this occupation. Of the feeder occupations, market research analysts had the most non-bachelor's entry-level position postings at 45. These pre-requisite higher education and experience requirements severely limit the number of people who can enter this pathway.

> IT management may see some impacts from the expansion of AI, including the integration of new technologies into existing management programs and techniques. It is not likely, however, that AI will drastically affect project manager roles which tend to leverage interpersonal skillsets.

The security clearance requirement is almost unescapable in this pathway. The most requested certification for both next-step occupations and technical writers is the Top Secret-Sensitive Compartmented Information Clearance (TS/SCI), the highest level of security clearance. **TS/SCI is the second most requested certification for project management specialists and market research analysts behind the PMP certification.** Another certification that can be helpful throughout the pathways is CompTIA Security+. This certification is required in several posts for the feeder occupations, and frequently in postings for computer occupations, all other.

Each feeder occupation prepares jobseekers well for the communication aspects of the project management specialist, but other common skills, like planning or leadership, are not nearly as important in the feeder occupations as they are in the target occupation. Understandably, the main skill that each feeder occupation needs to improve to move up the pathway is project management. This aligns well with the PMP being the most requested certification for project management specialists. A job seeker with that certification proves to employers that they have developed needed skills outside of their current job role to take the next step in their career. Experience with the Agile Methodology should also prove helpful in this pathway.

On the other hand, the skills needed for the two next step occupations are drastically different from each other. Workers moving into computer occupations, all others, will need to improve their knowledge of systems engineering, computer science, cyber security, AWS, and Python. Each of those skills are important and overlap the least with project management specialists. Meanwhile, workers moving into computer and information systems management will need to improve their knowledge of cybersecurity and computer science, and general IT, innovation, and leadership. Nonetheless, there are still transferable skills across entry- to mid-level roles including communication skills and basic programming, and skills like accounting and agile for mid-level to advanced roles (see *Table 14*).

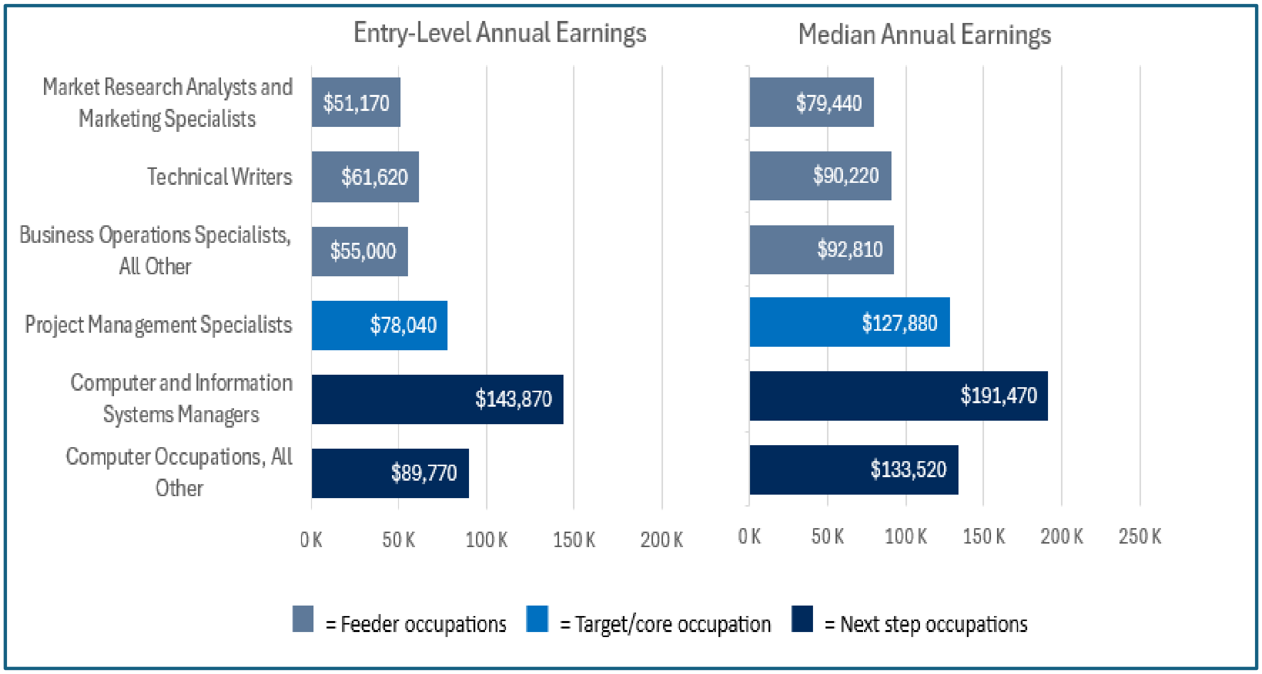
Table 14. Common Transferable Skills Across Occupations in the IT Management Pathway

Entry-Level to Mid-Level	Mid-Level to Advanced
Business Process	Accounting
Critical Thinking	Agile
Interpersonal Communications	Management
JavaScript	Team Leadership
Microsoft Excel	Writing

Note: The skills in this table were identified as those with similar levels of demand across entry-to mid-level and mid-level to advanced roles based on job postings data. The skills listed here represent a snapshot of possible transferable skills in this pathway.
Source: Lightcast.

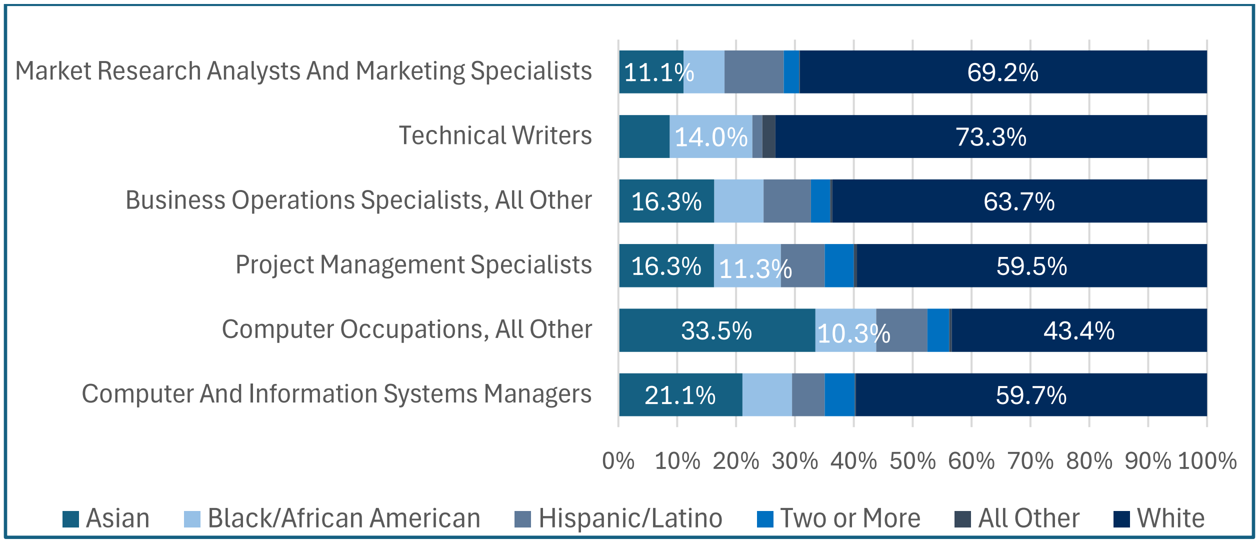
Out of the three feeder occupations, technical writers represent the only occupation that pays a living wage for a single worker at entry-level. While the median earnings are more promising, entry-level wages for business operations specialists and market research analysts only pay enough to be a living wage for two adults working in the same household without kids. Project management specialists and computer occupations, all others, are expected to make roughly the same wage at entry and median levels, with the next step occupation expected to make slightly more. Computer and information systems managers are the highest earning key occupation at entry-level and the second highest earning at median level.

Figure 29. IT Management Pathway Wages and Wage Growth



Most occupations along the pathway are majority White; however, there is greater representation of minority groups in the advanced occupations than in the entry-level roles – a dynamic that is flipped compared to data infrastructure and other pathways in the report. Given the broad range of feeder roles for computer occupations all other, it makes sense that this role may be more representative of different groups in the region. The underrepresentation of minority groups in the feeder roles presents more opportunities to strengthen and diversify this pathway as well as pathways leading to project management specialists.

Figure 30. Share of Region 7 IT Management Workers by Race/Ethnicity



Notably, each of the feeder occupations are majority women. While project management specialists are majority male in Region 7, the occupation is still more female (43%) than the average across our five key occupations selected for further analysis (33%). Both next step occupations are majority male. **Investing in these feeder occupations can strengthen advancement and help bring more women into senior-level occupations, resulting in both more racial and gender diversity across the entire pathway.**

While we might assume that non-technical/technology roles in the IT operations pathway would provide greater entry-level opportunities for those without a bachelor's degree, the opposite is the case, with occupations in the pathway requiring higher levels of education and experience for less sustainable wages.

Pathways Summary

Among the pathways identified for analysis, software development and cybersecurity offer more readily accessible entry-points, particularly through entry-level jobs like user and network support specialists. These key entry-level technology occupations provide opportunities for workers with less than a bachelor's degree. While employers and stakeholders emphasized user support/help desk as prime entry-level opportunities, network support roles may offer a more sustainable career path, both in terms of livable wages and ease of advancement into mid-level network/systems administrator and information security analyst opportunities. Credentials and certifications, specifically CompTIA A+, Network+, and Security+ can help secure employment in these jobs, however a majority will still likely require a bachelor's degree due to higher educational attainment and requirements in the region, on average. While some of these entry-level occupations may be affected by additional AI integration, other jobs may be created such as AI engineers. AI is seen as a threat for job displacement in some of the entry-level careers, but skills in using AI are more likely to enhance opportunities in cybersecurity.

The data infrastructure pathway (encompassing data centers and internet infrastructure) potentially offers even stronger opportunities for workers looking to enter the technology sector in Region 7. Although newer titles such as data center technician can be difficult to capture utilizing standard occupational taxonomies, data for a combination of those entry-level occupations most likely to encompass them (database administrators and electrical/electronic technicians) suggest a larger share of opportunities for those with less than a bachelor's degree, as well as more sustainable wages for a more representative workforce. Given that AI is expected to have minimal impact on physical occupations, the data infrastructure pathway may be more resilient to technological disruptions moving forward. In fact, AI is more likely to increase demand for data infrastructure given that generative AI is data intensive.

Although data analytics and science occupations represent the highest-paying pathway we examined and offers significant opportunities for wage growth even among entry-level workers, there are fewer entry points available to those without a bachelor's degree and related work experience. The data science pathway may also be the most impacted by emerging AI technologies given the demand for AI skills for current job postings in Region 7. Given the substantial demand for analytics roles expressed by employers and stakeholders, employers need to identify more pathway entry points for a broader segment of the workforce (especially those from underrepresented groups). Additionally. while we might assume that non-technical/technology roles in the IT operations pathway would provide greater entry-level opportunities for those without a bachelor's degree, we found that the opposite is the case, with occupations in the pathway requiring higher levels of education and experience for relatively lower wages.

Increasing access to careers is critical to tapping the full power of Region 7's workforce. Across pathways, there are opportunities to increase representation among communities of color and women. While entry-level opportunities are more representative of the region's population, certain groups (especially Black, Hispanic, and female workers) continue to be underrepresented. These disparities only increase as pathways progress to mid and senior levels. Finally, even among technology occupations, entry-level wages are generally only sustainable for dual-income households or single-income households without children. Many of the most promising entry-level occupations (support specialists and data technicians) do not offer self-sustaining livable wages in high-cost Northern Virginia. Creating efficient pathways from these roles into better-paying jobs through technical skills training is critical, not only for equity and sustainability, but to meet the most pressing employer demands.

Final Chapter: Preparing for Change

These pathways respond to the economic development and diversification priorities of the region. Their strengths and weaknesses correspond to challenges facing the region. By addressing issues and opportunities, area employers will improve their ability to adapt to new challenges. With further commitments to collaboration by public and private sector leaders, these tech talent pathways can support a more entrepreneurial and innovative Region 7 ecosystem.

GoVirginia Region 7 needs to ensure the pathways within this cluster remain strong to support the industry's ability to innovate, commercialize new technologies, and compete for talent with other top geographies, such as San Francisco or New York. Entrepreneurs and innovators benefit from homegrown talent development efforts that strengthen the local schools and support residents as they establish families and seek to advance their careers. For career starters and career changers, earn-and-learn programs and paid work experiences in entry- and mid-level career transition roles can reduce the time that talented individuals are earning entry-level wages, jumpstarting their (new) careers, and benefiting area employers in productivity gains. This is critical in a high cost of living region, especially if area employers hope to expand these tech talent pools to include more Women, Black, and Latinx populations.

These tech talent pathways are also important to grow a strong entrepreneurial ecosystem, where tech talent has the skills, resources, and opportunities to start new businesses. But smaller and medium-sized start-ups and spin-offs need explicit support to help fuel regional growth, innovation, and resilience, including in talent development. To avoid losing economic potential, especially given that the region has one of the largest concentrations of tech talent in the world, expanding and investing in local tech talent can be intentionally linked to nurturing the local innovation ecosystem, strengthening smaller startups, and eventually attracting more venture capital investment. Utilizing a regional approach that uplifts local talent alongside small and medium sized businesses will help support a more robust innovation ecosystem that leverages all the region's assets to contribute to more sustainable growth.[37]

The emergence of artificial intelligence also requires a coordinated, regional response to both understand and articulate strategies for adopting these new skills and technologies. A recent report from the Greater Washington Partnership found that AI/Machine Learning skills are some of the highest-growth skill sets in the region, with a much higher growth rate in the region than the rest of the country.[38] Northern Virginia also expects to see significant investments in the semiconductor industry in the coming years. Micron is likely to lead this charge, leveraging funding from the bi-partisan 2022 CHIPS and Science Act to invest $3 billion in an expansion of their Manassas facility by 2030. The expansion will move some manufacturing capabilities from Taiwan to Virginia and nearly double the company's current workforce of 1,230 people.[39] Region 7 leaders must proactively respond to these dynamics, focusing on initiatives that fortify resilient and diverse talent pathways that adapt to rapidly changing careers in these fields. The recommendations below provides a roadmap for Region 7 to strengthen and expand its tech talent ecosystem.

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[37] Clower, Terry and Jonathan Aberman, "The venture capital void," *Washington Business Journal*, 15 March 2024, https://www.bizjournals.com/washington/news/2024/03/15/the-venture-capital-void.html.

[38] Greater Washington Partnership, "2024 Skills Forecasting: Employer signaling for the future of work," 2024, https://greaterwashingtonpartnership.com/wp-content/uploads/2024/07/GWP-Skils-Forecasting-Report-2024.pdf.

[39] Robertson, Mark D., "Micron expects to expand Manassas facility soon," *Virginia Business*, 30 July 2024, https://www.virginiabusiness.com/article/micron-expects-to-expand-manassas-facility-soon/.

Final Recommendation: Supporting Region 7's Data Infrastructure

Based on the analysis in this report, three pathways offer the greatest opportunity for scalability and sustainability in the region: data infrastructure, software development, and cybersecurity. We still do not know the extent to which AI is going to transform these pathways, particularly the latter two. Area employers and education institutions, however, are well positioned to adapt and start up relevant education and training programs as AI and related technologies transform the skills needed for these key sectors. Evidence suggests that employers in the region are already providing some training and upskilling opportunities such as in-house training to integrate new technologies. These companies, and the more than 6,000 tech-oriented companies in the region, will require a robust data infrastructure, including data centers and support systems to ensure uninterrupted capacity and connectivity.

In the short term, there is an opportunity to bolster the region's data infrastructure to support a burgeoning ecosystem of data centers, semiconductor facilities, and emerging technologies. There is also a need to fortify pathways into relevant jobs that lead to, but do not require, a bachelor's degree at entry. Employers are increasingly demanding a sophisticated blend of technical and professional skills for advancement, and many report that important skills can be learned on the job if entry-level talent is motivated and supported. However, the work experience offered must be aligned with opportunities for advancement in the IT and emerging technologies sectors.

To anchor the region's tech talent development efforts, CREC recommends that GoVirginia Region 7 leaders invest in the data infrastructure pathway to expand the number of multi-skilled technicians that advance to mid-level management roles. The data infrastructure installation and maintenance pathways provide promising entry-level and career-change opportunities for both technical and trade-focused roles at a sustainable wage. As the data infrastructure pathway section describes above, database administrators and electrical/electronic technicians have a projected growth rate of 12.7% and 7.8% respectively, adding a total of roughly 600 new jobs by 2032 – a number that is likely to grow given recent investments in both data center and semiconductor infrastructure in the region. Mid-level careers include roles such as hardware engineers. As of 2024, there are 348 data centers in Northern Virginia – 239 of which are operational and 109 are in development.[40]

This investment will bolster key industries which support pathways to other in-demand job roles. For example, software developers are a prominent occupation in the Data Processing, Hosting, and Related Services industry (NAICS 5182), with over 2000 jobs and a projected growth rate of over 20% by 2032. Combined with the upwards of 500 businesses in Region 7 that are a part of this industry, this overlap reinforces the need for an education and training model that supports a multi-skilled talent pool. A recent talent assessment of the state of Oregon found the skills required for semiconductor and information technology roles are closely aligned, illustrating opportunities for transferability and progression across different sectors.[41] The analysis in this report also illustrated the transferability of professional skills such as communication and management, in addition to more specialized skills such as cloud computing and

[40] https://www.datacentermap.com/content/nova/
[41] SRI, "Oregon 2024 Talent Assessment," May 10, 2024, https://www.oregon.gov/highered/strategy-research/Documents/Reports/2024-talent-assessment.pdf.

machine learning. A multi-skilled pathway that addresses these different areas can help strengthen the region's tech talent workforce.

Region 7 can leverage existing academic programming to bolster earn-and-learn models, like apprenticeships, to help key regional employers develop entry- to mid-level technician talent. Apprenticeship and apprenticeship-like approaches in the tech sector require support from an institution of higher education which embeds foundational programming skills for IT and technicians, beginning when an individual is hired and fortified through a one- or two-year training period. This ensures participants can continue to earn and learn effectively throughout their career, gaining additional credentials and attaining BA and Graduate degrees.

Given that IT skills are increasingly necessary across the trades, IT skills can be embedded in existing construction and building maintenance programs. These support large businesses in the region. Small and medium-sized businesses will need additional support to develop multi-skilled leaders. Training providers working across large and small companies can ensure multi-skilled workers obtain skills they can translate across several career pathways.

Tables C5-C7 list the training programs and post-secondary credentials currently available within Region 7 to support the occupations identified in the entry- and mid-level roles of the data infrastructure pathway. Additionally, there are various programs within the broader Washington D.C., MSA that also provide training specifically related to data center operations. Laurel Ridge Community College has non-credit certification training for data center technicians and fiber optic installers. Germana Community College offers a for-credit Data Center Technician/IT Technician Career Studies Certificate which has a more IT tech-focused curriculum than some of the programs currently offered at NOVA. These programs can be utilized as other examples when building out this recommendation in Region 7.

Investing in multi-skilled technicians to upgrade, maintain, and defend the region's hardware and IT systems is necessary to support more than just the data centers and existing IT and emerging tech businesses. All businesses are increasingly tech-enabled. And with Micron's proposed expansion in Region 7 and the emergence of AI, there will be a high need for multi-skilled technicians who can move across and between sectors. Please refer to Appendix E for suggested next steps to translate this recommendation into action.

Program Examples

NOVA's data center model and programming can serve as a starting point for this work. NOVA has helped convene data center employers in the region who have coalesced around particular industry needs. Together, the data centers have worked as a group alongside local educators to make critical connections between academia and businesses. NOVA currently offers two different Data Center operations programs – an associate's and a certificate – that could be leveraged as part of a larger employer-based work-based learning program for data technicians with a targeted group of data center employers. George Mason University has also developed a course on data center engineering in tandem with AWS as a part of their broader engineering departments.[42]

[42] George Mason University, "Amazon develops data center engineering curriculum with Mason, " July 27, 2023, https://www.gmu.edu/news/2023-07/amazon-develops-data-center-engineering-curriculum-mason.

NOVA's Engineering Technology Career Scholars Program also offers a good opportunity for young jobseekers exiting high school to gain experience through a summer bridge program, complete the data center certificate, and receive a guaranteed interview for an internship at a data center partner. Micron is also a leader in this area, providing apprenticeship opportunities for process, equipment, or lab technicians in partnership with NOVA. The VAST network can also serve as a critical partner for this recommendation as the region works to coordinate technician training to support multiple industry needs.

To build the talent pipelines for manufacturing and IT, Hampton Roads Workforce Council has convened employers and other partners to advance a number of complementary programs that are coordinated on a regional scale across SE Virginia (Virginia Beach-Chesapeake-Norfolk MSA with a population of 1.8 million). This includes working with school districts and community groups to launch Next Gen high school internship programs of 60 hours to develop essential workplace skills. Large employers are championing job training in clean energy, maritime, and cybersecurity jobs (NewPort News Shipbuilding, Dominion Energy, with US EDA) and apprenticeship programs. These efforts are coordinated across 7 area economic development organizations, 7 area public K-12 school districts, equity-focused community-based organizations, Virginia Works and Virginia Apprenticeship Council, with support from community colleges, four-year universities including HBCUs, proprietary colleges, and the Joint Apprenticeship and Training Committee at IBEW Local 80. The Hampton Roads Community Foundation supported initial research and strategic alignment efforts that informed these collaborations, which include a focus on advocating for the needs of small and minority-owned businesses. The Hampton Roads Executive Roundtable supports ongoing employer leadership in tech talent development.

Similar programs have been successful for small businesses. The FAME program, introduced by Toyota and leveraged by employers nationwide, offers a framework for employer sponsorship of high school work-based learning and continues through full time employment and community college coursework. Graduates gain a full understanding of the manufacturing field while honing their skills at a primary place of work. The program effectively develops and refines professional skills that last a lifetime. Larger businesses could develop these programs to support their workers and to provide a model for small and medium-sized firms.

Important Considerations

In designing these programs, it is notable that the region needs to increase gender diversity to develop the talent for traditionally male-dominated occupations such as technicians/technologists and computer hardware engineers. Technicians/technologists occupations have more racial and ethnic diversity than related IT and emerging sector careers, and this group offers a promising talent pool for further development and advancement.

Table 15 below illustrates some of the strategies that various stakeholders in Region 7 can take to support the expansion of multi-skilled technician development. Future implementation projects over the next few years can align with these actions to support Region 7's burgeoning data infrastructure space. It is important to note that the region will likely need a lead facilitator for this work that is funded or sponsored by government, businesses, unions, and philanthropic partners in order to support various stakeholder groups in fulfilling their roles, designing their contributions, fulfilling their commitments, and evaluating their progress. Please see Appendix E for more details on this larger implementation challenge.

Table 15. Actions Needed by Stakeholder Group (2025-2027) to Support Region 7's Data Infrastructure

	2025	2026	2027
Large tech companies	Convene with other large companies; gain commitments to co-invest in multi-skilled technician talent development; identify priority positions and estimate hiring schedules.	Structure/stand up WBL and other opportunities for multi-skilled technicians alongside education providers; commit to sponsor paid learning opportunities aligned with data center investments.	Evaluate business ROI.
Small and mid-sized tech companies	Connect with education and training providers to discuss multi-skilled technician talent needs; identify priority positions; estimate hiring schedules; commit to sponsor paid learning opportunities.	Participate in work-based learning and other opportunities for multi-skilled technicians; advocate for small business supports to fill gaps in training pipeline.	Evaluate business ROI.
Data centers (large and small)	Identify priority positions; estimate hiring schedules; and commit to sponsor paid learning opportunities.	Fine tune work-based learning opportunities and relevant training to deliver industry-required skills and abilities.	Evaluate business ROI.
Government (GoVA, public workforce, economic development, municipal leaders)	Recruit partners to the table; develop champions across sectors (business, education, workforce training, unions); convene regular conversations about needs and best practices.	Continue to convene; support technician training; host workshops on employer pain paints that feature regional resources.	Continue to convene; provide and publicize ROI information about multi-skilled technician talent development programs.
Post-secondary educational institutions	Take stock of available opportunities and curriculum that could support multi-skilled technician talent development.	Develop and enhance curriculum and existing opportunities to support multi-skilled technician training (e.g., NOVA's data center program, VAST network) .	Evaluate program results and highlight student/employee ROI.
Private training providers, unions, other talent development intermediaries	Connect with government and post-secondary institutions about needs and best practices already established.	Develop and enhance existing opportunities to support multi-skilled technician training (e.g., IBEW apprenticeship).	Evaluate program results and highlight student/employee ROI.

Supplemental Recommendations

The software development and cybersecurity pathways are also important pathways to consider given their prominence in the region and high estimated growth in demand, as well as the need for upskilling and reskilling to capture AI business development opportunities. A magnet for innovation and entrepreneurship in IT and emerging sectors, Region 7 must enhance upskilling and advancement for new-to-career and experienced workers. The following supplemental recommendations provide direction for leveraging and scaling existing resources in the region to support more robust tech talent pipelines in Region 7.

Software Development

To support the software development sector, CREC recommends boosting worker retention for small- to mid-sized tech companies with robust upskilling support programs. There is a significant need for software developers in the region, spanning across companies of every size. Artificial intelligence, however, is likely to dramatically reshape this industry. Given that AI may have some impact on entry-level roles in this pathway, focusing on upskilling the talent already in the pipeline will help strengthen the prominence of this industry in Region 7 and ensure local talent is being trained in the latest advancements.

Small and medium sized companies need robust upskilling programs for software developers, beginning when they onboard with the company, to ensure they can manage the challenges of shifting tech requirements, developing both technical and management skills. With improvements, incumbent worker training programs can help onboard new talent, upskill current employees, and retrain IT and helpdesk support roles into more specialized roles.[43,44] Lateral and upward trajectories can be enabled via this training.

Program Examples

Many large employers in the region already have robust upskilling and career coaching initiatives that allow individuals to move through different pathways, but small and medium-sized companies often need to hire a particular skill set to fit an emergent need and have limited resources to provide upskilling. Larger employers and training providers will need to set an example in this space.

A customized training provider that serves large and small firms in the region can reduce costs for all and increase impact across the sector. One example is the Aon apprenticeship programs, with program locations in Washington, DC, which launched in 2017.[45] Aon apprentices are paid and work a 40-hour work week that includes both office and classroom time, and upon graduation are offered full-time employment in various departments with competitive wages. Aon's network of employers, non-profit, and community colleges have helped create more than 1,000 apprenticeship positions and are aiming to create 10,000 by 2030.[46]

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[43] Greater Washington Partnership, "Employer insights brief," October 2022, https://greaterwashingtonpartnership.com/wp-content/uploads/2022/10/FINAL-10.11.22-Employer-Insights-Brief.pdf.

[44] *Developing the North Carolina Cybersecurity Pipeline*. (2022). Center for Regional Economic Competitiveness.

[45] Aspen Institute, "Case Study: Next Generation Apprenticeships at Aon," February 2023, https://www.aspeninstitute.org/wp-content/uploads/2023/02/Case-Study-Next-Generation-Apprenticeships-at-Aon.pdf.

[46] Aon, "Learn, Earn and Develop Your Carrer", accessed November 22, 2024, https://www.aon.com/careers/early-careers/us/apprenticeships.

Region 7 can also build on existing programming being developed at NOVA to support AI competencies. Other institutions such as Ivy Tech Community Colleges in Indiana are also at the forefront of this work with their "Introduction to Artificial Intelligence" program focused on supporting both new and incumbent workers in this rapidly evolving field.[47]

Important Considerations

The analysis in this report emphasized lower levels of racial and gender diversity in more advanced managerial roles across multiple pathways. As such, providing targeted training and support as workers are advancing their career from entry- to mid-level and beyond is likely to address some of this stagnation and improve representation across the board.

Cybersecurity

To support the cybersecurity pathway, CREC recommends developing a consistent pipeline of local employers seeking to sponsor lab-based, paid work experiences. Cybersecurity will continue to be a prominent industry in Region 7 given the presence of the federal government and infrastructure that has grown to support these functions. To ensure the region's continued competitive advantage in this pathway, it will be important to support additional opportunities for lab-based work experiences that provide tangible experience with area employers. Given that certifications such as CompTIA Security+ are highly valued by this industry, there should be additional alignment efforts with education and training providers to ensure certifications are not only included in related academic programs but are recognized across the region. There is likely room for additional mid-level certification offerings, given the potential value of CISSP and other more advanced security-related credentials. The region can also connect this programming with pre-clearance training to ensure more earn-and-learn opportunities adequately prepare jobseekers for cyber careers.

Program Examples

The Commonwealth Cyber Initiative (CCI) has a Project-Based Learning Program model that provides experiential learning opportunities for cyber students attending a university within CCI's network. These opportunities involve industry partners who guide the project and act as mentors for students, all the while receiving access to a talent pool of highly skilled potential employees. To date, CCI has worked with NOVA, Virginia Tech, CACI International, and Microsoft to pilot these opportunities, with even more room to grow.[48] This CCI model can be scaled in the region to support students and incumbent workers alike. There are also several Centers of Academic Excellence in Cyber Defense in the region that are receiving funding from CCI for experiential learning programs that provide Virginia students with the skills and knowledge needed to launch successful careers in cybersecurity.

Outside of Region 7, the Carolina Cyber Network (CCN) offers another promising example for regional coordination in the cybersecurity field. The CCN aims to strengthen North Carolina's cybersecurity capabilities through a coordinated talent development system, connecting both public and private institutions. The network includes seventeen 2-year and 4-year institutions of higher education across the state, working together to provide students with hands-on experience and industry connections. In 2023,

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[47] Ivy Tech Community College, "Introduction to Artificial Intelligence (IT Academy)," https://www.ivytech.edu/classes/skills-training-classes/it-academy/introduction-to-artificial-intelligence-it-academy/.

[48] Commonwealth Cyber Initiative, "Project-Based Learning Program," https://cyberinitiative.org/talent-development/project-based-learning-program.html.

CCN member schools graduated 882 students, enrolled 234 high school students in cyber courses, and provided opportunities for 456 students to participate in cyber competitions.[49]

Important Considerations

As generative AI becomes integrated into more security products and solutions, the need for information security analysts will grow to help detect critical cyberthreats faster, identify vulnerabilities, and provide additional analysis and insights.[50] The Cybersecurity & Infrastructure Security Agency has developed a Roadmap for Artificial Intelligence to address efforts to use AI to enhance cybersecurity capabilities and ensure AI systems are protected from additional threats.[51] With these dynamics in mind, it is even more important to have opportunities for hands-on experience and training that can advance capabilities across roles in the cybersecurity pathway.

Sustaining Action: Address Persistent Barriers to Tech Talent Development

These recommendations will require employer leadership to succeed. Region 7 employers, both public and private, have a large role to play. The GoVirginia Region 7 Council, especially the senior business leadership, will be instrumental in both convening and supporting implementation efforts related to these recommendations. Furthermore, state and local government leaders will need to amplify the recommendations and invest in solutions that will help transform the region's talent pool. Region 7 education and training providers will be instrumental in bridging the divide between employer needs and jobseeker preparations.

Together, business, government, and education leaders can build more sustainable and representative tech talent pipelines in Northern Virginia. Below are some best practice examples to guide action:

- **Identify and address reasons for entry-level talent turnover.** Entry-level positions, such as computer user support specialist, often have higher turnover rates. This turnover could be due to everything from low wages and the lack of employer engagement to a misalignment of work with skills and career advancement. It is important for employers to understand the root causes of turnover so that entry-level talent – and particularly diverse groups of entry-level talent – feel supported and valued as they navigate through their career. Employer-led efforts to develop more clearly articulated career pathways will be invaluable.
- **Evaluate the bachelor's degree requirements in federal government contracting.** Strict education requirements in government contracting limit entry into many tech careers. Several large employers in the region are already loosening their own requirements – such as Amazon and Accenture – and could showcase the benefits of scaling back these requirements. Advanced degrees may be necessary for some advanced management positions. These requirements should be evaluated to determine their necessity.

[49] Carolina Cyber Network, "Strengthening North Carolina's Cybersecurity," accessed November 22, 2024, https://carolinacybernetwork.net/.
[50] Microsoft Security, "What is AI for cybersecurity?" https://www.microsoft.com/en-us/security/business/security-101/what-is-ai-for-cybersecurity.
[51] Cybersecurity & Infrastructure Security Agency, "Artificial Intelligence," https://www.cisa.gov/ai.

- **Expand talent sources beyond typical recruitment pools.** Employer leadership is critical to both sustain talent pipelines and provide resources to underrepresented communities to enter these pipelines, championing programs that facilitate transitions into the tech workforce. Veterans are an ideal target population as many qualify for security clearances that are needed in digital tech companies. Employers that champion these programs will make lasting connections with target populations that have the potential to make them employers of choice. All companies can benefit by joining and supporting these partnerships.
- **Shift to skills-based interviewing and hiring practices to better screen and invest in the right entry-level talent.** It is important for employers to articulate what core skills and competencies are most important for key occupations beyond traditional education or certification requirements. While shifting to skills-based hiring practices may take time and resources, re-imagining interviewing and hiring practices can immediately help to identify promising early talent that lead to better retention down the line. More targeted guidance will be needed for northern Virginia talent pipelines and larger employers will need to set an example.
- **Develop regional transfer agreements and stackable credential opportunities to support cross-institutional collaboration and learning.** NOVA and GMU have a transfer agreement and provide additional, targeted support to students via the ADVANCE program, which allows students to more seamlessly transfer to GMU to complete their bachelor's degree. Programs such as ADVANCE should be visible and accessible to employees and job seekers across the region, ensuring area residents are aware of options for working and pursuing higher education. These programs can demonstrate how credentials can be stacked to streamline the learning students are doing across institutions.
- **Build partnerships between public and private training providers to leverage collective resources, bring awareness to no cost or low-cost programs, and develop incumbent worker training opportunities.** While significant focus is directed towards public education and training institutions, the region has a myriad of private training providers with access to resources and training that could help bolster tech talent pathways. Building partnerships between public and private entities can help bring awareness to the whole ecosystem of resources in the region and provide alternative pathways for job seekers depending on their unique needs and abilities. Employers can work with the Region 7 Council or their county economic development organization to ensure training provider information is clear and to develop regional capacity to identify programs that will deliver the best ROI for individual employers' unique requirements.
- **Agree on metrics and tools to evaluate progress.** Most institutions of higher education in Region 7 are participating in programs that generate information on student outcomes. These programs include Census LEHD Post-Secondary Employment Outcomes (PSEO) and VOEE College and Career Outcomes Explorer. Every institution could have clear and transparent information on Key Performance Indicators for student progress via programs. The workforce system and private straining providers can work toward these standards as well. An ongoing, transparent, deliberative continuous improvement process that promotes regional engagement, inclusion, and improvement will help keep the region on track as opportunities and challenges arise.

- **Ensure public workforce programs and initiatives are aligned with current and future needs.** Existing programs, such as TalentUP Fairfax, already address regional challenges focused on addressing employer needs and leveraging business engagement, with participating employers of tech talent. Maintaining funding for programs such as these that show tangible results for tech talent employers – in addition to expanding them to other counties – would help leverage those resources and build on the expertise developed.
- **Support dedicated school personnel focused on the K-12 to career continuum.** Cultivating work-based learning and career opportunities for students takes significant time, and not every area school has available resources to create or maintain the required partnerships. Advocating for funding to support an individual at every school dedicated to this work can help ensure students have access to the resources in the region.
- **Build in training for "soft" skills, "employability" skills, "foundational" skills.** There is nothing new about employers seeking better "soft" skills. Every university, college, high school, and middle school should teach these skills. They are persistently in demand, and they are essential for advancement in one's career over a lifetime. Plenty of business support models exist to provide this kind of training and "wrap-around services" to employees and can be funded in part with WIOA funds. Teaching these skills outside of employment contexts, however, has not proved particularly effective, indicating that employers will need to provide work-based learning opportunities.

Appendix A: Methods

The GoVirginia Region 7 Talent Pipeline Initiative report utilized a mixed-methods approach for the analysis, weaving together quantitative data with qualitative insights. This section provides some additional details on the methodology used to generate our findings.

CREC and GMU-CRA conducted 35 individual interviews and 2 focus groups, speaking with 55 individuals across 45 different organizations in the region. The interview breakdown is as follows:

- 30 employers
    - 7 small employers (10-50 employees)
    - 11 medium-sized employers (50-250 employees)
    - 12 large employers (250+ employees)
- 11 education and training providers
- 4 government organizations

Individual interview contacts were sourced from a combination of job postings data, connections from regional chambers of commerce, and recommendations from the Region 7 TPI Research Advisory Board members. Interview outreach was conducted via email to companies that represented various aspects of the technology sector in the region (e.g., cybersecurity, IT, emerging technology, data centers, or government contracting). Explicit efforts were made to ensure there was representation from various sized employers as well as company expertise. Education/training and government organization outreach also aimed to provide a mix of geographies and public vs private institutions. Focus groups were facilitated through Research Advisory Board connections: one focused on small businesses and one focused on CIOs. Interview participants also spanned a range of roles including CEOs, hiring managers, HR professionals, and talent specialists.

Interviews were semi-structured around a consistent interview protocol that asked questions about their organization's hiring patterns, current talent ecosystem, key job roles and skills, and local education and training sources. Each interview and focus group lasted approximately 45 minutes and were conducted via the Microsoft Teams platform. Interview data was compiled and analyzed in Dedoose to produce a qualitative synthesis that highlights key takeaways as well as any similarities or differences in responses across the different interview groups.

Quantitative data was gathered from a variety of sources, including: the Census Bureau's American Community Survey and Population Estimates Program; the Bureau of Labor Statistics' (BLS) Quarterly Census of Employment and Wages (QCEW), Employment Projections, and Occupational Employment and Wage Statistics (OEWS) programs; as well as Virginia Works, the state office that produces and disseminates state and regional labor market information. Third-party data provider Lightcast was used for aggregated job posting data, including data on employers, education, experience, skills requirements, and job adjacency.[52] Data from O*Net Online were also used to identify job requirements, including education, experience, knowledge, and skills. Data on education and training providers, as well as participants/completers, were gathered through the National Center for Education Statistics (NCES)

[52] While Lightcast is often also used as a source for occupation data, including employment projections, for this report we have instead opted to utilize the most recent 10-year projections produced by Virginia Works, which utilize confidential microdata provided directly to the state by state/regional employers, rather than algorithmic estimates based on public summary data, and are therefore more likely to capture unique regional dynamics.

Integrated Postsecondary Education Data System (IPEDS), TrainingProviderResults.gov (abbreviated throughout this report as ETPPR), and the Registered Apprenticeship Partners Information Data System (RAPIDS).

In this report, demand for technology workers is analyzed based on employment and establishment location within Region 7's administrative boundaries (which include the jurisdictions of Arlington County, City of Alexandria, Fairfax County, Fairfax City, Loudoun County, Manassas City, Prince William County, Manassas Park County, and Falls Church). Given the fact that individuals filling these in-demand jobs in Region 7 may reside within a larger "labor shed" that extends beyond its boundaries, we analyze potential labor supply—including related college, university, and training program completers— based on the larger Washington, D.C. metropolitan area: this includes Region 7 plus neighboring jurisdictions in Virginia (including Stafford, Spotsylvania, Fauquier, Culpeper, Warren, Clarke, Madison, and Rappahannock counties, as well as the City of Fredericksburg), the District of Columbia, and suburban counties in Maryland (Calvert, Charles, Frederick, Montgomery, and Prince George's) and West Virginia (Jefferson).

To identify key talent pathways within the three technology industry clusters[53] identified above as critical within Region 7, it is necessary to first consider which job roles/occupations[54] are most important within each cluster. We began by examining localized staffing patterns (since the occupational composition of an industry varies based on location) to determine which occupations make up the largest share of employment in each industry cluster regionally. Assuming those that make up the largest share of employment are most critical to the functioning of an industry cluster, 31 occupations were identified as key to the priority industry clusters selected for analysis based on regional staffing pattern data from Virginia Works, largely those making up around 1% or more of employment across the combined clusters (or those employing around 1,500 or more jobs). The full list of occupations selected based on this analysis can be found in Table C1 (see Appendix C).

The majority of these are what might traditionally be considered "technology occupations:" those in the "Computer and Mathematical Occupations" SOC group (15-0000), as well as related occupations in other groups (i.e., "Computer and Information Systems Managers," and "Computer Hardware Engineers"). However, this list also includes "non-technology" occupations that play a critical role in the operation of firms within priority technology clusters (e.g., project management specialists, sales representatives, and market research analysts). These occupations may not require digital technology skills to the same degree, or at the same level of competency, as those in the "technology" group, but employers and domain experts interviewed for the report highlighted that workers in these roles may transition into more technical roles with some additional training and, therefore, represent an important component of technology talent pathways.

While all 31 of these selected occupations may be seen as cluster-critical based on the degree to which they contribute to industry employment, some are likely more valuable to consider as opportunities for talent development due to being "in demand" among regional employers. As a result, several demand

[53] The industry-based clusters examined in this report (computer services and emerging technologies) are defined based on the North American Industry Classification System (NAICS), which groups businesses with similar production processes for use in producing official industry statistics. The occupation-based cluster examined in this report (cybersecurity) is defined based on the Standard Occupation Classification (SOC) system.

[54] Occupations, as defined within the SOC system, can encompass many related job titles. For example, Software Developers (SOC code 15-1252) can include titles such as Application Developer, Software Engineer, and Software Architect.

factors were also used to identify priority occupations—in combination with feedback from employer interviews and focus groups—for subsequent pathway analysis. These demand factors include the projected growth rate of new jobs in an occupation over the next 10 years; its location quotient (LQ), a measure of how "concentrated" occupation employment is in a region compared to nationally; and the average annual number of job openings (either due to job growth or turnover due to job changers/labor market exits (e.g., retirements). While the BLS and Virginia Works provide projected openings over the next 10 years for each occupation, another proxy measure for recent/current demand is total annual online job postings.[55]

To determine education and training opportunities suitable to meeting demand for these occupations and, therefore, the potential supply of new candidates to fill open jobs, it is necessary to link selected occupations to associated program areas. While these linkages can be partially based on information derived from employer demand—i.e., identifying education programs/certifications requested in postings for an occupation, or via employer interviews and focus groups—postsecondary programs tend to be linked to specific occupations based on broad alignment in skills and knowledge.

The most common starting point for determining education/training program to occupation linkages in a way that allows alignment of completions (supply) and openings (demand) is a crosswalk developed by the National Center for Education Statistics (NCES) linking each SOC occupation to a series of related postsecondary program types/fields of study defined using the Classification of Instructional Programs (CIP) taxonomy. While state longitudinal data systems (SLDS) are often one potential source for individually linked postsecondary and employment data, these systems are typically only available to academic researchers and often require substantial project timelines to secure approvals from multiple state agencies. The Virginia Office of Employment Economics recently released public data that matches credit and non-credit graduates from Virginia institutions of higher education (from 2008-2022) with employment and wage records as well as online job profiles (e.g., LinkedIn) to map actual education to career pathways.[56] However, this data was released after a majority of analysis for this report was completed, and only provides public data based on broad program and occupation categories. As a result, our quantitative analysis of education and training supply focuses on institutions and providers offering postsecondary and training programs categorized using CIP codes linked to our selected technology occupations using the NCES crosswalk.

[55] Online job postings may not directly represent actual job openings. Similarly, online job postings tend to overrepresent jobs in the professional services and technology sectors, while underrepresenting industries such as construction and manufacturing that may utilize other methods for identifying candidates. For additional discussion, see: Anthony P. Carnevale, Tamara Jayasundera, and Dmitri Repnikov (2014), *Understanding Online Job Ads Data*. Georgetown University Center on Education and the Workforce, https://cew.georgetown.edu/wp-content/uploads/2014/11/OCLM.Tech_.Web_.pdf.

[56] Virginia Office of Education Economics, *Virginia College and Career Outcomes Explorer*, 8 July 2024, https://www.voee.org/virginia-college-and-career-outcomes-explorer/.

Appendix B: Previous Research

Previous research in this field served as an essential foundation for this report. In 2016, the Northern Virginia Technology Council (NVTC), which convenes employers and subject matter experts in the region, issued a Technology Workforce Assessment that identified the importance of “soft skills” (referred to in this report as professional skills) for employers in the region, highlighting specific shortfalls in talent supply for key occupations such as software developers – a finding that was confirmed in the Region 7 2021 Enhanced Capacity Building project on worker transformations during the pandemic.[57,58] NVTC also issues annual Data Center reports, highlighting the significance of the industry for this region; in 2023 alone, data centers provided $47 billion in economic output and over 26,000 jobs for Virginia, representing the largest data center market in the world.[59]

The Greater Washington Partnership (GWP) — a convener of employers and stakeholders across the greater Washington, D.C., Maryland, and Virginia (DMV) region – is another important organization in this field based on their skills forecasting and employer signaling system. GWP’s 2024 skills forecasting report found that Tech/AI skill demand grew by over 100% from 2019-2023, and that even as these jobs are quickly evolving, there are still gaps in more traditional tech roles and competencies that need to be filled. Region leaders also identified one of the biggest barriers to hiring talent is finding employees with cross-cutting skills, as well as measuring those during the hiring process.[60] GWP’s 2022 Employer Insights Brief also found that given increased demand for remote work arrangements post-pandemic, it has been increasingly difficult for employers to recruit workers to deal with confidential information because of these dynamics.[61]

Recent research also provides some more context for how both internal and external talent sources view Virginia as a place to live and work. Based on the study which included surveys and focus groups, 96% of current college students enrolled at Virginia colleges and universities would stay in the state after graduation if offered a full-time position and 49% of external talent would consider relocating to Virginia if a job matched their skill and salary requirements. Yet both internal and external talent are not confident that the state can address some of the “must-haves” identified in this research, including housing affordability, competitive salaries relative to cost of living, and diverse job opportunities. HR executives are also wary of their ability to recruit critical talent, as only 45% of HR executives were confident that they could fill future positions with candidates from the local and state workforce.[62]

Lastly, Northern Virginia Community College’s annual Workforce Index surveys regional business leaders to better understand barriers to recruitment and hiring. The most recent index illustrated that a tight

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[57] Northern Virginia Technology Council, “NVTC Greater Washington Technology Workforce Needs Assessment,” December 2016. https://static1.squarespace.com/static/553c0686e4b0ee62c7b82654/t/5c5159df4d7a9ca908872309/1548835301534/NeedsAssessment.pdf.

[58] Creating a Roadmap for Reskilling Displaced Leisure, Hospitality and Gig Workers for Technology Employment in a Post-COVID 19 Economy. Contract # 19-GOVA-07B. George Mason University, Marymount University and Amplifier Advisors. October 2021.

[59] Northern Virginia Technology Council, “The Impact of Data Center on Virginia’s State and Local Economies: 5th Biennial Report,” April 2024, https://www.nvtc.org/topics/data-center-and-cloud/report/.

[60] Greater Washington Partnership, “2024 Skills Forecasting: Employer signaling for the future of work,” 2024, https://greaterwashingtonpartnership.com/publications/2024-skills-forecasting-employer-signaling-for-the-future-of-work/.

[61] Greater Washington Partnership, “Employer Insights Brief,” 2022, https://greaterwashingtonpartnership.com/wp-content/uploads/2022/10/FINAL-10.11.22-Employer-Insights-Brief.pdf.

[62] Virginia Economic Development Partnership & DCI, “Virginia Talent Research & Discovery Findings,” presented March 2024.

labor market and high labor costs continue to present challenges to hiring and retention in the region, while work-based learning approaches are consistently underutilized options to expand recruitment. The index also found that 45% of employers in Northern Virginia are rarely or never willing to accept equivalent professional experience in lieu of education. [63]

These insights informed conversations with employers and talent providers for this report, focusing the CREC and GMU teams on which key occupations employers had a shortage of available candidates. This prior research also enabled CREC and GMU to dive deeper into the dynamics of specific talent pipelines in the analysis below, allowing the research team to address relevant labor market dynamics unique to Northern Virginia and the local context for continued talent pipeline development.

[63] https://www.nvcc.edu/dist/files/sites/about/offices/strategic-insights/lmi/research-insights/24-001-IndexSurveyReport23.pdf

Appendix C: Additional Tables and Charts

Table C1. Initial List of Target Occupations

SOC Code	SOC Title
11-3021	Computer and Information Systems Managers
11-1021	General and Operations Managers
13-1082	Project Management Specialists
13-1111	Management Analysts
13-1161	Market Research Analysts and Marketing Specialists
13-1199	Business operations specialists, all other
15-1211	Computer Systems Analysts
15-1212	Information Security Analysts
15-1221	Computer and Information Research Scientists
15-1231	Computer Network Support Specialists
15-1232	Computer User Support Specialists
15-1241	Computer Network Architects
15-1242	Database Administrators
15-1243	Database Architects
15-1244	Network and Computer Systems Administrators
15-1251	Computer Programmers
15-1252	Software Developers
15-1253	Software Quality Assurance Analysts and Testers
15-1254	Web Developers
15-1255	Web and Digital Interface Designers
15-1299	Computer Occupations, All Other
15-2031	Operations Research Analysts
15-2041	Statisticians
15-2051	Data Scientists
15-2099	Mathematical Science Occupations, All Other
17-2061	Computer Hardware Engineers
17-2071	Electrical engineers
17-2199	Engineers, all other
17-3023	Electrical and Electronic Engineering Technologists and Technicians
17-3029	Engineering Technologists and Technicians, Except Drafters, All Other
19-2099	Physical scientists, all other
41-3091	Sales Representatives of Services, Except Advertising, Insurance, Financial Services, and Travel

Table C2. Occupation Shares of Employment in the Computer Services Industry

Occupation	Share of Industry Employment, Region 7	Share of Industry Employment, National
Software Developers and Software Quality Assurance Analysts and Testers	26.0%	22.8%
Computer Systems Analysts	5.8%	5.0%
Network and Computer Systems Administrators	4.6%	2.3%
Information Security Analysts	4.5%	1.6%
Management Analysts	4.1%	2.3%
Computer User Support Specialists	3.9%	6.2%
Computer and Information Systems Managers	3.3%	4.8%
General and Operations Managers	3.2%	3.6%
Sales Representatives of Services, Except Advertising, Insurance, Financial Services, and Travel	2.9%	4.7%
Project Management Specialists and Business Operations Specialists, All Other	2.7%	3.8%

Source: Virginia Works Economic Information & Analytics Division, Long Term Workforce Area Projections, https://virginiaworks.com/.

Table C3. Occupation Shares of Employment in Emerging Technologies Industry Cluster

Occupation	Share of Cluster Employment, Region 7	Share of Cluster Employment, National
Software Developers and Software Quality Assurance Analysts and Testers	13.0%	5.8%
Computer and information research scientists	8.2%	0.8%
Information security analysts	4.0%	0.8%
Economists	3.6%	0.0%
Medical scientists, except epidemiologists	3.6%	5.2%
Management analysts	2.7%	0.8%
Social scientists and related workers, all other	2.3%	0.1%
Electrical engineers	2.1%	1.1%
Physical scientists, all other	2.0%	0.3%
Office clerks, general	1.9%	0.9%

Source: Virginia Works Economic Information & Analytics Division, Long Term Workforce Area Projections, https://virginiaworks.com/.

Table C4. Top In-Demand Credential for each Target Occupation by Unique Job Postings

Occupation	Top Qualification	Percent of Total Postings (2023)
General and Operations Managers	Valid Driver's License	6.8%
Computer and Information Systems Managers	Certified Information Systems Security Professional	8.9%
Project Management Specialists	Project Management Professional Certification	26.5%
Management Analysts	Project Management Professional Certification	5.8%
Market Research Analysts and Marketing Specialists	Valid Driver's License	6.3%
Business operations specialists, all other	Certified Information Systems Security Professional	19.0%
Computer Systems Analysts	CompTIA Security+	4.0%
Information Security Analysts	Certified Information Systems Security Professional	32.6%
Computer and Information Research Scientists	Enterprise Desktop Administrator (Microsoft Certified IT Professional)	3.4%
Computer Network Support Specialists	IAT Level II Certification	21.7%
Computer User Support Specialists	CompTIA A+	11.5%
Computer Network Architects	Cisco Certified Network Associate	20.5%
Database Administrators	IAT Level II Certification	6.0%
Database Architects	CompTIA Security+	4.6%
Network and Computer Systems Administrators	IAT Level II Certification	21.0%
Software Developers	CompTIA Security+	5.2%
Software Quality Assurance Analysts and Testers	Software Development Engineer in Test	7.3%
Web Developers	CompTIA Security+	10.6%
Web and Digital Interface Designers	Project Management Professional Certification	1.1%
Computer Occupations, All Other	Certified Information Systems Security Professional	10.9%
Operations Research Analysts	Project Management Professional Certification	4.2%
Statisticians	Valid Driver's License	4.3%
Data Scientists	CompTIA Security+	2.6%
Computer Hardware Engineers	Enterprise Desktop Administrator (Microsoft Certified IT Professional)	6.7%
Electrical engineers	Professional Engineer (PE) License	12.2%
Engineers, all other	Certified Energy Manager	5.6%
Medical scientists, except epidemiologists	Valid Driver's License	20.2%
Physical scientists, all other	Engineer in Training	6.6%
Clinical laboratory technologists	American Society For Clinical Pathology (ASCP) Certification	15.7%

Occupation	Top Qualification	Percent of Total Postings (2023)
Sales Representatives of Services, Except Advertising, Insurance, Financial Services, and Travel	Valid Driver's License	18.5%

Source: Lightcast.

Table C5. Training Provider Programs in Region 7 Associated with the Data Infrastructure Pathway

Program Name	Provider	Associated Credential
Database Administration	Agile1Tech	Database Administration
SQL Database Administration	LINXERVE Academy	Microsoft SQL Database Certification
Database Administration	PeopleNTech Institute of Information Technology, Inc.	Occupational Skills certificate or credential
Electrical Intermediate	Ace Tech Institute	Occupational Skills License
HVAC Technician Training Program Level I	United Aire-Temp, Air Conditioning and Heating, Inc	HVAC Tech I
HVAC Technician Training Program II	United Aire-Temp, Air Conditioning and Heating, Inc	HVAC Tech II
HVAC Technician Training Program III	United Aire-Temp, Air Conditioning and Heating, Inc	HVAC Tech III

Source: U.S. Department of Labor Employment and Training Administration, TrainingProviderResults.gov, retrieved 7 May 2024, https://www.trainingproviderresults.gov/. Program results area associated with SOC codes 15-1242, 17-2061, and 17-3023.

Table C6. Federally Registered Apprenticeship Count in Region 7 for Selected Target Occupations

Registered Apprenticeship Occupation and Program Number	Apprentice Count
Application Developer	**54**
2020-VA-79698	50
2021-VA-80275	4
Cyber Security Support Technician	**10**
2020-VA-78559	2
2021-VA-81533	8
Electrical Technician	**3**
2019-VA-73075	1
2022-VA-104267	2
Electronics Technician	**24**
2020-VA-77251	2
2020-VA-77324	6
2020-VA-77732	16
Health Information Management Business Analyst	**1**
2021-VA-80314	1
IT Analyst	**2**
2022-VA-111998	2
IT Project Manager	**10**
2022-VA-111502	10
Management Systems Auditor	**2**
2019-ZA-72834	2
Grand Total	**106**

Source: U.S. Registered Apprenticeship Partners Information Data System, retrieved 7 May 2024, https://www.apprenticeship.gov/data-and-statistics. Results were filtered using the following O*Net SOC codes: 13-1111, 15-1211, 15-1212, 15-1252, 15-1299, and 17-3023.

Table C7. Post-Secondary Programs in Region 7 Associated with the Data Infrastructure Pathway

Provider	CIP Code	CIP Code Description	Associated Credential
DeVry University-Virginia	**15.0303**	Electrical, Electronic, and Communications Engineering Technology/Technician	Associate's degree
DeVry University-Virginia	**15.0303**	Electrical, Electronic, and Communications Engineering Technology/Technician	Bachelor's degree
DeVry University-Virginia	**15.1201**	Computer Engineering Technology/Technician.	Bachelor's degree
Fairfax University of America	**11.0101**	Computer and Information Sciences, General.	Postbaccalaureate certificate
Fairfax University of America	**11.0101**	Computer and Information Sciences, General.	Master's degree
George Mason University	**11.0101**	Computer and Information Sciences, General.	Bachelor's degree
George Mason University	**11.0101**	Computer and Information Sciences, General.	Postbaccalaureate certificate
George Mason University	**11.0101**	Computer and Information Sciences, General.	Master's degree
George Mason University	**11.0101**	Computer and Information Sciences, General.	Doctor's degree - research/scholarship
George Mason University	**11.0101**	Computer and Information Sciences, General.	Bachelor's degree
George Mason University	**11.0802**	Data Modeling/Warehousing and Database Administration.	Postbaccalaureate certificate
George Mason University	**11.0802**	Data Modeling/Warehousing and Database Administration.	Master's degree
George Mason University	**11.1003**	Computer and Information Systems Security/Auditing/Information Assurance.	Postbaccalaureate certificate
George Mason University	**11.1003**	Computer and Information Systems Security/Auditing/Information Assurance.	Master's degree
George Mason University	**14.0901**	Computer Engineering, General.	Bachelor's degree
George Mason University	**14.0901**	Computer Engineering, General.	Master's degree
George Mason University	**14.1001**	Electrical and Electronics Engineering.	Bachelor's degree
George Mason University	**14.1001**	Electrical and Electronics Engineering.	Master's degree
George Mason University	**14.1001**	Electrical and Electronics Engineering.	Doctor's degree - research/scholarship
Marymount University	**11.0802**	Data Modeling/Warehousing and Database Administration.	Certificates of at least 12 weeks but less than 1 year
Marymount University	**11.1003**	Computer and Information Systems Security/Auditing/Information Assurance.	Bachelor's degree

Provider	CIP Code	CIP Code Description	Associated Credential
Marymount University	**11.1003**	Computer and Information Systems Security/Auditing/Information Assurance.	Postbaccalaureate certificate
Marymount University	**11.1003**	Computer and Information Systems Security/Auditing/Information Assurance.	Master's degree
Marymount University	**11.1003**	Computer and Information Systems Security/Auditing/Information Assurance.	Doctor's degree - research/scholarship
Northern Virginia Community College	**11.0101**	Computer and Information Sciences, General.	Associate's degree
Northern Virginia Community College	**11.0101**	Computer and Information Sciences, General.	Certificates of at least 12 weeks but less than 1 year
Northern Virginia Community College	**11.1003**	Computer and Information Systems Security/Auditing/Information Assurance.	Associate's degree
Northern Virginia Community College	**15.0000**	Engineering Technologies/Technicians, General	Associate's degree
Northern Virginia Community College	**15.0000**	Engineering Technologies/Technicians, General	Certificates of at least 12 weeks but less than 1 year
Northern Virginia Community College	**15.0303**	Electrical, Electronic, and Communications Engineering Technology/Technician	Associate's degree
Northern Virginia Community College	**15.0303**	Electrical, Electronic, and Communications Engineering Technology/Technician	Certificates of at least 12 weeks but less than 1 year
Strayer University-Virginia	**11.1003**	Computer and Information Systems Security/Auditing/Information Assurance.	Master's degree
University of the Potomac-VA Campus	**11.1003**	Computer and Information Systems Security/Auditing/Information Assurance.	Certificates of at least 1 but less than 2 years

Source: National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), https://nces.ed.gov/ipeds/. Program results pulled utilizing SOC-CIP Crosswalk for SOC codes 15-1242, 17-2061, and 17-3023.

Appendix D: Resource List

The GoVirginia Region 7 area has many existing resources for workforce development. Two workforce development boards serve the Virginia Career Works Alexandria Arlington Region and the Northern Virginia Region. Each of the six counties and Alexandria has its own economic and workforce development department, and three county economic development organizations have dedicated talent development staff. County staff anchor important talent development initiatives like TalentUP Fairfax.

Northern Virginia is home to several higher education institutions. George Mason University has campuses in Fairfax, Loudoun, and Manassas. Northern Virginia Community College has campuses in Alexandria, Loudoun, Prince William, Fairfax, and Manassas. Virginia Tech and UVA have branch campuses in Loudoun and Arlington. And Marymount University has three campuses in Arlington. Each county and a few cities and townships have their own public school district – all the counties plus Falls Church, Alexandria, Manassas, and Manassas Park.

The Northern Virigina Technology Council is a member association of technology businesses in the area focused on collaboration and workforce development and the Greater Washington Partnership is a cross-sector alliance of employers in Maryland, Virginia, and DC working towards economic growth.

There are some specific initiatives that should be highlighted.

Work-based learning at Colleges and Universities:

- The Commonwealth Cyber Initiative (CCI) has funded six experiential learning projects for faculty and students across the state. These are: cyber startups, STEM Industry Internships, AI-Security living lab experiences, training in the integration of cyber physical systems and security, drone racing and data poisoning and satellite reconnaissance. Their project-based learning program is designed to provide experiential learning opportunities to cyber students within CCI's network.

Funding and support services:

- V-TOP works with iQuasar to help Virgina employers with less than 250 employees to expand their internship opportunities. iQuasar does this by aiding the employers with job descriptions, marketing openings, searching for and screening applicants, and onboarding interns.
- TalentUP Fairfax helps Fairfax county jobseekers find internships in high demand occupations. There are interest forms for Fairfax county businesses that are willing to participate.
- The state of Virignia offers a tax credit of 35% of the costs to provide eligible training to qualified workers.
- Virginia Career Works Northern Region offers incumbent worker training grants to help employers re-train their existing workforce and support employees in gaining new skills.

Data and digital tools:

- VOEE's College and Career Outcomes Explorer provides career data for graduates from Virginia institutions of higher education (credit and non-credit) and shows employment outcomes and wage progression by program category one, four, and eight years following graduation. It also contains data on graduates' skills based on online job profiles.
- VOEE's Program-to-Skills Mapping Dashboard illustrates what skills should be taught in which academic programs.

- Merit is a workforce platform that can link jobseekers to potential employers. It can act as a digital wallet storing professional licenses and other credentials, including non-degree and continuing education credentials, which can be viewed by employers.

There is currently no intermediary organizations supporting employers and workers in IT training or apprenticeship in Region 7. However, there are intermediaries who can extend support to Region 7 companies or serve as important models for this work.

Apprenticeship Intermediaries:

- Revature offers companies a three-phase solution based on 1) skills assessment, 2) talent acquisition and onboarding and, 3) upskilling and integration. Their upskilling program can be continual to maintain a skilled, and skills first, workforce.
- CityWorks DC is a leading intermediary organization in the area focused on reshaping the landscape of education and career development for DC-area youth and young adults of color. Through their apprentice network, CityWorks is providing work-based learning opportunities, including opportunities in the tech sector.
- MAXX Potential sets up people who want to work in technology with projects directly with employers.
- Apprenti acts as a job board for potential employers. Would-be apprentices can sign up and take a competency exam. Upon passing an exam, candidates can interview potential employers. If the employer hires them, Apprenti will give them full time training before the on-the-job training starts.
- SkillBridge is a DoD program that links transitioning service members with industry partners to gain training in the civilian workforce.
- Northern Virginia Community College partners with employers to provide apprenticeship opportunities, including new opportunities in emerging industries such as semiconductors and data centers.
- Building Trades Unions offer apprenticeship opportunities for skilled trades, such as the International Brotherhood of Electrical Workers.
- Howard Community College's IT Apprenticeship program partners with local networking and technology firms to place apprentices into four entry-level roles: IT Field Support Specialist, Network Field Support Specialist, Information Systems Security Engineer, or Linux System Administrator. The program is 2-3 years and includes 4,000 hours of on-the-job training.

Appendix E: Action Plan

Background

To kick off the GoVA Region 7 Talent Pipeline Initiative, the Center for Regional Economic Competitiveness and George Mason's Center for Regional Analysis produced a Talent Pipeline Research Report (Nov 2023-Nov 2024). The report was issued to address industrial diversification issues that signaled declining local competitiveness in the tech sector and promising emerging technologies. Without investment and action to support tech talent and employers, Region 7 risked missing opportunities for industrial diversification, technology development, and deployment.

To stay ahead of the curve, Region 7 businesses should be restructuring job roles and career pathways to address new technological challenges. Unfortunately, the IT and even emerging tech sectors in Northern Virginia are very rigid, in large part due to the prevalence of government contracting. Representation of women and people of color is constrained. Demand for "mid-level" managers is acute and there are no "pipelines" of talent that meet employers' high expectations for experience and education. Key findings across these occupations include:

- Software developers, analysts, and tester occupations make up a significant share of both the computer services (26%) and emerging technology clusters (13%) compared to the rest of the nation (22.8% and 5.8%, respectively).
- While veterans make up 9% of the Region 7 population, they make up 12% of the workers in these occupations. Veterans make up 25% of information security analysts and electrical and electronic engineering technologists and technicians, more than any of the other occupations.
- Amongst the selected technical occupations, the portion of the job postings requiring any AI skill is 2 percentage points higher in Region 7 than for the nation at large, with machine learning, artificial intelligence, and natural language processing as the most sought-after AI skills.

Throughout the research project, the Region 7 Talent Pipeline Research Advisory Board emphasized the need to promote better regional collaboration, address region-specific issues such as security clearance requirements, and anticipate artificial intelligence opportunities and risks. Noting that Region 7 has a higher concentration of medium-sized (50-250 employees) businesses than any other tech hub in the country, regional leaders identified that solutions are needed to support growing businesses in this size category. Recognizing these challenges, the CREC/GMU report highlighted opportunities for Region 7 residents to advance via tech talent pathways. These opportunities depend upon coordination across employers to address acute pain points.

This action plan lays out how Region 7 leaders might translate the recommendations into action through a thoughtfully sequenced, multi-tiered approach – addressing the low hanging fruit while pursuing long term solutions. While illustrative examples of effective programs run by *likely* implementation partners are included in both the research report and this action plan, it will be up to GoVirginia to identify implementation partner commitments. GoVirginia should consider proceeding via processes that encourage innovation and new collaborations, for example, through a competitive solicitation for teaming proposals preceded by matchmaking sessions for potential teaming partners. GoVirginia could also set the stage for ongoing regional collaboration and alignment by soliciting and funding proposals from partners who have unique abilities to convene employers across municipal boundaries, coordinate across

K-12, community college, public workforce sector, and higher education training programs, while deepening region-wide support from education, workforce, and economic development leaders.

Talent Pathway Recommendation: Train multi-skilled technicians to fortify data infrastructure

The GoVirginia Region 7 Talent Pipeline Initiative report outlined the challenges and opportunities for tech talent pathways in Northern Virginia, highlighting which pathways can be strengthened to support Region 7's priority industry clusters. Five pathways were described and analyzed in detail regarding experience and credential requirements, skill transferability and wage progress, student and worker representation by gender and race, and AI disruption potential across key occupational roles.

Three pathways offered the greatest opportunity for scalability and sustainability in the region: software development, data infrastructure, and cybersecurity. To address immediate needs and opportunities in the region, the CREC/GMU team recommended that the GoVirginia Region 7 Council invite proposals that expand the number of multi-skilled technicians in the data infrastructure pathway. To help operationalize this recommendation, CREC has outlined the below next steps:

1. **Convene the primary stakeholders.** There are more than 500 businesses in Region 7 that fall under the Data Processing, Hosting, and Related Services industry code (NAICS 5182). According to the Data Center Map, there are 348 data centers in Northern Virginia – 239 are operational and 109 are in development.[64] These businesses can serve as a starting point for convening an employer-led group which includes small- and mid-sized companies in addition to the larger actors in the area.

2. **Identify effective training solutions that already exist.** There is currently an information gap for employers, and their employees, regarding effective training and funding solutions in the region. Beyond the highly visible four-year programs at universities, there are a number of affordable, short-term programs demonstrating promising results. The two workforce boards in Region 7 – Virginia Career Works Arlington/Alexandria and Northern Virginia Regions – are important funders, offering short-term training grants to employees and employers such as the Lead4IT program which helps strengthen the IT and cybersecurity workforce by supporting employers with upskilling funding and training plans. Employers, such as AWS, and training providers, such as NOVA, have established training models that could fortify the region's data infrastructure career pathway and prepare participants to pursue relevant higher education credentials. AWS also offers an Information Infrastructure Pre-Apprenticeship, a paid 4-week program which offers hands-on training, mentorship opportunities, and job placement assistance with local employers.[65] These programs alone, with minimal adaptations, have the potential to serve a range of employer needs and address short term constraints to the development of critical talent and skills. But first, businesses will have to confirm these are effective programs worthy of investment.

[64] Data Center Map, "Data Center Alley & Northern Virginia," accessed November 1, 2024, https://www.datacentermap.com/content/nova/.
[65] AWS, "AWS Information Infrastructure Pre-Apprenticeship (I2PA)," accessed November 1, 2024, https://aws-workforce.pearson.com/i2pa/.

3. **Co-invest in solutions that demonstrate high potential to address at least one employer pain point.** Leading companies, government, and philanthropy will need to co-invest in program evaluation and improvement. For example, the Claude Moore Foundation recently assembled a team of healthcare, finance, business, and philanthropy leaders through the newly formed Claude Moore Opportunities non-profit to guide statewide efforts in Virginia to address workforce needs in the healthcare industry. This alliance is forging a "health sciences workforce highway" with "on-ramps" from middle school through advanced education.[66] The Hampton Roads Alliance provides another example of sustained collaboration that generates regional investment. This public-private partnership brings together business leaders, local governments, and academic institutions to support talent recruitment and retention.[67]

The steps above will help Region 7 leaders prioritize data infrastructure pathway investments. An efficient and effective regional coordination process can plant the seeds for Region 7 businesses and funders to pursue larger scale results and prepare the region for future challenges and opportunities.

Each stakeholder in the region has a role to play. *Figure E1* below illustrates a call to action for each group as well as the intended results.

Figure E1. Call to Action Matrix

	Actions Needed	Intended Results
IT and Emerging Technology Companies	• Work together to prioritize and expand the most effective programs	Employers resolve pain points around tech talent hiring, recruitment, and retention. More employers provide necessary training to more employees; their investments sustain the most effective programs.
Government (GoVA, Public Workforce, Economic Development, Municipal Leaders)	• De-risk investments for other regional actors by funding effective planning and implementation processes • Convene and orient training providers and smaller businesses • Convene stakeholders to track progress and identify gaps as they arise	Continuous improvement processes are launched and maintained.
Post-secondary educational institutions	• Ensure the most effective training programs articulate to BA and advanced degree programs • Strengthen partnerships with K12 and public workforce system to enhance enrollment in priority programs	Better hiring, retention, and advancement results for Region 7 businesses and residents.

[66] Claude Moore Foundation, "Proposed Solution: Health Sciences Highway to Support Economic Development," 2024, https://claudemoorefoundation.org/wp-content/uploads/2022/06/Healthecarehighway.pdf.
[67] Hampton Roads Alliance, "About Us," accessed November 1, 2024, https://hamptonroadsalliance.com/about-us/.

Private training providers, HR solution providers, and other business/talent development intermediaries	• Celebrate clients (small and mid-sized businesses) that advance technology and talent development solutions • Engage small and mid-sized businesses in conversations around employee engagement, most effective training programs	Businesses that advance talent development solutions are celebrated and supported. Government funding and educational opportunities reach more businesses via effective training providers.

Low Hanging Fruit and Near-Term Success

There are several existing initiatives in the region that are working to support tech talent pathways that could be more visible to area businesses. TalentUP Fairfax and Genesys' internship program are both making important inroads in the region which focus on different aspects of talent pathways – the former focusing on current jobseekers and the latter preparing high school students to launch their career and education goals. Programs such as the Incumbent Worker Training grants and Lead4IT are also currently underutilized by employers and could aid strengthening their workforce. Virginia Career Works currently offers Incumbent Worker Training Grants to aid local employers to upskill or reskill their employees, which Region 7 can use to support small and mid-sized tech companies.

Employer ROI will be key to continuous sponsorship of projects that pay student stipends and/or wages, while worker ROI will be key to continuous enrollment. Selecting the right model(s) to celebrate and scale will be a challenge. Some programs may need additional capacity to scale regionwide. Smaller companies may need help to cover costs.

While there is no replacement for the longer-term work to convene, prioritize action, and track progress, described above, there are immediate ways to highlight effective programs and practices. For example, GoVirginia Region 7 leaders can start by highlighting employer-sponsored, paid work experiences in the region.

Low-hanging fruit includes:

- **Conduct regional workshops or training focused on addressing employer pain points around hiring, retention, and advancement.** Workshops can accelerate the exchange of information between business leaders on topics critical for the region, such as understanding available education/workforce assets, identifying effective talent training sources, and navigating security clearance issues, elevating the practices of leaders on the Region 7 Council and emerging leaders in the region. Employers' trusted partners—service providers and other employers—could host workshops/B2B forums to promote programs in the region that can deliver ROI.
- **Provide and publicize ROI information about work-based learning opportunities.** Facilitating the flow of information regarding estimated ROI for certain training investments (e.g., apprenticeships and internships) may encourage companies to offer more structured earn-and-learn programs to fill key talent or skill needs. Small and medium sized businesses may need additional guidance and support to offer effective internships or set up apprenticeship programs. For example, internships are lower commitment but also lower ROI for the employer sponsor and trainee; apprenticeships are higher commitment, requiring more support structure, with higher ROI for employer and employee.

- **Celebrate and support homegrown tech companies.** Region 7's tech talent ecosystem can support more local entrepreneurs and projects to strengthen innovation *and* talent. Post-secondary institutions such as George Mason and NOVA can help connect GoVirginia with entrepreneurs seeking to hire and develop local talent. Engaging these companies in tech talent development programs will provide visibility to those seeking work in an entrepreneurial environment, who may one day start their own business.

The Big Implementation Challenge

With no recognized local intermediary organization, Region 7 needs an entrepreneurial venture to deliver results for tech companies in the long run. To reduce the risk for any given employer, multiple leading employers will need to invest time and talent to develop continuous improvement processes that government and philanthropy can support. A new organization could address employer pain points in data center maintenance and the maintenance of core capabilities across data center clients to build a dedicated employer network.

Coordinating employer action on tech talent issues is a science and an art – and there currently are no dedicated practitioners in Northern Virginia. With no coordination of employers to address tech talent issues, it is difficult to sustain innovative and effective programming. Throughout the research, the CREC/GMU team found excellent programs with limited enrollment. CREC also talked to employers eager for solutions, who were not aware of the 30 related education and training providers that provide relevant training in tech competencies.

While the different goals of employers, educators, and training providers can make regional coordination difficult, aligning actions with a data-informed vision for the region can generate buy-in and maintain momentum. The tech sector challenges in northern Virginia are unique and require dedicated problem solving. Region 7 diversification, to maintain a competitive edge and resilience to change, requires jumpstarting entrepreneurial ventures so that homegrown companies are positioned to introduce and advance technological innovations.

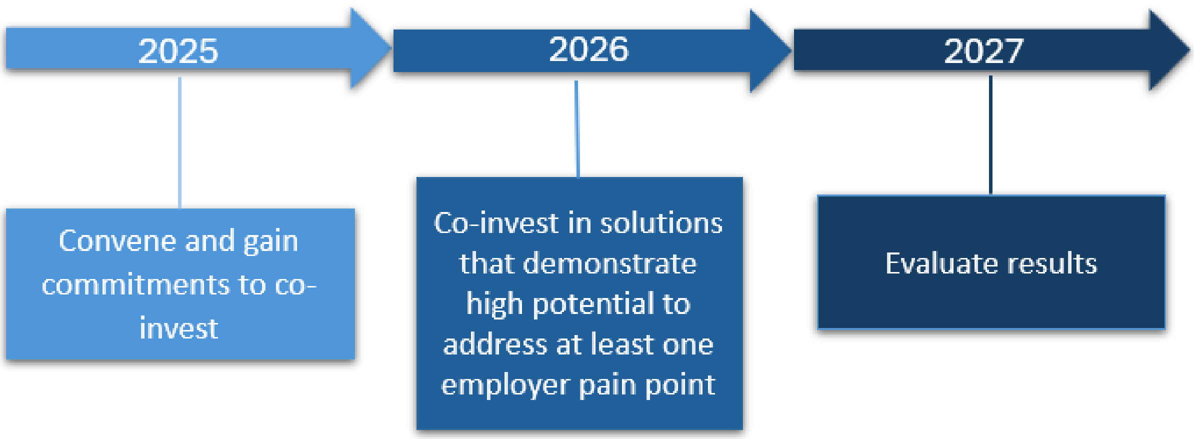
TPI Research Advisory Board members urged the CREC/GMU team to ensure that any coordination entity meets the following criteria:

- Adds value – and adds capacity – to model programs across the K12/college/career sectors
- Has a sustainable funding model based on public-private sector partnership
- Generates, supports, and sustains company commitment to train and retain new hires via "management" training programs
- Identifies gaps and adds capacity to support and sustain programs delivering ROI for small- and mid-sized companies

The Long Game

The Region 7 GoVirginia Council is in the best position, with no exceptions, to provide the seed funding and momentum for a regionally coordinated tech talent development initiative that prioritizes Region 7 businesses within the context of the regional labor market. *Figure E2* below details the activity timeline for the milestones.

Figure E2. Activity Timeline



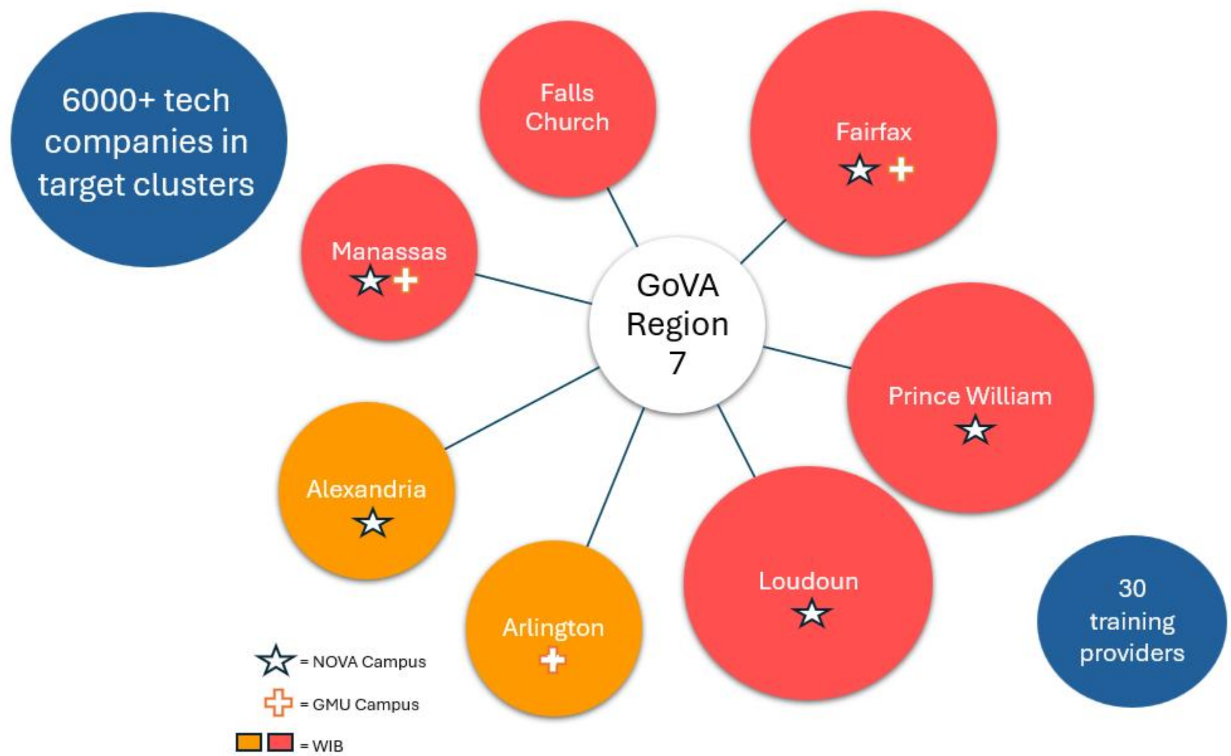
<u>On-going low-hanging fruit</u>

- Host workshops on employer pain points (AI, security clearances, etc.) that feature education and training resources available across the region
- Provide and publicize ROI information about work-based learning opportunities and employers already making investments
- Celebrate and support homegrown tech companies and entrepreneurs

While Region 7 GoVirginia leaders are in the best position to provide seed funding and launch this initiative, the Region 7 Council cannot be the hub that sustains this initiative and cannot be the only funder. Regional coordination is inherently political, and innovation in regional coordination involves risk. GoVirginia can help de-risk commitments and participation by leading area companies and positioning a hub entity to produce results for the region.

Figure E3 illustrates some of the tech talent development capacity available in Region 7 across its various jurisdictions. Ideally, regional coordination actions are strategic and effective and deliver results for multiple contributing stakeholders who have real “skin in the game”— such as employers and their intermediaries – while sustaining the attention of training providers eager to offer responsive programming. As previously mentioned, the art and science of convening and sustaining action by employers to address tech talent issues requires a willing and capable practitioner that is funded in the long term and motivated to add value to efforts regionwide.

Figure E3. Tech Talent Development Capacity in Region 7



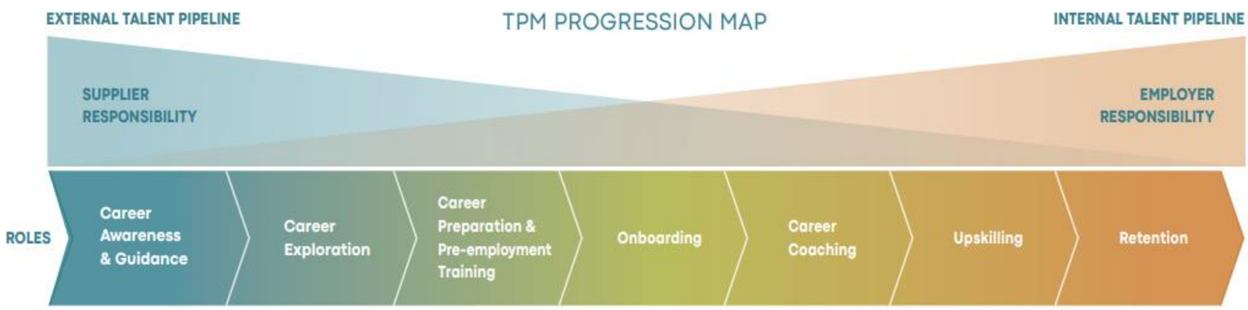
With government, private sector, and philanthropic funding, Region 7 leaders could invest in a new anchor organization with an entrepreneurial outlook and motivation to shift the orientation of business leaders to focus on home grown talent and tech. An anchor organization would work to sustain commitments of all the partners across municipal boundaries, and coordinate across the tech and education sectors, across K12, college, and career.

Return on Investment

Understanding and measuring return on investments for these initiatives will be key to improving programs, targeting future investments, and making data-informed decisions about the region's talent ecosystem. ROI can be measured through both short- and long-term outcomes, reflecting the time it takes to see impact in the community. Leading measures of short-term programmatic success can indicate whether partners are on track to accomplish a positive ROI. To ensure ROI for key stakeholders in the region, metrics can also be separated into employer vs employee progress and outcome measures. The types of employer outcomes that may be relevant include reduced number of unfilled job openings, increased number of qualified job candidates, reduced onboarding and upgrading costs, reduced staff turnover and increased retention. Employee outcomes, on the other hand, may include more metrics such as shorter search times, reduced search costs, better matches for skills, job retention, and advancement and upskilling opportunities.

Generating the specific metrics for this implementation effort will require communication across different actors in the ecosystem. There are several forums that can be used as examples for how actors can come together to agree on metrics. For example, the Chamber of Commerce's Talent Pipeline Management (TPM) program works to bring business, workforce, and economic development leaders together to create demand-driven strategies to strengthen talent pipelines and align business needs in a region. *Figure E4* below illustrates the TPM model and which actors are responsible for both external and internal talent pipelines along a career pathway.

Figure E4. Talent Pipeline Management Model



The first step in the 6-step process for these organizations is to organize employer leadership and collaboration. Stakeholders are encouraged to develop a plan for staffing and financing the collaborative, finding the focus, and securing buy-in. This type of forum is essential for developing a collective vision and reasonable metrics to measure collective progress. A similar data-driven approach was used by the Claude Moore Foundation in its recent planning and coordination to form a new healthcare collaborative in Virginia.

Conclusion

This action plan allows Region 7 to remain agile and responsive to the needs of the region while also focusing on promising solutions to strengthen existing tech talent pathways. The explicit focus on cybersecurity reflects Region 7's prominence in this industry. The federal government's presence provides an edge over other leading tech metros across the country, and helping to support jobseekers through additional skills and credentials will help ensure talent is sourced locally. The large presence of transitioning military can also help fill in-demand roles and contribute to the growth of small and medium businesses – thus diversifying the business landscape in the region.

Through this plan, Region 7 is positioned to effectively engage and coordinate across actors both internal and external stakeholders, with a particular focus on gaining buy-in from leaders across the nine jurisdictions. There are many promising initiatives and resources already in place in Northern Virginia: the challenge now is how to both leverage and build upon those resources to maximize impact. Questions remain such as how artificial intelligence and machine learning will change the occupational landscape. Nevertheless, this action plan and underlying research will help leaders stay abreast of those dynamics by fostering a more collaborative network of stakeholders to ever-evolving workforce challenges and opportunities.