



STRENGTHENING
OHIO'S BROADBAND
& 5G WORKFORCE

Ohio

Governor's Office of
Workforce Transformation

BroadbandOhio

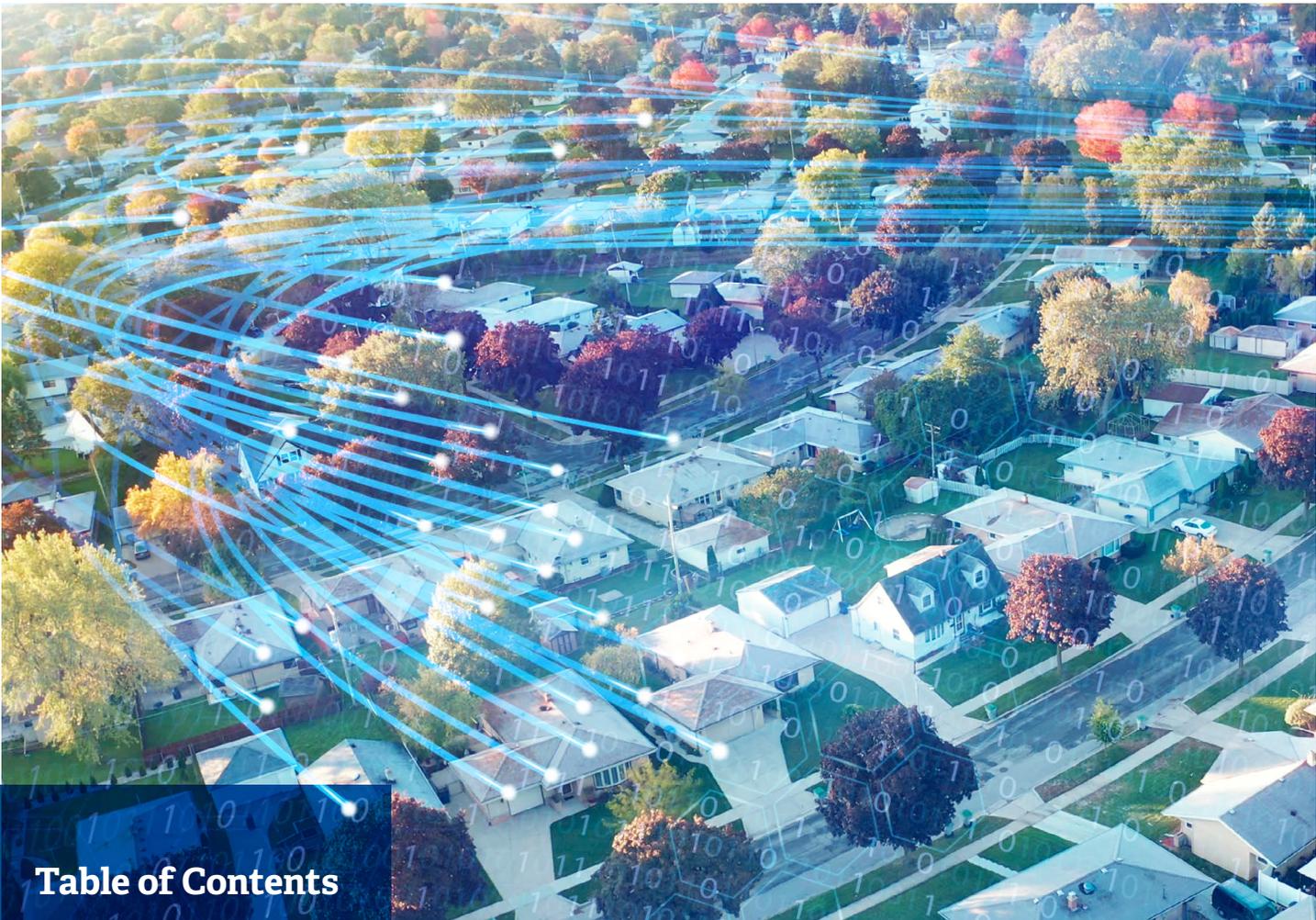


Table of Contents

1	Executive Summary	3
2	Introduction.....	4
3	Process.....	4
4	Discussion.....	4
	Broadband Industry Career Awareness.....	5
	Establishing and Scaling Education and Training Programs	5
	Awareness of State and Federal Funding for Training Programs	6
5	Strategies	7
	Ohio Broadband and 5G Sector Partnership.....	7
	Broadband Industry Career Awareness.....	7
	Establishing and Scaling Education and Training Programs	8
	Capitalizing on State and Federal Funding Programs	9
6	Conclusion	9
	Appendix 1.....	10
	Appendix 2.....	15



1 Executive Summary

Even prior to the COVID-19 health crisis, Ohio had significant gaps in broadband coverage – an issue the DeWine-Husted Administration began addressing immediately upon taking office.¹ The issues created by this gap became more evident at the start of the pandemic when millions of Ohioans had to stay home to work and learn remotely. The internet speeds needed for bandwidth-intensive applications, like video conferencing – sometimes on multiple devices – showed how speeds below the broadband threshold left far too many Ohioans behind and unable to effectively participate in the modern economy, education system, and healthcare system.²

To address the digital divide, the DeWine-Husted Administration proposed significant investments in broadband expansion – approximately \$500 million between state and federal dollars, which will create 1,250 direct construction jobs that will need to be filled, compounding the current labor shortage.³ The deployment of 5G in Ohio is estimated to create 32,000 jobs solely in network infrastructure.⁴ Ohio needs a strategic plan to address these workforce issues so the buildout of broadband and 5G infrastructure can happen quickly.

In response to this workforce shortage, the Governor’s Office of Workforce Transformation and BroadbandOhio drafted a strategic plan that outlines a detailed framework and roadmap to address three main issues: lack of industry career awareness, lack of education and training programs, and lack of awareness of existing state and federal funding programs. Ensuring Ohio has universal broadband access and a mature 5G network is a top priority for this administration. The ultimate goal of this strategic plan is to make Ohio a prime destination for new, innovative technology companies to form and utilize the next generation of wired and wireless communications. Reaching that goal requires a skilled workforce.



Governor DeWine, Lt. Governor Husted Announce Broadband Expansion Project in East Cleveland

1. *The Ohio Broadband Strategy* (InnovateOhio, 2019)

2. <https://www.fcc.gov/consumers/guides/household-broadband-guide>

3. *Appendix 1 found on page 10*

4. https://api.ctia.org/wp-content/uploads/2021/01/5G-Promises-Massive-Job-and-GDP-Growth-in-the-US_Feb-2021.pdf

2 Introduction

To help bridge the digital divide, the DeWine-Husted Administration proposed, and the legislature funded, significant state investments in broadband expansion as part of the Governor's 2022-2023 Executive Budget, "Investing in Ohio's Future."⁵ These state investments are in addition to federal dollars allocated to close the broadband gap.⁶ Between state and federal dollars, Ohio expects an infusion of approximately \$500 million for broadband expansion.⁷ A significant portion of these dollars will be deployed over fiscal years 2022-2023.⁸

This large capital infusion means the demand for skilled labor to physically build broadband infrastructure will increase exponentially. Based on estimated funding, broadband infrastructure build-out in Ohio will create 1,250 direct construction jobs that will need filled to expand access.⁹ A \$500 million investment in broadband infrastructure will also increase Ohio's GDP by \$751 million.¹⁰ Additionally, the United States, including Ohio, has begun deploying 5G – the next generation of wireless

communication technology, which pulls from the same general labor pool. In Ohio, 5G will create approximately 107,000 new jobs in the state, while increasing Ohio's GDP by \$36.4 billion.¹¹ Approximately 32,000 of these new 5G jobs will be directly tied to the deployment of 5G infrastructure.¹²

The Governor's Office of Workforce Transformation and BroadbandOhio have commissioned the Strengthening Ohio's Broadband & 5G Workforce analysis to evaluate the broadband and 5G workforce, identify gaps in workforce supply, and propose strategies to mitigate these gaps. Success on this will allow proposed broadband and 5G infrastructure projects to proceed with minimal disruption due to labor shortages and will infuse industry-oriented curriculum in our education system.

5. <https://www.lsc.ohio.gov/pages/budget/current/CurrentGA.aspx?Budget=MainOperating&ID=MainOperating&Version=contentFI>

6. <https://innovateohio.gov/wps/portal/gov/innovate/priorities/resources/broadband/#:~:text=For%20more%20than%20300%2C000%20households%20in%20Ohio%20representing%20close%20to,internet%20is%20a%20critical%20barrier>

7. Funding details: Investing in Ohio's Future – Budget Proposal; HB 2; The American Rescue Plan Act - Coronavirus State and Local Fiscal Recovery Fund; U.S. Department of Treasury - The Coronavirus Capital Projects Fund (CCPF); FCC Seeks Comment on Emergency Connectivity Fund; FCC - The Rural Digital Opportunity Fund; FCC - Emergency Broadband Benefit; The BroadbandOhio Connectivity Grant

8. *Id.*

9. *Appendix 1 found on page 10*

10. *Id.*

11. *Appendix 2 found on page 11*

12. https://api.ctia.org/wp-content/uploads/2021/01/5G-Promises-Massive-Job-and-GDP-Growth-in-the-US_Feb-2021.pdf

3 Process

To ensure Ohio conducted a thorough analysis, the Governor's Office of Workforce Transformation and BroadbandOhio engaged stakeholders across the broadband and 5G spectrum from telecom, construction subcontracting, industry associations, trade groups, rural electric co-ops, nonprofits, career-technical education providers, Ohio Technical Centers, and two- and four-year colleges and universities.

Over a four week period, the state used a total of 10 stakeholder meetings to ensure it was accurately tracking the preliminary issues identified and to solicit feedback on what Ohio should do to address the broadband and 5G workforce shortage. The meetings created positive collaboration between industry and education on identifying ways to build the broadband workforce needed in Ohio.

4 Discussion

The broadband industry was facing a labor pool crunch before the COVID-19 pandemic.¹³ The Federal Communications Commission (FCC) created a working group within its Broadband Deployment Advisory Committee (BDAC) that began examining the broadband industry's workforce challenges in 2019.¹⁴ The BDAC report was an extensive, fifteen-month process that looked at the broadband industry's workforce challenges at the national level. The Co-Chair of the FCC BDAC report, Dr. Rikin Thakker, who currently serves as the

Chief Technology Officer at the Wireless Infrastructure Association (WIA), was an active participant in Ohio's broadband workforce analysis, using his national expertise to assist the state in identifying the key challenges for Ohio to address. The BDAC report and discussions with stakeholders clarified the need for the state to focus on a few key issue areas: broadband industry career awareness, education and training programs, and awareness of state and federal funding for training programs.

13. *Preparing The 5G Workforce (Field Engineer, 2019)*

14. <https://www.fcc.gov/sites/default/files/bdac-job-skills-training-opportunities-approved-rec-10292020.pdf>

Broadband Industry Career Awareness:

A recurring theme throughout the analysis was a lack of awareness of the viable career paths offered within the broadband industry. The BDAC report specified that "without a clear identity of the broadband industry, the skills gap will likely only grow."¹⁵ Educational institutions lack awareness of employer needs, the general public is unaware of job opportunities in the broadband industry, and workers within the industry often do not realize that there are opportunities for advancement. Additionally, employers lose out from high turnover because employees tend to transition jobs for minimal compensation increases without realizing the possible career and salary advancement paths.¹⁶ To illustrate that point, stakeholder meeting participants stated that broadband infrastructure talent often move into power and electric utility subcontracting because those industries have a higher base rate of pay.

In the stakeholder meetings, which included Ohio-based companies, a consistent theme in relation to career awareness was the need to create middle and high school-level programs to expose students to the broadband industry. Industry representatives thought



a multi-pronged approach would have the greatest impact on developing the next generation of broadband workers. Introducing curricula in middle and high school alongside existing STEM programs, internships, preapprenticeships, and apprenticeships should be part of attracting and retaining Ohio's best talent.

Establishing and Scaling Education and Training Programs:

Facilitating the establishment and scaling of education and training programs for the broadband industry is another key issue to address. The industry has repeatedly stated, even prior to COVID-19, that attracting and retaining skilled talent is "among the biggest chokepoints in deployments."¹⁷ The skills gap and labor crunch in the broadband and 5G space have become so severe that construction companies have turned away work because of the shortage of labor.¹⁸ This labor crunch affects equipment manufacturers as well because there is not enough talent to operate the machines needed for broadband and 5G infrastructure build-out.¹⁹

To meet the increasing demand for broadband and 5G infrastructure, the industry needs to recruit significantly more workers. These workers must be educated and trained, but the United States does not have many broadband or 5G specific programs. One reason is the lack of industry standardization for the credentialing of particular occupations.²⁰ Registered apprenticeship programs are one solution to this challenge, but are somewhat new for the telecom industry and need more funding support to expand. The lack of standardization has led to incumbent workers with very individualized skillsets, making it difficult for industry to communicate

to educational providers the grouping of skills needed to establish education and training programs for broadband occupations.²¹

This trend has begun to shift as the industry begins to standardize its training. In 2020, the U.S. Department of Labor awarded WIA a \$6 million grant to expand apprenticeship in the telecommunications industry.²² Currently, WIA administers 11 occupations through the Telecommunications Industry Registered Apprenticeship Program (TIRAP).²³ These 11 occupations represent a significant number of the most critical broadband and 5G industry occupations including tower and wireless technicians, fiber optic technicians, and utility construction technicians. More occupations with engineering skillsets are being designed now. In addition to the TIRAP model, both WIA's Telecommunications Education Center (TEC) and NATE: The Communications Infrastructure Contractors Association (NATE) informed the state they have each designed, and are in the process of designing, plug-and-play curriculum models that training providers can stand up to begin scaling training efforts. TEC has a catalog of over 30 courses that were designed with the help of subject matter experts (SMEs) from industry and academia to address 5G training needs.

15. *Id.*
16. *Id.*
17. Testimony of Lisa Youngers, President & CEO of Fiber Broadband Association, "The 5G Workforce and Obstacles to Broadband Deployment" (U.S. Senate Testimony before Committee on Commerce, Science, and Transportation, 2020)
18. *Id.*
19. *Id.*
20. <https://www.fcc.gov/sites/default/files/bdac-job-skills-training-opportunities-approved-rec-10292020.pdf>
21. *Id.*
22. <https://wia.org/wia-awarded-6-million-dol-grant-to-train-5g-workforce/>
23. <https://www.tirap.org/what-apprenticeships-is-tirap-administering/>

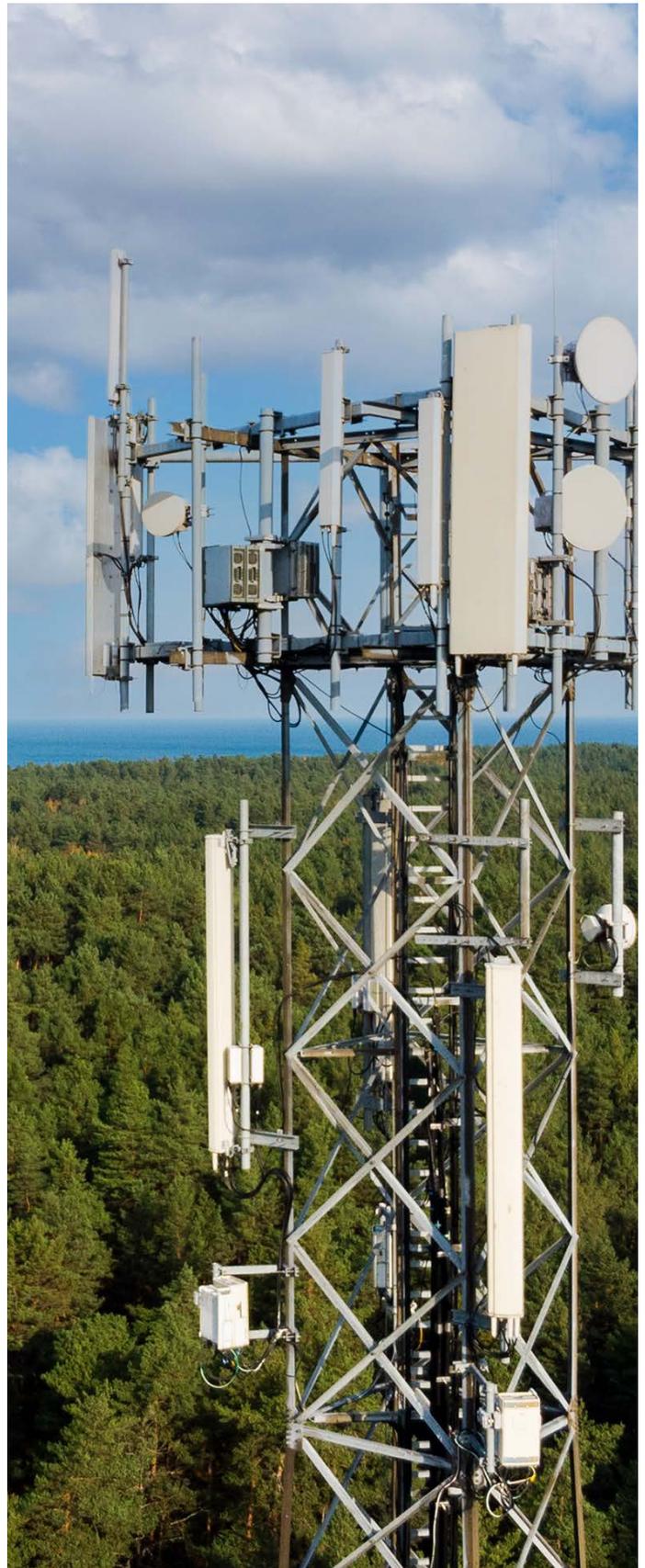
NATE's Tower Technician 1 curriculum is estimated to be ready for a fall 2021 launch. The issue now is how Ohio can scale these efforts to ensure the state has the training capacity to produce the level of talent needed for broadband and 5G infrastructure build-out.

Awareness of State and Federal Funding for Training Programs:

There is both a lack of funding and awareness of funding for training programs to upskill and reskill workers for the broadband industry from a national perspective.²⁴ However, in Ohio, it is not a lack of funding, but a lack of awareness of the funding available to Ohioans, employers, and training providers. During the stakeholder meeting process, multiple Ohio-based companies were unaware of the TechCred program, which assists employers in upskilling or reskilling their workforce with technology-focused, short-term credentials.²⁵ The program reimburses employers up to \$2,000 per credential and \$30,000 per application period for eligible credentials completed in less than one year.²⁶ In addition to TechCred, the Individual Microcredential Assistance Program (IMAP) helps Ohioans who are low income, partially unemployed, or totally unemployed participate in a training program to receive a credential at no cost to the student.²⁷ This program reimburses training providers up to \$3,000 per credential when an Ohioan earns a qualifying technology-focused credential.



Both TechCred and IMAP, among other workforce training programs, can serve as funding vehicles for a significant portion of the initial workforce deployment needed to build out broadband and 5G infrastructure in Ohio. For example, the Tower Technician 1 program designed by NATE, which takes approximately eight to ten weeks to complete, is estimated to cost \$3,000. TechCred would cover two-thirds of the cost, and IMAP would cover 100 percent of the cost. A first-year Tower Technician can make \$45,000 to \$75,000 per year: a great outcome for both the student and the state.²⁸ At the regional level, Ohio's 20 local workforce development boards (LWDBs) provide services under the Workforce Innovation and Opportunity Act (WIOA), which will pay for training that leads to post-secondary credentials for eligible adults, dislocated workers, and youth. WIOA may also pay for on-the-job training (OJT) to reimburse an employer's costs of training a hired participant in the workplace.



24. <https://www.fcc.gov/sites/default/files/bdac-job-skills-training-opportunities-approved-rec-10292020.pdf>

25. <https://techcred.ohio.gov/wps/portal/gov/techcred/about>

26. *Id.*

27. https://development.ohio.gov/bs/bs_imap.htm

28. Testimony of Jimmy Miller, Chairman of NATE, "The 5G Workforce and Obstacles to Broadband Deployment" (U.S. Senate Testimony before Committee on Commerce, Science, and Transportation, 2020)

5 Strategies

To continue efforts for broadband expansion, it's important to take a system-wide approach to the workforce needs of broadband and 5G development. Investments made in workforce development will ensure broadband and 5G infrastructure projects are built on time. Any delay in infrastructure build-out means delays in broadband access and GDP growth. For 5G, every 1 percent shortfall (roughly 1,070 workers) in talent supply,

including direct and indirect talent, could mean missing out on \$546 million in potential GDP benefits for Ohio from 2020-2030.²⁹ The strategies laid out below were developed in partnership with industry and education stakeholders. These strategies include short, medium, and long-term objectives that seek to ensure both broadband and 5G deployment will be supported by a workforce capable of building and maintaining it.

Ohio Broadband and 5G Sector Partnership

Similar to the FCC BDAC, an entity should be established that will implement the statewide strategy to produce the right talent, at the right capacity, and at the right time. The creation of a Broadband and 5G Sector Partnership ("Sector Partnership") would accomplish that objective. Forming a central convening entity will help reduce duplicative efforts among regions and allow regional partnerships to be forged. Doing so will allow regions to complement strengths and mitigate weaknesses,

share assets and burdens, and distribute best practices to stakeholders across Ohio. This proposed Sector Partnership would be led by an industry intermediary that understands the industry, education, and government – and the mandate to remain technology-neutral. The industry intermediary would be supported by the Governor's Office of Workforce Transformation and BroadbandOhio to ensure the Sector Partnership meets the policy goals of the administration.

Broadband Industry Career Awareness

Industry stakeholders believe there is a significant need for high school students to be exposed to the industry. Curriculum in middle and high schools combined with internships are the key to that exposure, and a focus should be placed on curriculum development, internship, preapprenticeship, and apprenticeship opportunities. An important component of curriculum development would be the initial first step of identifying broadband occupations along the educational continuum and further defining the essential skills necessary to be successful in those occupations. This information would be assembled into a career pathway model to easily showcase to stakeholders the various entry and exit points of broadband careers.

In the short term, internships could quickly be implemented by significantly expanding the High School Tech Internship Pilot Program, a competitive opportunity for employers to hire high school interns and receive reimbursement for their wages. The High School Tech Internship program provides a quick-to-market, structured model for students to get exposure to the broadband and 5G industry while earning a wage. Additionally, this program structure will ensure students are going through a work-based learning model that outlines the job duties, learning outcomes, and role of the business during the experiences. Ohio's Comprehensive Case Management and Employment Program (CCMEP) also funds internships as a work experience for eligible youth, most of whom are out of school or on public assistance.

29. https://api.ctia.org/wp-content/uploads/2021/01/5G-Promises-Massive-Job-and-GDP-Growth-in-the-US_Feb-2021.pdf



Linking employers with the CCMEP provider in each county could lead to a steady pipeline of motivated youth into broadband careers.

In the medium-to-long term, efforts should include working with the industry intermediary to develop elective and AP classes, using the identified career pathway model, in traditional and career technical

education settings in Spectrum, Wi-Fi, Telecom, Wireless, and Fiber technologies. These opportunities will give students exposure to the industry, the opportunity to explore career paths within the industry, and the ability to earn credit in high school and credit for their postsecondary education.

Establishing and Scaling Education and Training Programs

One of the most significant barriers to large-scale broadband and 5G infrastructure deployment is lack of labor, thus creating the need for education and training programs in Ohio. Currently, Ohio has few broadband or 5G-specific training programs. However, one such program is located at Terra State Community College in Fremont.³⁰ This program is new and had its initial cohort in the spring of 2021.³¹ The industry has developed and continues to develop plug-and-play curriculum models that could be scaled for use in Ohio. In addition, there are many education and training programs throughout the state that have similar components to what is needed for broadband and 5G but need modifications to meet the industry's need.



Lt. Governor Jon Husted is at Terra State Community College in Fremont to meet with students in the Utility Construction Installer program.

In the short term, institutions and training providers should be identified to be partners with the telecom industry. From there, identify plug-and-play, non-degree curriculum models that could be implemented quickly at these organizations to start addressing the labor crunch. For example, through the stakeholder engagement process, the state learned that NATE's plug-and-play Tower Technician 1 curriculum model is designed to be established as a credit or noncredit program that can be brought to market in a matter of weeks and costs approximately \$200,000 for initial capital expenses. The program is designed to be short, lasting approximately eight to ten weeks. It gives students the skills needed to sit for the National Wireless Safety Alliance (NWSA)

exam to be a Tower Technician 1 – an industry-recognized portable certification. For a student, the program cost would be \$3,000, leading to a job that pays \$45,000 to \$75,000 in their first year of employment.³² Dr. Gemma Frock, who is facilitating a team of SMEs to design the plug-and-play Tower Technician 1 program for NATE, previously developed the first of its kind program at Aiken Technical College in South Carolina, which had 100 percent placement rates for students who completed the certification.³³ TEC's "5G Readiness Program" is another program that can be plugged in as a 10-weekend certificate program at a community college or 4-year degree institution. Most of the content can be delivered online and students get to learn practical aspects of broadband and 5G through field trips to live-cell sites at the end of the program.

In the medium-term, the proposed Sector Partnership would establish a framework to create a "Broadband & 5G Connectivity Center" ("Connectivity Center") housed at a large university with smaller nodes in select regions of the state. This Connectivity Center will be led by the industry intermediary and work to execute the statewide strategy set by the Sector Partnership. This is where secondary and postsecondary education stakeholders, in partnership with industry, will map out the process to create a seamless ecosystem of curriculum and training programs geared for careers in the broadband and 5G industry that are implemented strategically at the smaller nodes. The first mission of the Connectivity Center will be to map all postsecondary programs in the state and identify which can be modified quickly to integrate broadband and 5G plug-and-play curriculum developed or distributed by the Connectivity Center.

In the long-term, in addition to developing secondary education curriculum (electives and AP classes) that result in an industry-recognized credential, the Connectivity Center would begin developing and implementing industry-centered registered apprenticeships, majors, and degree programs at the postsecondary level geared toward the broadband and 5G industry. At a more granular level, it would include the rollout of registered apprenticeships, the creation of new in-demand occupations for 5G and broadband, the creation of two-year associate degree

30. http://terra.edu/degrees_programs/technology_skilled_trades_division/construction_technology/utility_construction_installer_certificate.php

31. *Id.*

32. Testimony of Brendan Carr, FCC Commissioner, "The 5G Workforce and Obstacles to Broadband Deployment" (U.S. Senate Testimony before Committee on Commerce, Science, and Transportation, 2020)

33. *Id.*

programs, the creation of a major in Cellular/Wireless Infrastructure for four-year degree programs, the creation of an Interdisciplinary Professional Master's Program in Telecommunications for in-career workers, and the creation of an "Executive Certificate on Broadband and

5G Strategies" for executives at various business schools in the state. This A-to-Z approach will help Ohio have the workforce to physically build the infrastructure, maintain it, and capitalize on the economic benefits of broadband connectivity and the first mature 5G network in the region.

Capitalizing on State and Federal Funding Programs

Ohio has multiple state funding programs that could be used to quickly bring to market the talent supply needed for the broadband and 5G industry. With TechCred receiving increased funding in fiscal years 2022-2023, it is a prime vehicle for broadband and 5G industry employers to upskill or reskill incumbent workers or potential employees they would hire if they had additional skills. To complement TechCred, IMAP will add a focus on broadband and 5G industry career paths, providing Ohioans who are unemployed or underemployed the opportunity to go through training at no cost to earn a credential that will qualify them for an entry-level job in the industry. An example of a potential broadband and 5G IMAP program is NATE's Tower Technician 1 curriculum. From there, TechCred could be used to assist employers in financing additional skill development for these new employees – further increasing their skills and earnings.

In carrying out the WIOA program, the business-led LWDBs interact with employers in their local area to identify hiring needs to meet area employer demand.

Broadband and 5G industry employers may strategize with the LWDB in their area on the investment of federal funding to prepare job seekers for employment in this sector.

To accomplish this, the Governor's Office of Workforce Transformation will continue to work hand-in-glove with the industry to ensure employers are aware of TechCred and that they are connected with IMAP completers. This will also involve collaborating with incumbent industry players and their associations to identify the industry's universe of subcontractors and other ancillary employers to perform outreach to raise awareness of the programs. This will include presentations to industry groups, including attending events where there are large concentrations of broadband and 5G employers.

6 Conclusion

Through this analysis, Ohio has identified stakeholders in broadband and 5G infrastructure build-out, evaluated existing research, and convened meetings with stakeholders to discuss what is needed for the broadband and 5G industry's workforce. The findings are clear, both from the literature and from stakeholder engagement: there is a broadband industry workforce shortage. In Ohio, specifically, state and federal investments in broadband will create roughly 1,250 direct construction jobs.³⁴ The deployment of 5G will create approximately 32,000 jobs from network infrastructure deployment and another 75,000 indirect jobs from new and improved business use cases across industries.³⁵ To address this workforce shortage, a strategy should involve (1) working with industry and education stakeholders to increase broadband industry career awareness, (2) establishing and scaling education and training programs to build workforce capacity, and (3) capitalizing on existing state and federal funding programs to finance this undertaking in partnership with the industry.

Ohio has the potential to lead the United States in developing a highly skilled broadband and 5G workforce

that will close digital equity gaps and propel our state's economic engines into the next generation of wireless technology. Expanded broadband access will allow unserved and underserved Ohioans to participate in the modern economy by allowing access to quality healthcare through telehealth, access to quality education through remote learning, and access to remote employment opportunities. The deployment of 4G allowed the app ecosystem to flourish – establishing players like Uber, Lyft, Airbnb, and others. Efforts to enhance and expand broadband, along with other innovation initiatives, will help solidify Ohio's position as the most innovative, creative, and entrepreneurial state in the Midwest.



34. Appendix 1

35. https://api.ctia.org/wp-content/uploads/2021/01/5G-Promises-Massive-Job-and-GDP-Growth-in-the-US_Feb-2021.pdf



Expanding Broadband: The Ohio Case

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Dr. G. Jason Jolley, Ohio University

June 2, 2021

Introduction

This is a case study of the potential impacts of broadband expansion on Ohio's employment. This analysis uses an approach similar to the 2021 Brookings report, *How federal infrastructure investment can put America to work* (Escobari et al., 2021). In the process we can say something about potential occupations that might be impacted by broadband expansion, and the supply of workers in these occupations and (as Brookings calls them) adjacent occupations. However, we use industry-level employment for this study. Ohio does not collect occupation as part of its Unemployment Insurance Wage system, occupation indicators are only available for workers who are unemployed, and these indicators are not sufficiently detailed to estimate the stocks and flows of individuals who are unemployed and available for work. We do make some educated attempts to illustrate the potential occupational impacts of these investments by using existing Ohio occupational data.

Assumptions

- There is a \$500 million investment in Broadband employment that occurs in a single year (year 1).
- The investment generates 2.5 jobs per \$1 million investment, for a total number of 1,250 jobs directly generated by the investment. This is hard wired into the report from Brookings.
- The employment directly generated is produced in one of six NAICS (industry) codes as follows, with the 2.5 new jobs per \$1 million distributed across six industries according to the weights noted in parentheses; for example, out of 2.5 jobs created, half of a job is created in the Wired Telecom industry for each \$1 million investment. These weights are reapplied from the Brookings report.
 - 237130 - Power & Com. Line and Related (0.625)
 - 335921 - Fiber Optic Cable Manf. (0.25)
 - 335999 - Misc. Elec Equip (0.375)
 - 515210 - Cable and Other Sub. Prog. (0.25)
 - 517311 - Wired Telecom (0.50)
 - 517312 - Wireless Telecom (0.50)

Industry mix

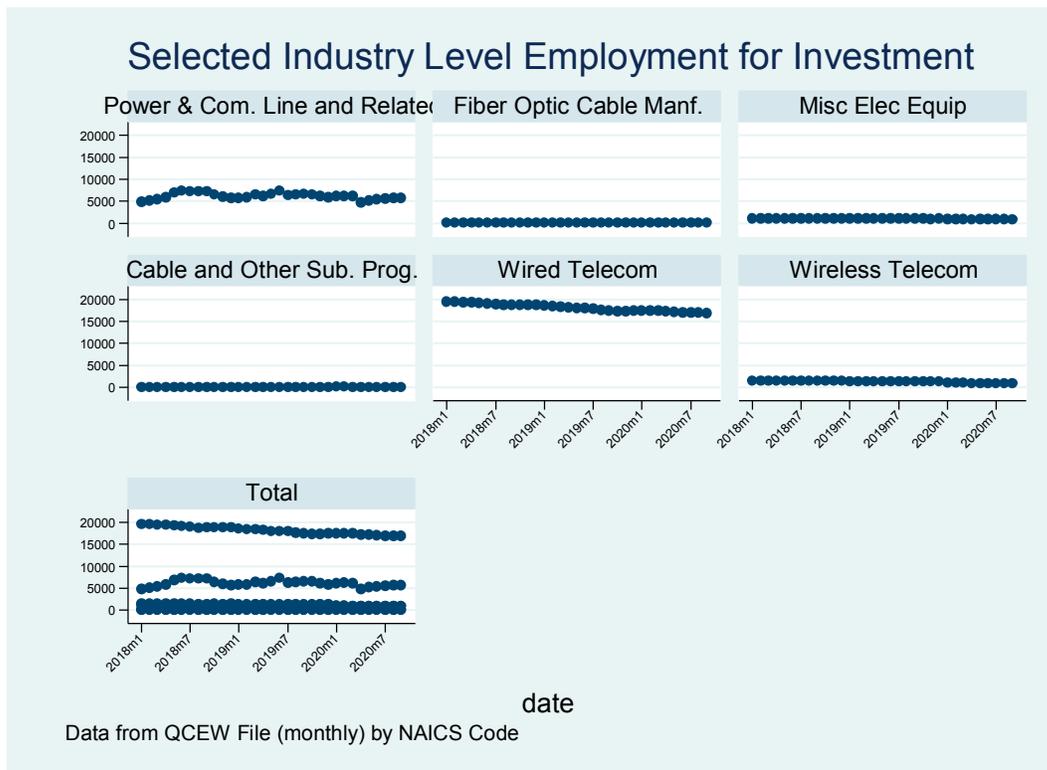
The industry codes used to estimate employment are taken from the Brookings report, and mapped to IMPLAN classification. The industry weights are as follows:

- 237130 - Power & Com. Line and Related Structures Construction (25%)
- 335921 - Fiber Optic Cable Manufacturing (10%)
- 335999 – Misc. Electric Equipment and Component Manufacturing (15%)

Appendix 1

- 515210 - Cable and Other Subscription Programming (10%)
- 517311 - Wired Telecom (20%)
- 517312 - Wireless Telecom (20%)

Using these weights we examine employment by industry code. The trend of employment in these NAICS codes is taken from the six digit codes in the Quarterly Census of Employment and Wages for 2018-2020 (by month). These numbers are used to help understand the relative impact of these investments above on the jobs.



Total employment in the six broadband impacted NACIS codes has varied on a monthly basis since 2018. Monthly employment in the six codes peaked in the summer of 2018 at 29,111 (July 2018) and experienced a low in summer of 2020 (24,607 in June 2020). The largest number of jobs in this group of NAICS codes occurs in the Wired Telecommunications industry. The smallest monthly employment is seen in the Cable and Other Sub. Programming.

Estimated Jobs Created by Industry Code

The following lists total number of estimated new jobs in direct employment, indirect employment and induced employment overall.

Impact Summary				
Impact Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	1,250	\$97,536,241	\$385,707,202	\$925,763,639
Indirect Effect	2,567	\$141,568,619	\$230,515,181	\$446,222,203

Appendix 1

Induced Effect	1,479	\$73,580,214	\$134,960,556	\$234,457,339
Total Effect	5,296	\$312,685,074	\$751,182,939	\$1,606,443,181
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There is an estimate of 1,250 jobs created directly from the \$500 million investment in Broadband. In addition, there are approximately 4,000 jobs that will be created indirectly or through increased spending. **Please note that the Brookings report limited job creation to the direct effects.** The initial \$500 million investment in Broadband leads to a \$751 million increase in the state's GDP (e.g., value added) in year one. It also leads a total of \$1.6 billion in economic output; however, value added is a more important measure as it captures contribution to state GDP.

We predict that the estimated 5,300 new jobs will be in a range of industry sectors. The largest number of jobs is in Employment Services, which covers a wide range of industries including temporary staffing. Much of the direct effect of investment in Broadband is in Telecommunications and Construction, although there are also some impacts on employment in Leisure or Hospitality based on increased spending.

Top Ten for Employment					
Sector	Description	Total Employ.	Total Labor Income	Total Value Added	Total Output
472	Employment services	580	\$21,409,772	\$30,951,167	\$48,524,822
433	Wired telecommunications carriers	333	\$25,699,358	\$84,215,238	\$154,943,376
52	Construction of new power and communication structures	313	\$21,284,964	\$29,351,539	\$47,794,605
434	Wireless telecommunications carriers (except satellite)	257	\$15,760,822	\$201,361,250	\$473,464,745
447	Other real estate	206	\$3,837,615	\$14,871,415	\$39,534,145
339	All other miscellaneous electrical equipment and component manufacturing	188	\$17,502,587	\$21,263,068	\$63,085,725
497	Commercial Sports Except Racing	187	\$7,421,236	\$5,187,709	\$8,668,438
509	Full-service restaurants	132	\$3,207,586	\$4,724,763	8,545,657
432	Cable and other subscription programming	126	\$10,559,022	\$59,634,678	\$178,720,862
335	Fiber optic cable manufacturing	125	\$13,691,678	\$16,851,960	\$60,847,734
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Occupational Impacts

At this point, we are not able to measure directly the distribution of jobs by occupation based on these industries. The crosswalks from Ohio are not available using the EMSI data at this time, although we expect to be able to get access for future work. However, we would note that for some of these industries there are occupations that appear on the 2018-2028 “30 fastest growing occupations” list issued by the Ohio Department of Job and Family Services, Bureau of Labor Market Information in January 2021. For example, SOC Code 2371 “Utility System Construction” is likely an occupation that would map to the industry “237130 - Power & Com. Line and Related Structures Construction.” This occupation is predicted to grow by 15.6% over this time period. Moreover, other construction occupations, such as “2382 – Building Equipment Contractors” are projected to gain the most new jobs (8,185 between 2018 and 2028).

Clearly, each of the industry codes listed here would be represented in the occupational list. If we simply took the SOC codes from the Brookings report and assumed that Ohio’s occupational structure of the six industry codes is the same as the national report, we would see the following possible growth in the corresponding occupations.

Direct Employment by Occupation Code				
Occupational Code (SOC)	Occupational Title	% of Jobs Created (Brookings)	Total Jobs Created	Total Jobs Created as a Percentage of Annual Openings
49-2022	Telecommunications Equipment Installers and Repairers, Except Line Installers	13.18%	165	20%
49-9052	Telecommunications Line Installers and Repairers	9.22%	115	26%
41-3091	Sales Representatives, Services, All Other	6.38%	80	2%
43-4051	Customer Service Representatives	6.28%	79	1%
47-2061	Construction Laborers	4.71%	59	1%
49-9051	Electrical Power-Line Installers and Repairers	4.14%	52	18%
13-1198	Business Operations Specialists, All Other	2.44%	31	1%
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers	2.44%	31	2%
17-2072	Electronics Engineers, Except Computer	2.19%	27	11%

Based on this list (which is essentially a guess that Ohio’s occupational structure is the same as the national structure for broadband employment) we conclude that the 1,250 direct jobs created by the \$500 million investment is primarily in volume in the largest measure in telecommunications related fields. These occupations tend to have relatively small numbers of people employed, and therefore, a modest increase in the total number of jobs created can lead to a very large percentage increase in the

Appendix 1

total jobs created annually. For many occupations, however, the growth will be relatively modest in terms of a percentage increase in the volume of hiring expected in a normal year.

The following chart provides some additional information about the job qualifications and pay of the specific occupations.

Code	Occupational Title	Employment		Change in Employment		Annual Openings				Median Wage May 2019	Typical Education
		2018 Annual	2028 Projected	2018-2028	Percent Growth	Exits	Transfers	Total			
49-2022	Telecommunications Equipment Installers and Repairers, Except Line Installers	8,475	7,898	-577	-6.8%	-58	228	674	844	\$25.20	Postsecondary non-degree award
49-9052	Telecommunications Line Installers and Repairers	3,704	3,863	159	4.3%	16	88	334	438	\$20.45	High school diploma or equivalent
41-3091	Sales Representatives, Services, All Other	35,749	37,236	1,487	4.2%	149	1,077	3,543	4,769	\$25.02	High school diploma or equivalent
43-4051	Customer Service Representatives	100,806	96,357	-4,449	-4.4%	-445	4,734	8,404	12,693	\$16.70	High school diploma or equivalent
47-2061	Construction Laborers	47,997	52,887	4,890	10.2%	489	1,687	3,923	6,099	\$20.04	No formal educational credential
49-9051	Electrical Power-Line Installers and Repairers	3,076	3,251	175	5.7%	18	77	189	284	\$34.89	High school diploma or equivalent
13-1198	Business Operations Specialists, All Other	37,895	39,560	1,665	4.4%	166	1,052	2,666	3,884	\$33.81	Bachelor's degree
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers	16,631	17,002	371	2.2%	37	526	1,016	1,579	\$30.99	High school diploma or equivalent
17-2072	Electronics Engineers, Except Computer	3,657	3,677	20	0.5%	2	74	168	244	\$46.26	Bachelor's degree

Lastly, it is worth noting that these impact numbers do not capture any catalytic effects from increased Broadband access, such as improvement in educational outcomes, increase in employment opportunities, access to new markets, etc.

Reference

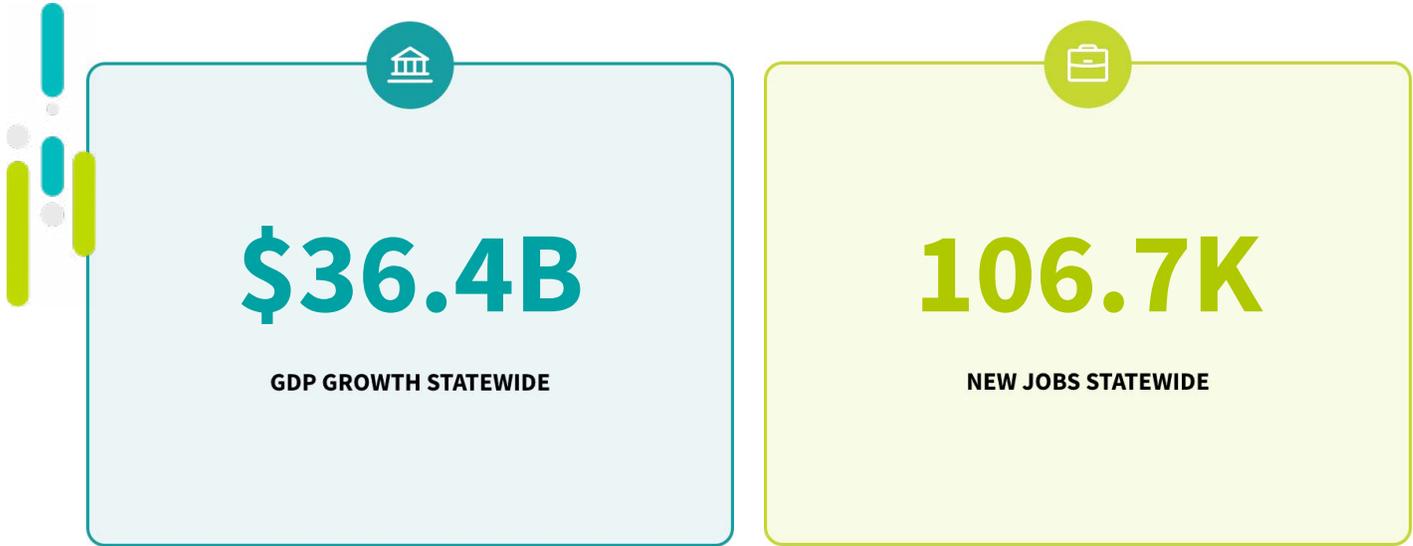
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5G ECONOMIC IMPACT



Ohio

The 5G Economy will have a significant impact on America’s cities and towns, large and small. Over the next ten years, we will see benefits across the country, including **4.6M** new jobs and **\$1.7T** in economic growth.



Metro Areas

	GDP Growth	New Jobs
Akron, OH	2.0B	6.2K
Cincinnati, OH-KY-IN	8.3B	26.3K
Cleveland-Elyria, OH	6.5B	19.6K
Columbus, OH	8.2B	25.0K
Dayton-Kettering, OH	2.4B	6.7K
Toledo, OH	2.0B	6.1K

Congressional Districts

	GDP Growth	New Jobs
District 01	4.3B	12.0K
District 02	2.2B	6.4K
District 03	2.9B	8.2K



Congressional Districts	GDP Growth	New Jobs
District 04	1.8B	5.6K
District 05	2.5B	7.5K
District 06	1.2B	3.9K
District 07	1.6B	5.3K
District 08	2.0B	5.9K
District 09	1.5B	4.1K
District 10	2.4B	6.6K
District 11	2.3B	6.2K
District 12	2.6B	7.6K
District 13	885.2M	2.7K
District 14	2.6B	7.9K
District 15	3.2B	9.8K
District 16	2.5B	7.1K

