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Ohio Broadband Trends

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Responsibility for facts, their interpretation, and conclusions drawn vests with the author.

Executive Summary

This report is a retrospective analysis of several research tasks specifically regarding residential broadband Internet adoption and use in Ohio. It is also intended to provide prescriptive guidance for policymakers, as well as public and private investors, in broadband. The formal data collection period under review is 2008 through 2014 inclusive, while recognizing some earlier context and the developments that have continued in the time since.

Overall, the perception of need for residential broadband is increasing, despite the prevalence of smartphones. Availability of broadband services, the definition of which is constantly increased, is a near-universal 95% in Ohio, yet adoption by residential subscribers plateaued beginning in 2013 at 76%. Under the current federal definition of broadband, 25 Mbps downstream, Ohio ranks 42nd among reporting states.¹ Further, survey results indicate that the coverage and quality of services provided in Appalachia Ohio substantially lag behind those in urban areas.

Since 2011, the federal government has declared broadband to be a “universal service.” Broadband is well on the path of replacing basic telephone service as the primary method of communication in the United States. As such, federal subsidies will now flow to both providers and subscribers of broadband service. This paper discusses how Ohio can take advantage of this sea-change in federal policy to better economic and social development.

Beyond broadband access, several aspects of Ohioans’ lives would benefit from the greater adoption and use of broadband-enabled technology. For instance, Ohio does not fare well in comparison to other states in terms of educational attainment, poverty, infant mortality, and cancer incidence. Improvements in outcomes can result from better engagement with appropriate institutions via broadband access. For example, the Cleveland Clinic, consistently ranked among the nation’s best hospitals, can now provide online consultation with a clinician within minutes for \$49.

¹ Federal Communications Commission, 2016 Broadband Progress Report, Report 16-6, Released January 29, 2016. Appendix G, At 25 Mbps downstream, the national adoption rate was 37% while Ohio’s was 11%.

Telecommunications is a unique industry with a distinct cost structure, endless cross-subsidies, and overlapping regulation. A competitive market will effectively resolve most product availability and pricing issues, but a competitive market will not automatically address and realize the greater social benefits of increased broadband adoption and use in schools, by government, and among vulnerable, often-disconnected low-income communities. Addressing these social concerns and gaps requires affirmative public policy informed by sound data.

Ohio is fortunate to have a series of surveys conducted by Connect Ohio that reliably report broadband adoption and usage statewide. The results of these surveys at times diverge from respected national surveys such as the Pew Research Center's. Yet, Ohio's system of governance is based on local accountability. As such, federal broadband initiatives do not necessarily align with Ohio's needs, nor have sufficient accountability built-in.

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1. Introduction

The last decade has been the most exciting time for telecommunications in Ohio and the United States. That is, until the next one! The industry has “re-imaged” itself, not only with novel devices and services, but also with constant media and pervasive e-commerce. Behind that re-imaged persona, however, is a complicated industry based on layers of economic and technological premises whose success is critical to the well-being of all Ohio businesses and consumers.

The purpose of this report is to share with policymakers and other state stakeholders the objective analysis of nearly a decade of detailed data regarding broadband Internet service in Ohio. The report is important and timely considering that recent federal actions establish access to broadband essentially as a “right,” as had previously been the policy regarding basic local telephone service.² Therefore, this report is somewhat prescriptive and predictive considering that, over the last decade, several government programs have attempted to increase the geographic coverage of broadband as well as its adoption.

To foreshadow the major conclusions of this report, Ohio consumers fare well in access to basic broadband telecommunications, defined historically as a downstream data rate of 768 kilobits per second (Kbps).³ Surveys by Connect Ohio show that adoption or “take” rate of basic broadband has reached a plateau of about 76% in Ohio, with a rather immovable population of users that do not subscribe to service for varying reasons. Ohio's businesses also fare well in that service providers will commit to serve nearly every location at a range of broadband speeds, subject to construction charges, and there is generally competition among providers of business broadband service.

From these rates, this report attempts to drill-down into specific questions about broadband adoption in Ohio, seeking trends, and more importantly, where gaps persist. Narrowing these gaps is vital. Policies for public and incentivized private investment in broadband expansion have the ability to improve lives and to avoid social costs created by poverty. Public interest and

² Federal Communication Commission, FCC-11-161 *et seq.*, Connect America Fund: A National Broadband Plan for Our Future. See also FCC-14-190.

³ To put this in perspective, a single typed character requires eight bits.

avoided-cost arguments both will conclude that broadband engagement is good for the state. However, cost-benefit analysis requires “intellectual courage”⁴ as we do not yet know the marginal benefit to providing better access to healthcare information, to mitigating the effects of school snow days, to improving commerce and employment opportunities via the Internet.

Ohio is among the more challenging states to serve with broadband as attributes range from urban to rural, from industrial to agricultural, from topologically plain to mountainous, and there is a strong sense of local control within government. Yet, statewide, one policy often has to “fit” all situations. In many cases, detailed performance data are buried at the institution or county level, or lack granularity to derive trend. Ohio policymakers are hindered with excessive data collection through student testing without the aggregation and analysis to see what works—and to close the respective gaps.

However, the telecommunications industry in Ohio has the benefit of a brief era of well-performed surveys and studies. From 2009-2014, nonprofit organization, Connect Ohio, received federal funds to collect and analyze data about home broadband adoption and usage, as well as barriers to technology adoption. The survey process, as well as other data collection activities, generated successful collaborations statewide and enabled objective assessment of what programmatically works and what does not in terms of broadband adoption.

This report has four objectives that build upon one another as outlined below. Where these objectives are first covered, they will be highlighted in boxes in the text.

1. Provide an analysis of broadband adoption and availability trends in Ohio.
2. Conduct an analysis of demographic and geographic factors impacting the broadband and adoption trends.
3. Analyze state economic development indicators resulting from the broadband adoption and availability trends and demographic and geographic factor considerations.

⁴ Weimer, David, Wisconsin-Madison professor, in “Predicting the Benefits (and Costs) of Anti-Poverty Policies,” http://www.irp.wisc.edu/newsevents/workshops/teachingpoverty101/participants/Presentations/Weimer_CBA_Pov101_June_5_2013.pdf.

4. Review and analyze programs, organizations, and efforts that have positively or negatively affected broadband adoption and availability trends, demographic and geographic factors, and state economic indicators in Ohio and other states.

2. Background for Trends in Broadband Availability and Adoption in Ohio

The emphasis of this report is on “pivots,” or changes in direction. To the extent that this report pays particular attention to the underserved, there a single “non-pivot” to note:

Objective 1

Analysis of broadband adoption and availability trends in Ohio

the Ohio economy has not recovered to the levels experienced prior to the 2008 recession (the actual peak was in March 2000),⁵ especially for subgroups including Appalachian residents⁶ and displaced workers.⁷

There is an interesting question in economic development research as to whether a product breakthrough is inevitable—whether that success is deterministic, or something else is at work. One such breakthrough in technology was the Apple iPhone, in hindsight an obvious extension of the iPod, followed immediately by smartphones running Google Android. While the transition from text-based services to the hypertext Worldwide Web marked a prior period, the primary pivot in this report is a consequence of the emergence of smartphones, coupled with the corresponding capacity upgrades in commercial wireless networks to accommodate these devices.

Two additional pivots characterized demand for new services in Ohio and across the globe: social media and streaming media. Finally, several pivots characterized federal and state law and policy, beginning with the American Recovery and Reinvestment Act of 2009, otherwise known as the Stimulus Act.

⁵ Bureau of Labor Statistics data summarized by Buckeye Institute, <http://buckeyeinstitute.org/uploads/files/ObN-2015-12.pdf>.

⁶ U.S. Department of Agriculture, Economic Research Service, “Rural America at a Glance,” 2015 Edition.

⁷ Perkins, Olivera, “Ohio Has Yet to Recover All Jobs Lost to the Great Recession and Also the One in 2001,” [Cleveland Plain Dealer](#), 9/27/2015.

2.1 Ohio Distinctions

Ohio has experienced many milestones and distinctions in telecommunications that are interesting and relevant to this report. CompuServe, one of the first commercial online services, began in Columbus, Ohio in 1969, and ultimately formed the core of two other commercial online services—America Online and now Internet backbone provider, Verizon Business. What CompuServe Information Service achieved broadly, Dayton's Lexis-Nexis and Columbus's Online Computer Library Center (OCLC) became respectively the authoritative sources for legal research and library catalog information. The Greater Cleveland Freenet (GCFN) was the nation's original community bulletin-board system (BBS) and functional precursor to e-mail and the Web with online forums, albeit text-based via dialup modems. While GCFN eventually failed, its capability for library access continued and arguably Ohio's leadership in library automation is a descendant.



CompuServe[®]



LexisNexis[™]



OnBase[®] by Hyland Later startups, such as Cleveland's Hyland Onbase (<https://www.onbase.com>) and Overdrive (<https://www.overdrive.com>), are market leaders in electronic health records and electronic books. Ohio workforce also leads Air Force and Army (National Guard) cybersecurity efforts, and Columbus and The Ohio State University still have a legacy of a longtime Bell Labs presence.



Ohio is also unique in having locally run network service providers, such as Buckeye Telesystems in Toledo, Cincinnati Bell and Time Warner Cable in Columbus, and Horizon in Chillicothe, as well as a long history of rural, independent telephone companies primarily in northwest Ohio. The state of Ohio, through an initiative of The Ohio State University, manages a fiber network that serves government and education entities across the state at data rates up to 100 Gbps and interconnects with national backbones. The state has also developed a private

wireless system for public safety purposes whose radio and backhaul infrastructure are in a position for dual-use by a commercial service provider. This potential will be addressed in the conclusion of this report.

In addition to these Ohio telecommunications “firsts,” Ohio state government has been an innovator in broadband outreach. The staff of eCom-Ohio, residing at Ohio State University, used twenty laptops to dial randomly across phone exchanges in search of modems in 2000 and produced its first broadband access map in 2001 (see Appendix B). The Ohio Department of Development’s Thomas Edison Program used the agricultural extension service model in 2002 to launch regional “Information Technology Alliances” to support the I.T. industry. The Governor’s Office on Appalachia then funded OSU’s Technology Policy Group to continue the eCom-Ohio effort, focusing on 29 Appalachian Counties. Afterwards, in 1997, Governor Strickland launched the Connect Ohio initiative in 2007 that was among the first state-level broadband initiatives.

2.2 Technology Pivots

A decade ago, the typical residential computer was a desktop running Window XP (or Windows 98) on a single core Pentium processor⁸—perhaps along with a glass monitor—and the preferred cellphone was the Motorola Razr.⁹ Apple products were running MacOS and the company was just ending its *Think Different* campaign.¹⁰



Think different.®

Since that time, two pivots have emerged that are forever intertwined: the iPhone and Android

⁸ Compaq DX2000 with Windows XP Pro shown, See: <http://www.pcworld.com/product/29445/compaq-dx2200-desktop.html>.

⁹ Moto RAZR V3 shown; See: <http://www.cnet.com/pictures/motorola-razr-v3-history/>.

¹⁰ Stilanten, Rob, Forbes On Marketing, December 14, 2011, <http://www.forbes.com/sites/onmarketing/2011/12/14/the-real-story-behind-apples-think-different-campaign/>.

smartphone launches and the wireless providers' migration to 3G/4G and optical backhaul networks. Led by Blackberry, the smartphone era emerged in 2008, combined with the commitment by wireless providers to update technology (from 3G GSM and CDMA to 4G LTE), as well as expand capacity.

The early 2000's were marked with the emergence of Apple's device leadership: the iPod in 2002, iPhone in 2008, and iPad in 2010. Google's Android emerged concurrently for both phones and tablets. Yet, the role of Apple in accelerating the adoption of broadband-enabled technology cannot be overstated. The launch of the iPad in 2010 solidified Apple's formidable lead in applications and retail marketing of broadband-enabled technologies and devices. In response, Google Android is an example of a professional product delivered at little cost with the intent of disrupting a competitor, such that its market share now slightly exceeds the iPhone.¹¹ The role of smartphone usage—especially in Ohio—is the subject of a later section.

Social media emerged in the reporting period, as well as use of mobile as its primary medium. Facebook, launched in 2004, reached one billion users in 2013, and currently has over 1.6 "monthly active users"—and the majority of its revenue was derived from mobile advertising.¹² Twitter, which has negligible revenue, is designed around mobile SMS messaging, but its user base also became predominantly mobile in 2013.¹³ Pandora Radio launched simultaneously with the iPhone in 2012, with 80 million daily users but running financially at a loss.¹⁴ Spotify, a music service preferred by many, emerged in the U.S. from Sweden in 2011, and was reported to potentially overtake Pandora's user by the end of 2015; moreover, Spotify subscribers are more likely to pay, and to pay more.¹⁵

¹¹ McNish, Jacquie and Sean Silcoff, *Losing the Signal: The Untold Story Behind the Extraordinary Rise and Spectacular Fall of Blackberry*, Flatiron Books, 2015 and comScore reports and archives handset market share quarterly. See: <http://www.comScore.com/insights/rankings>.

¹² Facebook is a publicly-held company, and these statics come from <http://investor.fb.com>, most recent quarterly earnings Q1 2016.

¹³ New Compete study: Primary mobile users on Twitter, <https://blog.twitter.com/2013/new-compete-study-primary-mobile-users-on-twitter>, February 11, 2013.

¹⁴ See <http://investor.pandora.com> for 2016 Q1 Financial Results, including \$57.4 million EBITA loss.

¹⁵ The Motley Fool, "Spotify Is About to Overtake Pandora Radio," July 6, 2015. <http://www.fool.com/investing/general/2015/06/16/spotify-is-about-to-overtake-pandora-radio.aspx>

Accompanying the emergence of smartphones was the upgrade of backhaul networks from base station to switching center in order to fulfill the needs for greater bandwidth. First, and this is somewhat evolutionary, was the emergence of fiber optic links in the access segment delivered to (or near) subscriber premises. Metro Ethernet (ME) technology is the substrate for business and cell site fiber optic connectivity, as well as digital cable television and data offerings. ME services displaced the legendary, low-data rate (1.5 Mbps) T-1 copper circuit.

One useful method of analyzing the rate of change in broadband networks is the cost per megabit-per-second per month. Because of the economies of scale in broadband networks, as demand increases, the per-unit cost decreases. Over the course of the Connect Ohio project, this amount fell by a factor between ten and one hundred. That is, by replacing (cannibalizing) prior classes of transmission and routing/switching equipment with software—and often PC-based equivalents—the “decimal point” has moved left two places when assessing the cost of service. This has most affected business telephone service—both premises equipment and long-distance per-call costs.

2.3 Law and Policy Pivots

Law and policy were very relevant throughout the reporting period for Ohio and the nation, both leading and lagging the market for telecommunications services. Further actions from Columbus and Washington, D.C. will affect price and availability of services on a continuing basis, especially in 2016.

While wireless communication has solely been the domain of the federal government regulation, most wired telecommunications have been subject to Ohio jurisdiction. Wireless contains licensed and coordinated services, such as broadcast and mobile, while the remainder (e.g., Wi-Fi, Bluetooth, ZigBee, etc.) are regulated, but unlicensed—another paradigm for usage.

Providing telecommunications service is characterized by substantial capital investment, yet modest operating costs. This is not unlike other activities such as energy, water, and transportation in that providers are geographic monopolies—if not a public entity itself. It's not entirely mathematical, but one telecommunications “law” is that the power of a communications network is related to the number of parties connected to it (cf. Metcalfe's Law). In a strict

business sense, there are benefits (such as reduced costs) to having firms of substantial scale and scope. Public utilities had historically been fully vertically integrated geographic monopolies, balancing the obligation to serve all customers at a fair price in return for the franchise to serve. History also indicates that these enterprises tend to want to be natural monopolies, despite actions to divide or divest them.

Efficient pricing is a result of market competition, which is in fact the statutory policy of the State;¹⁶ but given the role of monopolies, the Public Utilities Commission of Ohio (PUCO) was created to perform the rate-setting role, *inter alia*. While business structures and technology platforms have evolved over time, the notional common rate—or “postage stamp” approach—across the state has more than concealed the vast differences in the cost to serve customers. Ohio Bell Telephone, historically Ohio's largest provider, operated primarily in high-density, naturally profitable urban markets while private and co-op public phone companies did business in other locales after requiring a federal recurring subsidy to serve high-cost customers, capital grants for infrastructure buildings, and substantial per-call compensation for completing calls that originated (and were billed) elsewhere.

2.4 The Digital Divide

The expression, “digital divide,” is the term to describe the gaps in service quality, service availability, and other outcomes. The expression entered common usage in 1995 through a series of U.S. Department of Commerce publications entitled, “Falling Through the Net,”¹⁷ which influenced the rewrite of U.S. Communications law.¹⁸ The expression was later used by the United Nations to indicate differences in telecommunications service adoption among developed, developing, and other countries.¹⁹ In July 2015, The White House Council of

¹⁶ Ohio Revised Code § 4927.02, to wit: “It is the policy of the State of Ohio ... to rely primarily on market forces” for service levels and rates. Note also that interesting elements of Ohio telecommunication policy are present in the biennial state budget.

¹⁷ U.S. Department of Commerce, *Falling Through the Net: A Survey of the “Have Nots” in Rural and Urban America*, 1995. Contains the first known use of the term “Digital Divide.” <https://www.ntia.doc.gov/ntiahome/fallingthru.html>.

¹⁸ Hammond, Allen S. IV (1997), “The Telecommunications Act of 1996: Codifying the Digital Divide,” *Federal Communications Law Journal*: Vol. 50: Issue 1, Article 6.

¹⁹ The World Summit on the Information Society, www.itu.int/net/wsis, adopted the expression, Digital Divide, in 2003, and it persists in its most recent “WSIS+10 Vision for WSIS Beyond 2015, see: <http://www.itu.int/net/wsis/documents/HLE.html>.

Economic Advisors issued a report stating that the digital divide is, 'concentrated among older, less educated, and less affluent populations, as well as in rural parts of the country that tend to have fewer choices and slower connections."²⁰

There is also a wide broadband availability gap in many parts of the country. Part of this gap includes measures of broadband performance. This gap persists even as networks have been built out because the demand for higher speed and quality broadband is increasing as fast as providers can construct infrastructure, particularly as video content on the web increases.

Definitions of "Broadband" Throughout the Years

Year	Context	Rate
1995	NTIA Report	19.2 Kbps, nominal dialup
2008	FCC Basic Broadband Benchmark	768 Kbps download
2010	National Broadband Plan Broadband Availability Target	4 Mbps download/1 Mbps upload
2014	Connect America Fund (subsidies in rural areas)	10 Mbps download/1 Mbps upload
2015	FCC Advanced Services Benchmark	25 Mbps download/3 Mbps upload

Streaming compressed digital video provides significant aggregate demand and is a constant engineering challenge. While interactive video game performance is based on latency more than data rate, the requirements for YouTube and Netflix are complicated and both content- and device-sensitive. Neither source is amenable to jitter (i.e., variation of delay or latency) or packet loss (both jitter and loss contribute to stalling and pixilation). Netflix states that, in high-definition and 2K modes, a minimum of 3 Mbps is required, ranging to 8 Mbps.²¹

²⁰ Council of Economic Advisers Issue Brief, "Mapping the Digital Divide," July 2015.

https://www.whitehouse.gov/sites/default/files/wh_digital_divide_issue_brief.pdf

²¹ "Per-Title Encode Optimization," Netflix Tech Blog, December 14, 2015. Specifically reference the "bitrate ladder" table. *Netflix provides the de-facto datarate requirement for many users.* Netflix has just begun streaming in 4K Ultra High Definition, whose requirements are estimated to be 15 Mbps.

Both Netflix²² and its prior Content Delivery Network (CDN) provider Akamai²³ have evaluated access network providers in their broadband performance, and although their methodologies²⁴ differ from the FCC's, it provides interesting insights into average performance. Akamai's customers include broadcasters (ESPN, MTV, etc.), software distributors (Microsoft, Adobe, antivirus firms, etc.), and cloud service providers (e.g., Microsoft Azure), and their users experienced over 10 Mbps downloads—nationally and in Ohio. In late 2015, Akamai ranked the U.S. #12 in average data rate of its connections (12.6 Mbps), #41 in rate of broadband adoption (80% at the 2010 4 Mbps standard), and #16 in the adoption of 10 Mbps service. South Korea ranked first at 20 Mbps and 96% adoption. U.S. and Canada broadband outcomes are similar; however, there are important gaps between states in the U.S. For example, the state of Delaware would rank second globally in adoption of 4 Mbps.

Netflix serves a broader user base and reports that its U.S. providers deliver median data rates of 3.75 Mbps (Cable modem) and 2.5 Mbps (DSL)²⁵—both of which are at the threshold of a positive user experience. The Netflix leaderboard indicates fairly consistent performance by access method, but that other nations have more subscribers using fiber optic connections. A recurring lesson is that new build-outs can deploy the best available technology, taking a region that is lacking service to higher tier of performance in a single step.

²² The Netflix Company Blog provides a monthly "ISP Speed Index." See <https://media.netflix.com/en/company-blog>.

²³ Akamai publishes a quarterly "State of the Internet" report. See <https://www.akamai.com/us/en/multimedia/documents/report/q3-2015-soti-connectivity-final.pdf>.

²⁴ Belson, David, "State of the Internet Metrics: What do They Mean?" in the Akamai company blog, <https://www.stateoftheinternet.com/trends-blogs-2015-02-state-of-the-internet-metrics-what-do-they-mean.html>.

²⁵ "Netflix ISP Speed Index for November, 2015," <https://media.netflix.com/en/company-blog/netflix-isp-speed-index-for-november-2015>.

3. The American Reinvestment and Recovery Act

First, ARRA tasked the Federal Communications Commission (FCC) with developing a National Broadband Plan. When the FCC released that plan in 2010, it set two aggressive goals, which included a national goal of 100 Mbps broadband service to 100 million homes by 2020 and 1 Gbps service to all community anchor institutions.

ARRA provided the U.S. Department of Commerce National Telecommunications and Information Administration (NTIA) with \$4 billion in funding for grants. In Ohio, several grants were awarded, including \$7.0 million through the State Broadband Initiative (SBI) grant, several broadband adoption grants through the Broadband Technology Opportunities Program (BTOP), and broadband infrastructure projects worth \$140 million for new construction of over 3,000 miles of fiber.

Ohio's SBI activities were performed by Connect Ohio and the Connect Ohio Technology Association. Under this award, Connect Ohio conducted capacity building activities; provided technical assistance for last mile enablement at the county level; and led statewide broadband data collection, integration and validation, as well as addressed verification for public safety. The surveys on broadband adoption were also funded through the SBI initiative.

Connect Ohio's parent nonprofit, Connected Nation, also received \$6.9 million through BTOP for a statewide broadband adoption program called "Ohio Public Adoption through Libraries: Every Citizen Online." This program upgraded over 300 public computing centers and provided training to over 43,000 users on computer and Internet use. The Toledo-Lucas County Public Library received BTOP funds (\$2.2m) to upgrade a computer center and create a mobile one. Other BTOP grants involved in Ohio entities, but were national in scope or based elsewhere.

Through the infrastructure project awards, The Ohio State University's OARnet convened the "Ohio Middle Mile Consortium," which included:

- Connecting Appalachia Middle Mile Consortium (Horizon Telecom), \$66.5 million, 34 counties
- Transforming Northeast Ohio (OneCommunity), \$44.8 million, 20 counties
- GigE PLUS Availability Coalition (Com Net,), \$30.0 million, 28 counties

Additional ARRA Programmatic Assessments from Ohio

Ohio's large ARRA infrastructure projects constructed over three thousand miles of new fiber optic links at an average cost in excess of \$50,000 per mile. The level of network design effort to reconcile end-to-end connectivity needs against existing, installed fiber and other facilities is not known. The cost of these construction projects approximates the sum of annual FCC subsidies to Ohio.

As part of these projects, installation of new fiber was dependent in many cases on attachment to existing poles or use of existing conduits, which was a regulatory issue unresolved in Ohio until 2015.²⁶ Lack of pole access resulted in new construction, subject to environmental concerns. Positively, however, operators of ARRA-funded expanded networks are beginning to interconnect with other Internet and telephone providers, a process known as NNI (Network-to-Network Interface), which extends functionality for each party—to each other's customers—with opportunities for more economical service delivery.

Additionally, under ARRA, the Department of Energy was awarded nearly \$100 million through the Smart Grid Investment Program, of which many projects had communication components. AEP and Duke Energy deployed "smart meters" that provided real-time consumption information including remote meter reading, remotely controllable thermostats, disconnect/reconnect features, and utilized cellular infrastructure.²⁷ No time-of-use rate structure has been

²⁶ See Public Utilities Commission of Ohio, Case 13-579-AUD-ORD, cf OAC 4901:1-3 Concerning Access.

²⁷ Ohio.gov, Energy Choice Ohio. Note the absence of time-sensitive residential electric rates in Ohio. See: <http://www.energychoice.ohio.gov/ApplesToApplesCategory.aspx?Category=Electric>.

implemented in Ohio, arguably negating the incentive for customers to modify consumption patterns and diminishing the value of the investment in meters.²⁸ Investor-owned, municipal and rural electric providers were also awarded grants for various remote telemetry and control systems intended to improve reliability.

Consumer-driven demand—from smartphones and streaming video—accelerated investor-funded upgrades to both broadband wireless and optical backhaul networks, much of which improved broadband access to certain populations. The nature of these projects ranges from fiber to conduit to municipal data centers. Acceptance of such projects is not universal, with some noting that municipal efforts—including preparing proposals for Google Fiber—serve also as levers for existing providers to upgrade or expand facilities.²⁹ One of the architects of the FCC's National Broadband Plan today considers fiber network ownership to be one option among many.³⁰

²⁸ Gearino, Dan, "AEP Must Prove 'Smart Meters' Save Customers Money Before Charging to 'Opt Out,'" Columbus Dispatch, April 27, 2016.

²⁹ "What have we learned from Google Fiber," by Blair Levin in cnet.com, July 31, 2015.

³⁰ *The Next Generation Network Connectivity Handbook*, by Blair Levin and Denise Linn, July, 2015.

4. Connect Ohio Survey Results

To examine the digital divide in Ohio, Connect Ohio performed statewide residential broadband adoption and use research surveying from 2008 through 2014. This research was originally undertaken via state funding that was later supplemented by federal grants from 2010 through 2014. Connect Ohio began this research with an awareness of the disparities in broadband adoption among particular groups, but without specific hypotheses in mind, nor known assumptions or biases.

To reach the desired +/- 3% margin of error with 95% confidence, approximately one thousand survey calls were completed—likely requiring ten times as many contacts in order to acquire respondents that, when weighted, could reflect Ohio's demographics. Results were coded for demographics, county, and ZIP code, which were then coded as urban or Appalachian. Analysts state that “correlation is not causation,” so care is needed both to filter trends that are not statistically significant (i.e., within the margin of error), and to seek fuller understanding of root causes of outcomes.

These data afford a rare, public opportunity for cross-cutting analysis over several years, primarily based on a series of annual surveys/interviews with broadband adopters and non-adopters across Ohio from 2008 through 2014. Statistical samples comprising 1,000 interviews have a very good accuracy, +/-3% with 95% confidence. Random sampling is essential to surveys, polling, and quality control—enforcing more discipline and understanding than 100% inspection.

4.1 Key Ohio Findings

A full delineation of the findings is below. Overall, broadband adoption in Ohio by any medium increased annually until plateauing in 2013, while median data rates continued to increase. Yet, broadband adoption is not uniform, with substantial gaps between population groups, and some gaps subject to trends. The reasons for non-adoption are many, including a resilient group that does not adopt broadband despite its availability.

1. Ohio's broadband adoption rate is 76%, having reached a plateau in 2013. This is consistent with FCC, Census, and Pew results.
2. Appalachian broadband adoption is 68%, which is significantly less than the statewide rate and, particularly, non-Appalachian adoption of 78%.
3. The ratio of cable modem subscribers to DSL subscribers has grown from 1:1 to 2:1. However, the geographic availability of DSL is restricted, so when the services compete, the preference is less profound.
4. Median³¹ urban data rates compare favorably to national averages, exceeding 10 Mbps for DSL, 15 Mbps for cable modem, and 50 Mbps for optical access.
5. Service in Appalachia has substantially lower median data rates, 1.5 Mbps for DSL and 10 Mbps for cable modem service.³² Satellite Internet and Non-carrier wireless (2%) are not preferred solutions, and their adoption may have peaked (WL in 2009). Anecdotally, some wireless Internet Service Providers (ISPs) are known to have ceased operation.
6. Ohio lacks general availability of fiber optic Internet access with data rates up to 1 Gbps. Recent announcements indicate introduction or presence of such service from DSL suppliers in selected urban markets³³ without equivalent offerings in rural settings or by cable modem providers.
7. Availability exceeds adoption in Ohio, and by some measures will approach 100%—considering ubiquitous satellite Internet and promised 4G LTE coverage. At the de facto Netflix-HD standard of 3 Mbps, county-level maps indicate total terrestrial coverage; some individuals point out that, at street level, there are unserved areas.
8. Smartphone usage (not simply ownership) for Internet access is strong in Ohio, equally used in Urban and Appalachian settings, 62%, more than in suburban and rural settings.
9. Substitution effects and cord-cutting effects are harder to discern directly, but many mobile subscribers are encountering data-cap limits: 45% of Appalachian users will in at least one billing cycle, compared to 35% of non-Appalachian users. These figures indicated heavy Internet use at a private, non-Wi-Fi enabled location, i.e., home.

³¹ This author prefers using the median, rather than mean, as a measure of central tendency, reducing the effects of extreme outliers; survey data is already coded by ranges of data rates, which is readily amenable to ordering.

³² Two samples are suspect, with survey responses indicating data rates vastly (Monroe County) or moderately (Highland County) in excess of those known to be offered by the cable provider.

³³ AT&T Ohio Policy Blog, December 15, 2015, regarding GigaPower introduction to Cleveland and Columbus, <http://ohio.att.com/blog/?PostId=2205>; See also <https://www.cincinnati-bell.com/fioptics/>.

4.2 The Non-Adopters

As mentioned previously, The White House Council of Economic Advisors recently characterized broadband non-adopters as likely to be older, less educated, less affluent, and rural. Connect Ohio's results are more detailed and more interesting, and they are expressed in the language of probability or likelihood. Results are bound by statistical

Objective 2
Analysis of demographic and geographic factors impacting broadband adoption and availability

significance based on a margin of error when considering the entire survey. While national surveys cannot “see into” individual states, the Connect Ohio surveys cannot see into counties – but are very, very good at breaking down state characteristics across many individual dimensions. Moreover, the survey “inherits” existing knowledge about population demographics, so effort goes into finding results that diverge from a statewide average or a known distribution, say, of ages.

Respondents are asked for their reasons for not adopting broadband service, and their answers are instructive, having changed over time. The initial barrier to adoption was the perceived lack of available of service, which has diminished as discussed before, and whose current status is depicted in maps in the appendix. Beyond access, in 2009,³⁴ reasons for not adopting broadband ranked as follows: no home computer available, 41%; no need for Internet, 26%; and cost of service, 14%. By 2014, the reasons for not adopting had changed: no need for service, 22%; no home computer available, 21%; cost or value of service, 14%; service not available, 5%; and too difficult, 5%.

In addition, according to Connect Ohio’s research on Ohio's broadband non-adopters...

- An urban household is less likely to be a non-adopter than population predicts, thus suburban and rural households are more likely than expected to be non-adopters.
- An Appalachian household is more likely to be a non-adopter than either the statewide average predicts, or for non-Appalachian households.

³⁴ The 2009 Assessment used a different question with different coded answers, preventing an equal comparison. Answers have been combined for clarity, and non-significant results are not shown.

- Likely to have a far lower household income than the statewide average. The median non-adopter household income is in the range \$25K-\$35K, while median adopter households are in the next-higher cohort, \$35K-\$50K.
- Likely to be much older. The median age of survey respondents was in the range 35-44, while the median age of non-adopters was in the range 55-65; over 40% of non-adopters are over age 75.
- Likely to be less well-educated, with the median education attainment of a high school diploma. The median level for adopters is the next level, having attended some college (without graduating).
- More likely than the overall population to have a form of physical impairment affecting vision, hearing, or mobility (i.e., walking), at twice the incidence rate for each.
- Less likely to have children in school, actually one-half as likely. This is valid regardless of geography.
- Analysis did not indicate a significant difference in adoption based on race or ethnicity.

Unfortunately, survey results become unreliable when working with small numbers of samples, as would happen with considering multiple variables at once. Yet, effects such as education and income are presumably not independent. One can presume that the confluence of significant effects does strengthen statements involving likelihood. Conversely, drawing conclusions from small samples would raise the margin error unacceptably. So, no ranking of counties is available from survey data (e.g., five counties, averaging six samples each, reporting having no non-adopters, which invites an obvious but improper conclusion of 100% adoption).

4.3 From Availability and Adoption to Implementation

Broadband availability and adoption are the means to many improved outcomes across commerce, employment, education, government, and healthcare. Identifying gaps in availability and adoption, and implementing strategies to close them, has been the impetus of public and private activity. Ohio survey results, however, reveal certain patterns of usage that do not indicate uniform progress toward the goals introduced in this section.

Education

To unpack the issues involved in all levels of education is well beyond the scope of this report. However, assessment of current educational technology requirements and their level of fulfillment are relevant, and the fact that these requirements are unevenly fulfilled across the state is significant.

Perceived opportunities include:

- Distance learning, including instruction, assignments, and group collaboration
- Instruction and collateral materials, partially or wholly in digital format
- Contingent solutions – for absences due to travel, illness, weather
- Open matriculation – transferable across institutions
- New models, new entrants, new disciplines

Positively, these provide opportunities for improved education at reduced costs; but alternatively, these requirements have a persisting dependence on infrastructure that could stall or stop progress for many. For example, such opportunities lead to specifications for end-to-end services characterized by network data rate, latency, jitter, loss, symmetry, reliability, security, and so on. Some Ohio locales will easily acquire infrastructure to meet the specifications because it will be generally available; in other locales, with effort, such facilities can be constructed and implemented; yet in certain locations, whether student-facing infrastructure will become available is still to be determined.

Connect Ohio survey results indicate that broadband adoption is often driven by having school-age students at home. Approximately one quarter of Ohio households include a child of school age, and the presence of those students reduces the rate of non-adoption among those households by half. Many students in Ohio directly receive their education online—Ohio was recently ranked second in the U.S., behind Arizona, for having 31,000 online students.³⁵ Moreover, Ohio has another 25,000 home-schooled students.³⁶ In 7% of Ohio households,

³⁵ Ideastream, "Ohio #2 in Online School Enrollment," <http://www.ideastream.org/stateimpact/2012/03/23/ohio-2-in-online-school-enrollment/> March 23, 2012.

³⁶ School Choice Ohio, "Explore Homeschooling," <http://www.schoio.org/school-options/explore-school-options/school-sectors/homeschool.html> content 2013.

students have received a laptop or tablet from school (often termed a “1:1 program”). Yet, Appalachian students are exactly half as likely as their non-Appalachian counterparts to receive a 1:1 device, and one-fifth of those households lack broadband.

There is no count of classes or students at the college level that are online – or in a blended format. The general efficacy of these programs – or even their methods – is unproven, but there is a high level of participation.

Employment

According to economist Peter Cappelli, the entire hiring process is increasingly dependent on applicants having Internet access.³⁷ Professor Cappelli also notes that competition for jobs is high, with multiple applicants per position, and the screening is highly focused. Nationally, the number of job openings may be nearly that of the number of job seekers. The state of Ohio notes that the number of unemployed is about 250,000—a rate under 5%—with statewide employment around 5.5 million.³⁸ Interestingly, the number of job openings in Ohio is substantial, potentially around 175,000.³⁹

As an indirect measure, the U.S. Bureau of Labor Statistics “Time Use Study” indicates that, as average commute time increases, working at home is more prevalent.⁴⁰ An increasing trend, 23% of the employed in the study did some work at home. Working at home is over twice as common for those who attained a bachelor's degree (37%) as compared to those with a high school diploma (14%). But, telecommuting typically requires sufficient at-home connectivity.

Given the above information, it is concerning that Connect Ohio survey results indicate less engagement with employment-related activities online by some groups:

- Working at home, even occasionally, is an option for 28% of Ohio households.
- Appalachian households are less than one-tenth as likely (3%) as non-Appalachian households to work from home.

³⁷ Cappelli, Peter, *Why Good People Don't Get Jobs*, Wharton Digital Press, 2012.

³⁸ Ohio Department of Job and Family Services, Ohio Labor Market Information, <http://www.ohiolmi.com>.

³⁹ This estimate is based on a simple proportion of openings, currently 5.5 million per US BLS, on Ohio's proportion of the national population. See <http://www.bls.gov/jlt/>.

⁴⁰ American Time Use Survey, Bureau of Labor Statistics, U.S. Department of Labor. <http://www.bls.gov/tus/>.

- Appalachian adults are, however, twice as likely (6% vs 3%) to use the Internet for work from a location outside the home, such as a library, restaurant, etc.
- Appalachian subscribers are less likely to use the Internet for job searching.

Healthcare

The emerging paradigm of “P4 Medicine” (personalized, predictive, preventive, and participatory) is substantially interactive and information-driven, holding promise for improved outcomes, dependent upon broadband infrastructure throughout.⁴¹ Ohio has significant healthcare distinctions, both positive and negative, increasingly tied to technology—specifically broadband connectivity.

Ohio has, in many ways, a leadership role in healthcare delivery and innovation based on broadly embracing technology. For example, the Cleveland Clinic is nationally ranked in several specialty areas.⁴² Northeast Ohio, with Minneapolis, leads the Midwest in medical commercialization.⁴³ Cardinal Health is Ohio's largest business, supplying pharmaceutical and medical consumables.⁴⁴ Hyland Onbase is Ohio's fastest growing software company—electronic health records.⁴⁵ In addition, Nationwide Children's and Cincinnati Children's do impactful work in the fields of genomics and cancer research.⁴⁶

In contrast, Ohioans face a number of life-threatening medical conditions, many of which are preventable. Nearly one million Ohioans (10.4% vs 9.3% rate for the U.S.⁴⁷) currently have diabetes, and another four hundred thousand exhibit signs of pre-diabetes.⁴⁸ This is higher than the U.S. incidence rate. Per the Center for Disease Control (CDC), the direct and indirect

⁴¹ P4 Medicine is Predictive, Preventive, Personalized and Participatory. See the Institute for Systems Biology, <https://www.systemsbiology.org/research/p4-medicine/>.

⁴² *U.S. News*, “U.S. News Best Hospitals 2015-16,” <http://health.usnews.com/best-hospitals/rankings>.

⁴³ DeAolia, M.C., “New year brings more promise for Cleveland's biotech industry growth: Tech Czar Talk,” http://www.cleveland.com/business/index.ssf/2016/01/new_year_brings_more_promise_f.html.

⁴⁴ *Fortune*, “The 2015 Fortune 500,” <http://fortune.com/fortune500/>.

⁴⁵ Ohio Development Services Authority, Office of Research, “Ohio IT,” <http://development.ohio.gov/files/research/B1011.pdf> see Major Projects.

⁴⁶ The White Lab, The Research Institute, Nationwide Children's Hospital. Dr. Peter White developed the software package “Churchill” for fast sequencing of genomes. See <http://churchill.nchri.org/index>.

⁴⁷ National Diabetes Statistics Report, 2014, Center for Disease Control, <http://www.cdc.gov/diabetes/pubs/statsreport14/national-diabetes-report-web.pdf>.

⁴⁸ Diabetes Prevention and Management, Ohio Department of Health, http://www.odh.ohio.gov/sitecore/content/HealthyOhio/default/diabetes/odpcp.aspx?sc_lang=en. Report refers to 2013 data from the Ohio Behavioral Risk Factor Surveillance System.

costs were \$245 billion in 2014, of which nearly \$10 billion was estimated to be for Ohio (based on Ohio's 3.6% of the U.S. population). Ohio also ranks 45th nationally in infant mortality, near bottom for deaths of African American babies.⁴⁹ By federal standards, 69 out of 88 Ohio counties contain "medically underserved areas" (MUAs) as defined by too few primary care providers, high infant mortality, high poverty, or a high elderly population. In addition, Ohio's death rate from unintentional drug overdoses,⁵⁰ with heroin abuse is specifically termed an "epidemic,"⁵¹ although the Ohio Department of Health has reported that some trends are improving.⁵² Perhaps the findings from The Commonwealth Fund's 2015 state analysis sums Ohio's state of medical care best when it reported:

Ohio is ranked 33rd overall in the scorecard. The state is in the second quartile for "access and affordability" and "prevention and treatment," in the third quartile for "avoidable hospital use and cost," and in the bottom quartile for "healthy lives" and "equity."⁵³

Against this backdrop, information-driven, broadband-enabled engagement is an element of many programs and interventions. The Kaiser Family Foundation reported that 1.4 million Ohioans used the Ohio Benefits portal.⁵⁴ The Ohio Health Information Partnership also operates a system known as CliniSync, involving 14 hospitals plus service providers as an "exchange" for patient electronic health records.⁵⁵ OHIP further notes that almost 90% of Ohio hospitals have committed to a health information exchange (HIE). Another example is the Southern Ohio

⁴⁹ Zeltner, Brie, *The Plain Dealer*, "Ohio ranks 45th nationally in infant mortality, near bottom for deaths of black babies," *The Plain Dealer*, August 6, 2015.

http://www.cleveland.com/healthfit/index.ssf/2015/08/ohio_ranks_45th_nationally_on.html.

⁵⁰ Ohio Department of Health, "Unintentional Drug Overdose Death Rates by County, 2008-2013," <https://www.odh.ohio.gov/~media/HealthyOhio/ASSETS/Files/injury%20prevention/CountyDrugData2013.pdf>.

⁵¹ Ohio Governor's Cabinet Opiate Action Team, *Epidemiological Report, No. 3, Increasing Heroin Overdoses in Ohio: Understanding the Issue*, Ohio has 15 unintentional drug overdose deaths per 100,000 residents, vs. the national average of 8.3 per 100,000, April 2014.

<http://mha.ohio.gov/Portals/0/assets/Research/Reports/HeroinOverdoseReportFIN43014.pdf>.

⁵² Ohio Department of Health, Drug Overdose in Ohio, <https://www.odh.ohio.gov/sitecore/content/HealthyOhio/default/vipp/drug/dpoison.aspx>.

⁵³ *Aiming Higher: Results from a Scorecard on State Health System Performance, 2015 Edition*, The Commonwealth Fund, <http://www.commonwealthfund.org/publications/fund-reports/2015/dec/aiming-higher-2015>.

⁵⁴ Brooks, Tricia, et al., Medicaid and CHIP Eligibility, Enrollment, Renewal, and Cost-Sharing Policies as of January 2016: Findings from a 50-State Survey, <http://kff.org/medicaid/report/medicaid-and-chip-eligibility-enrollment-renewal-and-cost-sharing-policies-as-of-january-2016-findings-from-a-50-state-survey/> Ohio is among states that expanded Medicaid, but uses the federally-run exchange, healthcare.gov, as its insurance marketplace.

⁵⁵ The Ohio Health Information Partnership is a private nonprofit organization that started in 2009 with a \$43.8 million federal grant, and Clinisync is their online service. See http://www.clinisync.org/about-us/our-history_copy.

Healthcare Network (SOHCN), which provides broadband connectivity services to 19 hospitals and over 100 facilities across 34 counties.

In another survey, the Pew Foundation noted that the leading use of smartphones is to “look up information about a health condition” (62%), which is greater than job searches (43%) or educational tasks (30%).⁵⁶

Telehealth is a growing industry in Ohio, and general expansion of telehealth services was considered in the most recent State budget process, but was not enacted.^{57 58} In 2015, Ohio implemented a new law that permits Medicaid reimbursement for certain telehealth purposes in consultation with doctors and psychologists.⁵⁹ Separately, the services introduced by Cleveland Clinic, MyCare Online, and specifically one offered by Anthem Blue Cross and Blue Shield, livehealthonline.com, consider the need for the patient encounter to be covered by insurance.⁶⁰ An Anthem executive, referring to such telehealth consultations, noted, that “in five years, this won't be a big deal anymore—it will be commonplace.”

An estimated 76.9 million wearable health technology devices, including pulse monitors, blood pressure monitors, EKGs, and others, were shipped worldwide in 2015.⁶¹ Led by fitness trackers, the volume of product shipments is on a trajectory of doubling annually into 2019. In addition to dedicated monitors, dual-use devices, such as smart watches and even the cameras on smartphones, provide health monitoring capabilities. Recently, the Food and Drug Administration (FDA) approved mobile applications for sharing information from continuous

⁵⁶ Smith, Aaron, “U.S. Smartphone Use in 2015,” Pew Research Center, <http://www.pewInternet.org/2015/04/01/us-smartphone-use-in-2015/>

⁵⁷ Correspondence (undated) from A. J. Groeber, Executive Director, State Medical Board of Ohio, to State Rep. Ryan Smith, http://www.ohioafp.org/wp-content/uploads/SOMB_Telemedicine_Letter.pdf.

⁵⁸ State Medical Board of Ohio, Position Statement on Telemedicine, <http://www.med.ohio.gov/Portals/0/DNN/PDF-FOLDERS/Laws-Rules/Position-Statements/Telemedicine.pdf> May 12, 2012.

⁵⁹ Ohio Revised Code, Chapter 5160, Telemedicine, <http://codes.ohio.gov/oac/5160-1-18> effective 1/2/2015.

⁶⁰ Zeltner, Brie, Cleveland Clinic launches MyCare Online, \$49 urgent care consults via mobile devices http://www.cleveland.com/healthfit/index.ssf/2015/06/cleveland_clinic_launches_myca.html. June 11, 2015.

⁶¹ Reuters Press Release, Fueled by Growing Demand for Smart Wearables, IDC Forecasts Worldwide Wearable Shipments to Reach 173.4 Million by 2019, <http://www.reuters.com/article/ma-idc-idUSnBw145126a+100+BSW20150914>. September 14, 2015.

glucose monitors for diabetes.⁶² These technology enablers, coupled with acceptance from insurers and the government, indicate further reliance on broadband for better health outcomes.

The Cord-Cutters

Over the survey period, broadband subscribers upgraded data rates and many changed providers as the availability of higher-speed service began to draw existing subscribers from other providers. However, because Connect Ohio surveys did not interview the same individuals every year, it has no direct insight into individual decisions to change providers or devices; but Pew surveys estimate a national annual attrition rate of 15%. Though removed from the survey, customer dissatisfaction doubled in a short period—as high as 5% for DSL.⁶³

Ohioans acquire and use smartphones at the same rate as the national average, 52%, and Connect Ohio survey results do not portray their use as a substitute for residential broadband while other reports have contended to do so. The notion that subscribers use broadband to view video, replacing cable and satellite television, was not part of the survey. However, anecdotal evidence suggests that more and more broadband subscribers are using those connections to disconnect standard video subscriptions.

The Bureau of Labor Statistics “Time Use Survey” notes, among many interesting results, that among younger demographics, video game use has “socializing,” sports, reading, and “thinking”—but has yet to exceed television viewing.⁶⁴ Pew reports that nearly half of U.S. adults are gamers (49%, about the same proportion for males and females).⁶⁵ Another Pew study noted that 40% of U.S. adults own a game console, which rises to 56% for those ages 18-29.⁶⁶

⁶² U.S. Food and Drug Administration, FDA permits marketing of first system of mobile medical apps for continuous glucose monitoring, <http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm431385.htm>, 1/23/2015.

⁶³ 2012 Connect Ohio Residential Technology Assessment.

⁶⁴ U.S. Bureau of Labor Statistics, Time Use Survey (2014), Charts by Topic: Leisure and Sports Activities, <http://www.bls.gov/TUS/CHARTS/LEISURE.HTM>.

⁶⁵ Duggan, Maeve, “Attitudes about Video Games,” Pew Research Center, <http://www.pewInternet.org/2015/12/15/attitudes-about-video-games>.

⁶⁶ Anderson, Monica, “Technology Device Ownership, 2015,” Pew Research Center, <http://www.pewInternet.org/2015/10/29/technology-device-ownership-2015>.

Nielsen follows trends in both broadcast television and SVOD, or Subscription Video on Demand, as well as games. Nielsen data associates cord-cutting with their youngest adult demographic, which does spend nearly as much time watching videos as other age groups, but prefers alternative means (tablet, smartphone, game console, and computer) at a rate 50% above the traditional television experience, while the oldest age group prefers traditional television over alternatives at a rate of 3:1.⁶⁷ Nielsen reports that more game “console hours” are spent watching streaming video than for playing games.⁶⁸ Mobility aside, the youngest group's affinity for non-mobile, presumably residential, viewing favors broadband to traditional television by about one-third.

In terms of Nielsen “shares,” U.S. adults appear to devote, subject to demographic differences, as much time to non-traditional TV “experiences” as with traditional television viewing—with overlap considered “multi-tasking.”

This discussion did not consider content ownership and distribution, merely the access methods. The trend is very compelling, that each younger demographic group prefers broadband access more than its next-older cohort, that broadband access to entertainment content will become the norm.

4.4 State Comparisons

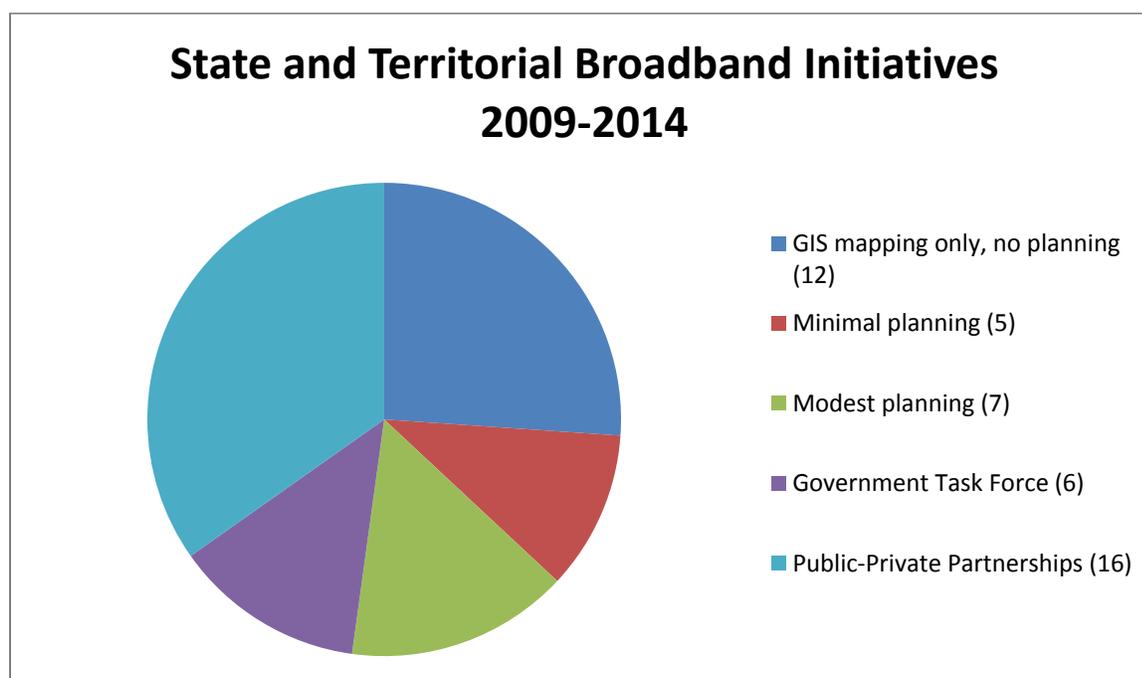
From 2009-2015, the U.S. Department of Commerce, National Telecommunications and Information Administration funded state and territorial broadband initiatives pursuant with ARRA funding. Federal funding for those state programs, which included Connect Ohio, has ended, but many states have maintained elements of these wide-ranging and diverse program.

States followed several different models for advancing residential broadband adoption, financing

⁶⁷ The Nielsen Company, “Comparable Metrics Report, Q3 2015,” <http://www.nielsen.com/content/dam/corporate/us/en/reports-downloads/2016-reports/comparable-metrics-report-q3-2015.pdf>.

⁶⁸ The Nielsen Company, “Game Consoles in 2015: One Stop Shop for Games and Entertainment,” <http://www.nielsen.com/us/en/insights/news/2015/game-consoles-in-2015-one-stop-shop-for-games-and-entertainment.html>, 4/9/2015.

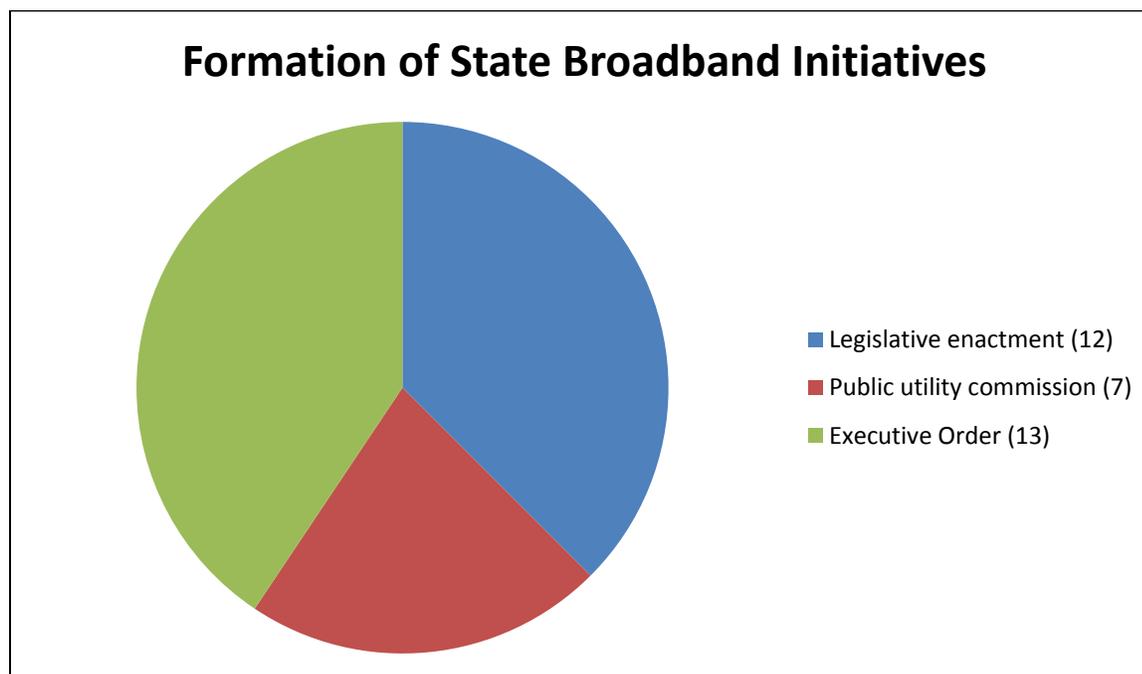
construction of networks, or fulfilling other components of the ARRA-funded projects. The National Conference of State Legislatures (NCSL) published a survey on Broadband Task Forces, Commissions, or Authorities in December 2014. Given that federal SBI funding is no longer available, there has been no need for NCSL to refresh this survey. Interpretation of this survey is interesting, and some reasonable next steps for Ohio are apparent when comparing other state approaches.



Source: National Conference on State Legislatures, *State Broadband, Task Forces, Initiatives or Authorities* (Dec. 2014).

The NCSL survey of states revealed a number of different choices states and territories have made in organizing broadband leadership. Under ARRA, all states and territories were given federal grants to establish broadband data development and state broadband initiative programs. One-third of the states and territories used these grants narrowly, with 12 using the program solely to fund existing agencies with GIS capabilities. Twelve states and territories used these grants to fulfill only minimal or modest level of broadband planning activities, and there is no evidence to suggest that these planning activities resulted in any additional access or adoption.

Many states created Task Forces to implement the broadband mapping and planning grant, but several of these consisted only of government representatives and initiatives. Sixteen states formed or created public-private task forces and initiatives like Connect Ohio. These state and territorial broadband initiatives were formed by many means.



Source: National Conference on State Legislatures, *State Broadband, Task Forces, Initiatives or Authorities* (Dec. 2014).

The method in which a state forms a state broadband initiative is important, because it demonstrates whether there is an ongoing commitment to the initiative. Initiatives created by executive action or regulation are at risk of significant change with the next gubernatorial election. Initiatives created and funded by statute are more likely to be long-lasting and transformative. This is particularly important for broadband, because it can take years for a broadband network to move from the planning to deployment stages. Using the FCC's current benchmark of 25 Mbps download/3 Mbps upload for advanced broadband services, 6 of the 12 states in broadband adoption have established broadband policy through a state statute. 8 of the top 12 leading states have established a permanent agency or authority position in state government.

While these interpretations are based on dispassionate analysis of tabular data, some other tangible factors may be relevant. States in the top adoption tier are in New England and the Pacific Northwest, characterized by both dense population and providers with fiber-to-the-home service. These regions could have substantially utilized SBI as a mapping exercise—using a permanent agency created by statute to carry out broadband policy goals.

The author posits that, for other regions, the use of a public-private partnership—the Ohio model—coupled with invested internal and external stakeholders has the best likelihood of improving adoption.

Several states have narratives that were not captured by the NCSL survey. Both Ohio and Iowa have extensive state-funded, public-purpose, middle-mile networks serving government and education needs. Michigan, whose MERIT networking is similar to Ohio's OARnet, has made long-term investments in dual-use networks, but whose rankings are similarly undistinguished.

5. National Results and Trends

Telecommunications, especially broadband, is one of the most amenable technologies to measurement ever invented. This information, though, is private and proprietary. Almost to a point of infringing on personal privacy, the best information on broadband user behavior is compiled from content providers more than from network providers. Marketing firms, Alexa⁶⁹ and comScore,⁷⁰ assess the lists of top websites and mobile applications (which are essentially the same Internet destinations), and most of these are deemed “advertising supported” in that personal profile information is collected to provide better-targeted ads. The extent of the depth of marketing information is itself interesting.⁷¹

Policymakers must turn to more traditional means to obtain objective data about Internet usage. The traditional “long form” of the U.S. Census has become the American Community Survey (ACS), which now annually includes questions regarding computer and Internet use along with many other occupational and demographic questions. ACS is refreshed annually for large cities, but is less current for other areas. The Pew Research Center's Internet and American Life project provides recurring general and topical national surveys that are also highly cited. Pew's Home Broadband 2015 survey, is assessed at length later in this report.⁷²

The Federal Communications Commission (FCC), through its semi-annual Form 477 data collection process, requires service providers to report on broadband availability quarterly at the census block level. The U.S. contains about 11 million census blocks, of which about five million are uninhabited. For perspective, Cleveland's Cuyahoga County has over 15,000 census blocks, while rural Monroe County has 700. Every one of Ohio's wired and wireless broadband providers must report service or coverage where it meets or exceeds 768 Kbps download/200 Kbps upload in a census block. And yet, with such abundance of data, there is a scarcity of actionable information to support analysis and, consequently, inform policymakers.

By comparison, the U.S. Postal Service claims to deliver to 154 million physical addresses. At

⁶⁹ Alexa, “The Top 100 Sites on the Web,” www.alexa.com/topsites.

⁷⁰ Comscore, “The 2015 Mobile App Report,” www.comscore.com/Insights/Presentations-and-Whitepapers/2015/The-2015-US-Mobile-App-Report.

⁷¹ See the 60 Minutes segment, The Data Brokers, for background on “persistent supercookies.” March 9, 2014, <http://www.cbsnews.com/videos/the-data-brokers-selling-your-personal-information/>.

⁷² Pew Research Center, December 21, 2015, “Home Broadband 2015” <http://www.pewInternet.org/files/2015/12/Broadband-adoption-full.pdf>.

the federal level, due to the confidential nature of the census, there is no central registry of addresses, subscribers, and their service provider(s). Thus, the FCC's policy activity is driven by models derived from the mapping database.

According to the 2014 American Community Survey conducted by the United States Census,⁷³ Ohio's residential broadband adoption rate ranks 30th among states, narrowly ahead of rival Michigan (37) and neighbors Indiana (41), Kentucky (43), Pennsylvania (31), and West Virginia (48), but significantly behind large states such as New York (16) and California (11). The FCC recognizes Ohio broadband adoption as 77.1%, similar to the latest Connect Ohio survey results of 75.9%. Overall, the New England region scored highest, while southern states tended to score lower.

The Pew Research Center provides authoritative national insights from its annual study of residential broadband using a survey instrument and process that is strikingly similar to Connect Ohio's state-specific surveys. With a slightly larger sample size, Pew's results are reliable +/- 3% and are coded with similar demographic information with one exception: it does not detect Appalachian representation. This analysis considers the noteworthy Pew conclusions, as well as where Ohio results differ.

The following points are taken, generally verbatim, from Pew's 2015 Home Broadband Survey.⁷⁴

- The share of Americans with broadband at home has plateaued and more rely only on their smartphone for online access.
 - The increase in smartphone-only adoption mirrors the decline in-home broadband adoption.
 - Those who are smartphone-reliant face challenges.
 - More people now say home broadband access is important.
 - Non-broadband users now show a strong appreciation for the importance of home services in ways they did not five years ago.

⁷³ US Census, 2014 American Community Survey, Ranking Tables, Percent of Households With a Broadband Internet Subscription.

⁷⁴ Home Broadband 2015, Pew Research Center, December 21, 2015. See both the full report and the survey instrument at <http://www.pewinternet.org/2015/12/21/home-broadband-2015/>.

- Many (or most) adults think a lack of broadband brings disadvantages. More now say that home broadband is important.
 - For finding out about job opportunities or gaining new career skills: 52%.
 - For learning about or accessing government services: 46%.
 - For learning new things that may improve or enrich their lives: 44%.
 - For getting health information: 43%.
 - For keeping up with news and information: 36%.
 - African Americans, Hispanics, and young adults most likely to view lack of home broadband as a major disadvantage—more likely than the average respondent.
 - Non-broadband adopters are increasingly likely to view the lack of home broadband as a disadvantage—but less likely than the average respondent.
- Barriers to broadband adoption, stated by smartphone owners and non-owners.
 - Perception by non-adopter that smartphone is sufficient: 69% and 27%.
 - Cost is a substantial challenge for many non-users: 59% and 59%.
 - Have other options for Internet access outside of home: 59% and 46%.
 - Cost of computer is too expensive: 41% and 45%.
 - Service is not available or speed is unacceptable: 27% and 23%.
 - A majority of non-broadband users have never had broadband at home, and just one-quarter of them are interested in getting it in the future.
 - 36% of non-broadband users have had high-speed service in the past.
 - 59% said they have never had a home broadband subscription.
 - 25% are interested in acquiring service; 75% are not.
 - Nearly one-half (46%) of those who do not have broadband at home—or 15% of all Americans—are in a hard-to-reach category that suggests they may not be broadband subscribers any time soon.
 - Less educated: only 8% have a college degree, compared to 14% of other non-adopters [Ohio: 40% of adopters have degrees, 23% of non-adopters].
 - Older: 39% are age 65 or older, compared to 19% of other non-adopters [Ohio: 21% of adopters and 42% of non-adopters are 65 or older].
 - Less connected: 44% are Internet users and 29% have smartphones, compared to 72% and 53% respectively. [Ohio: overall 76% and 54% usage of broadband and smartphones, respectively, whether or not a residential user household].

- One-third of Americans do not have a smartphone, citing the following reasons:
 - 36% indicate smartphones are too expensive (data plan or device itself).
 - 29% say they do not need one or are happy with current phone.
 - 15% are uninterested or have not gotten around to it.
 - 9% say it is too complicated.
- One-in-seven Americans, 15%, are television “cord-cutters.” Another 9% have never had a cable or satellite subscription.
 - 84% of cord-cutters do have “advanced Internet access” (just not a television subscription). 27% of these are smartphone-only, 75% have smartphones, and 58% have data-only broadband service without traditional television content.
 - Subscription rate declines by age, from 83% (ages 50 plus) to 63% (ages 18-29).
 - More young adults than all respondents, 75% to 64%, cite alternative access to content such as Netflix as their reason.
 - More lower-income households were cord-cutters, 21% for incomes less than \$20K, than for higher-income respondents, 14% for incomes over \$75K.

6. Economic Impact

The decade covered by this report was marked by recession and partial recovery. This section and the next examine the economic outcomes of broadband access, especially investment, at the statewide and project levels, respectively, during the survey period. It should be noted, however, that relating consequences to actions is a challenge across the social sciences, especially economics, because rarely can rigorous experiments or even pilots be controlled. Moreover, it is difficult to control “treatments” applied to various groups and to know to what extent those treatments interact.

Objective 3

Analysis of state economic development indicators resulting from increased adoption and availability

There are many aggregate measures of the economic health of the nation and states, and they have many components from which to choose. For example, the Conference Board nationally considers consumer confidence, leading/predictive indicators, employment trends, online help-wanted postings, and CEO confidence.⁷⁵ The Federal Reserve Bank of Cleveland, whose Fourth District includes Ohio and adjoining areas within Pennsylvania, West Virginia, and Kentucky, provides authoritative data and analysis for the region, state, and major metropolitan areas. Its measures include:

- Unemployment rate
- Gross domestic product (GDP)
- Housing prices
- Employment
- Employment growth by sector
- Relative employment growth
- Housing permits
- Consumer debt
- Credit card delinquency rates
- Average weekly earnings
- Income per capita
- Demographics and education

Other components elsewhere used by analysts include interest rates, debt, inventories, labor costs, wholesale orders, jobless claims, building permits, and freight transport utilization.

⁷⁵ The Conference Board, “Economic Indicators,” <https://www.conference-board.org/>, accessed 5/16/2016.

Inputs into the aggregate economic analysis in this paper include:

- Ohio American Reinvestment and Recovery Act (ARRA) funds.
- Capital expenditures by infrastructure providers privately funded.
- Private investment by non-infrastructure firms in the Information and Communications Technology (ICT) sector.
- Private investment by enterprise firms, not infrastructure providers, and not ICT sector.

The economic stimulus package, tangible projects and tax cuts coupled with anti-inflation measures, are uniformly credited with increased employment.⁷⁶ In Ohio, that translates to returning unemployment to pre-recession levels.⁷⁷ Stimulus funds built 3,000 route miles of new fiber networks in Ohio, and much or even most of that expense was labor. Yet, the stimulus funds account for approximately 2% of Ohio broadband capital expenditures, as detailed below, unlikely directly affecting Ohio's aggregate economic outcomes. Estimating material costs at \$50 million, the remaining \$150 million was likely spent locally. Remaining expenditures cover installation labor, which cease at project completion. Economists note a short-term multiplier effect for local expenditures.

Providers migrating to 4G LTE have been investing annually from \$4 billion (Sprint and T-Mobile) to over \$16 billion (Verizon Wireless) to about \$20 billion (AT&T) for wireless, optical backhaul, and switching. The major cable providers in Ohio—Time Warner and Charter—are investing \$3 billion annual into network upgrades. Intuitively, as a result of bandwidth demands by iPhone users and Netflix viewers, capital expenditure investments of \$50-\$60 billion annually, conservatively estimating Ohio as 3% of U.S. broadband prospects, implies over \$10 billion in Ohio broadband capital expenditures, dwarfing federal investments by over an order of magnitude over the survey period 2008-2014.

A series of AT&T press releases states over \$3 billion in broadband investments during the seven-year survey period—during which time their national investment totaled \$140 billion.⁷⁸

⁷⁶ Wolfers, Justin, "What Debate: Economists Agree the Stimulus Lifted the Economy," New York Times, July 30, 2014. <http://www.nytimes.com/2014/07/30/upshot/what-debate-economists-agree-the-stimulus-lifted-the-economy.html>

⁷⁷ Federal Reserve Bank of Cleveland, "Annual Report 2013." <https://www.clevelandfed.org/2013-annual-report/assets/pdf/2013-annual-report-federal-reserve-bank-of-cleveland.pdf>.

⁷⁸ Press releases are within the Policy Blog at <http://ohio.att.com/>, specifically postings on 3/7/2015 and 3/25/2014.

Using the AT&T amounts for calibration, expected expenditures by Verizon would exceed \$2 billion, \$2 billion for other wireless providers, and \$4 billion for cable providers.

Qualitatively, it cannot be said that broadband investments were the mechanism for Ohio's recovery from recession—based on the measure that Ohio unemployment has not yet recovered. ICT employment in Ohio exceeded 70,000 in 2013, largely in professional positions.⁷⁹ U.S. Bureau of Labor Statistics shows nationally that total ICT employment remained stable, but there were shifts between classifications—offsetting gains and losses.⁸⁰ In Ohio, there was a net loss in I.T. employment of 5,300 jobs from 2010-2015.⁸¹

Analysis of Ohio's Commercial Activity Tax receipts may provide a useful measure of the health of Ohio's I.T. industry, which includes telecommunications. CAT was phased-in and its receipts have increased about \$1 billion per year to \$30.5 billion in 2015. Note that aggressive collection from merchants with no Ohio presence are not yet reflected in these totals.⁸² This total includes services, not retail products such as handsets. This total indicates a modestly-increasing average revenue per user (ARPU) over a stable number of subscribers.

Ohio businesses remain competitive due to residential broadband. The reasons are qualitative and indirect, for employer and employee, both short-term and long-term.

Benefits for the Employer:

- Improved broadband service to company premises
- Ability to avoid travel costs for meetings, remote technical support, job searches
- Greater options for collaboration in an R&D or creative setting

⁷⁹ Ohio Development Services Agency, "Ohio Industry Series," "Information Technology." 2012 is the most current available State data. http://development.ohio.gov/reports/reports_industry_series.htm. See also: Ohio by the Numbers for employment by sector over a broader period, <http://buckeyeinstitute.org/uploads/files/ObN-2015-12.pdf>.

⁸⁰ Bureau of Labor Statistics, U.S. Department of Labor, National Private Sector Business Employment Dynamics Data By Major Industry Classification. Specifically review Telecommunications. <http://www.bls.gov/bdm/bdmind3.htm#TELECOM> as well as the DATA PROCESSING and OTHER-IT sections immediately following.

⁸¹ Buckeye Institute, "Ohio by the Numbers – December 2015." See <http://www.buckeyeinstitute.org/issues/job-creation-and-entrepreneurship>. Note that Ohio lost 26,400 I.T. jobs 1990-2015. Buckeye Institute obtains its figures from the U.S. Bureau of Labor Statistics. I.T. is the closest Buckeye category to subsume telecom.

⁸² Ohio Department of Taxation, "Commercial Activity Tax 2008-2015," http://www.tax.ohio.gov/tax_analysis/tax_data_series/cat/publications_tds_cat.aspx.

- Better coordination with suppliers, customers; outsourced services
- Work-at-home options
- Greater continuing education/skill building options
- With better residential access, higher quality of life for employees
- Long term: better-prepared local workforce
- Alternatively, relocate workplace to a more attractive (or less costly) venue

Benefits for the Employee:

- Better informed of employment opportunities; online job application
- Work-at-home and continuing education/skill building options
- Higher quality of life
 - Better engagement with healthcare institutions and information (long-term)
 - Better engagement and outcomes for children in school (long-term)
 - Access to credentials, degrees via distance learning
 - Entertainment, social media

Cleveland Federal Reserve Bank researchers recently searched 75 years of economic history to determine what factors most raised the incomes of state residents.⁸³ Their conclusion was compelling: innovation and education, measured respectively by the number of patents generated and by level of educational attainment. The latter is merely, they write, a proxy for “human capital,” which is an area subject to public policy and investment as well as an area in which Ohio ranks below the national median. Software historically has not been patented, so some means is necessary to account for all information technology innovations.

To conclude this section, service providers made capital investments of about \$10 billion in Ohio in the reporting period, while ARRA “Stimulus” funds added about \$150 million. Disbursements for labor, not directed toward savings, would have had multiplier effect in local communities, while some property appreciated in value due to the construction of telecommunications facilities. Positions gained in broadband infrastructure—including handset sales—likely offset job losses in crafts that they replaced.

The presence of broadband has intangible benefits both to employer and employee that help the state, and some localities, competitive for retention and expansion.

⁸³ Federal Reserve Bank of Cleveland, “Annual Report 2005: Altered States: A Perspective on 75 Years of State Income Growth,” <https://www.clevelandfed.org/en/newsroom-and-events/publications/annual-reports/ar-2005-perspective-on-75-years-of-state-income-growth.aspx>.

7. Future Federal Broadband Policy Reforms

While ARRA was intended as a one-time inducement into the economy, the Federal Communications Commission has ongoing programs to provide subsidies based on social goals. In particular, the federal Universal Service Fund is a series of funds that are deployed for different purposes.

Objective 4

Analysis of state and federal broadband programs

- The High Cost Fund has been traditionally allocated to incumbent telephone providers to mitigate the cost of serving high-cost, low-income, and rural, medically in-need subscribers. This fund provides subsidies approaching \$4 billion per year. In 2014, Ohio providers received \$40.7 million in High Cost Fund subsidies. The FCC started the process of transitioning this fund to directly support broadband in 2011, and the Commission has recently transitioned the High Cost Fund to what is now called the Connect America Fund, which is explored in further detail below.
- The Lifeline Fund (approximately \$1.7 billion per year) subsidizes the purchase of voice telephone service by certain qualifying low-income households. It generally provides a \$9.25 per month discount for voice service to consumers that document that their income is at or below 135% of the federal poverty rate. Ohio low-income consumers received benefits of \$74.5 million in 2014 from the Lifeline program. The FCC is currently considering extending this to cover the purchase of broadband service.
- The Schools and Libraries Universal Service Fund, commonly referred to as the e-Rate program, provides discounts on the purchase of telecommunications and broadband services by K-12 schools and public libraries. The e-Rate program funds procurement of networking products and services by schools and libraries so that their discounted price reflects the percentage of students receiving free and reduced price lunches. These funds must be spent through a regulated telephone provider. The Ohio Department of Education notes that a cumulative \$1 billion has flowed to local schools and libraries. Moreover, the state of Ohio provides an annual connectivity subsidy of \$1,800/building. In 2014, Ohio schools and libraries received discounts totaling \$71.3 million. In 2015, the FCC increased the e-Rate cap from \$2.3 billion per year to \$3.7 billion per year citing the increased need for broadband.

- The Rural Healthcare Fund subsidizes telecommunications connections for rural health providers. In 2014, the fund provided \$193 million in such subsidies nationally, with \$1.2 million going to Ohio.

Across all funds, Ohio is not only a “net payer” into the federal Universal Service Fund; it is the 8th largest “net payer” in the country.⁸⁴ Ohio’s providers contributed \$278.3 million to the federal program in 2014, while Ohio providers and consumers received only \$187.7 million in subsidies.

However, the FCC is transforming these funds to better support broadband services, which could benefit Ohio directly and immediately. For example, as mentioned above, the FCC is phasing in the Connect America Fund (CAF) broadband network subsidies in what was formerly the High Cost Fund.⁸⁵ The Connect America Fund provides infrastructure grants for incumbent telephone providers to infill broadband service. The original CAF intended to extend broadband to 1 million locations, including approximately 7,000 in Ohio. However, the \$9 billion second phase of CAF, announced in 2015, will award funds to AT&T, CenturyLink, Fairpoint Communications, Frontier Communications, Windstream, and Cincinnati Bell to provide broadband facilities (about \$400/site) to approximately 150,000 Ohio locations over the next 6 years.

At the state level, policy tends to align with practice after-the-fact, rather than to pursue social goals. Moreover, the state's role as a leading consumer of technology makes it a make-shift “anchor tenant.” Recognizing that all things wireless are regulated at the federal level, state and local regulation has been limited to cable television and telephone service providers. Unlike its regulation of electricity and gas, Ohio's public utility regulators implemented an alternative approach to telecommunications—one based on price (price cap) and quality rather than review of capital and operating expenses.

State law was amended in 2007 to grant single statewide cable television franchises to accommodate statewide competition, at which time government oversight shifted from price

⁸⁴ Federal Communications Commission, “Universal Service Monitoring Report, 2015,” http://transition.fcc.gov/Daily_Releases/Daily_Business/2016/db0316/DOC-337019A1.pdf

⁸⁵ Federal Communications Commission, Connect America Fund Portal, <https://www.fcc.gov/general/connect-america-fund-progress-portal>. See Connect America Fund Claims and Disbursements by Study Area/State.

regulation at the municipal level to compliance at the state level. This change presaged the decline in cable and satellite television subscriptions, offset by increases in on-demand services such as Netflix and Hulu.

An all-too-common practice, state broadband policy was further advanced in the 2015 budget bill,⁸⁶ which identifies a transition from circuit-based analog first-mile telephony to an Internet-based platform for which Voice-over-IP (VoIP) is a service. This has been the preferred mode of service delivery to institutional customers for many years, and its adoption for residential subscribers is a natural progression. The Public Utilities Commission of Ohio currently has a proceeding entitled, Telephone Network Transition, which encompasses both a collaborative process and a docket focused strictly on Ohio's administrative law.⁸⁷ Special emphasis is placed on 911 services and the needs of low-income customers, but the process does treat the transition as certain, not optional. Public comments include interesting points from stakeholders including TDD/TTY users and low-income subscribers.

On the horizon are two federal initiatives that may be consequential to Ohio broadband services as well. The FCC ruled in 2015 on the principle of "net neutrality," explained as providers buffering nonpriority traffic, i.e., whose source was a noncustomer. While this ruling is being contested, its moniker is "free and open Internet," which seems hard to dispute. In the absence of traffic shaping, providers must overprovision resources—pushing all traffic into a higher-performing traffic class, which is likely to incur additional costs and hence, be more costly.

More importantly, especially to Ohio, is the a federal program termed FirstNet, which has a complex model to share mobile spectrum between public safety and mobile operators, thus creating a cellular-like network for public safety users while having the fixed infrastructure subsidized by other subscribers. To the extent that public safety entities use the same wired telephone network as other subscribers, this is not novel; to provide priority to public safety

⁸⁶ Ohio HB64, 131st General Assembly, Main Operating Budget, FY2016-2017. Specifically refer to the Redbook prepared by the Legislative Service Commission directing the Public Utility Commission, <http://www.lsc.ohio.gov/fiscal/redbooks131/puc.pdf>.

⁸⁷ Telephone Network Transition page at PUCO is appended with meeting minutes and formal comments. See: <http://www.puco.ohio.gov/puco/index.cfm/be-informed/consumer-topics/telephone-network-transition>.

users at all times and to provide rapid reconfiguration are significant challenges to FirstNet, which currently has no detailed architecture.

Ohio already has such a system, the Multi-Agency Radio Communication System (MARCS), whose radio coverage exceeds that of all wireless carriers combined, and whose backhaul technology is in its second generation with expanded capacity to fulfill FirstNet requirements as well as a dual-use scenario with commercial wireless providers. This novel public-private partnership for wireless backhaul, in addition to supporting public safety, appears to be lowering the barrier to entry for one or more retail broadband service providers.

For example, Agile Networks,⁸⁸ a service provider headquartered in Ohio, developed a high-capacity wireless broadband mesh network directly connecting MARCS sites,⁸⁹ which is a model that can be replicated in other states that use 800 MHz public safety radio systems. Unlike traditional microwave systems, this mesh provides a high-availability, low-latency redundant backhaul network that is interoperable with broadband Internet.⁹⁰ While its first application was to serve public safety, Agile Networks' infrastructure has been used to provide *point-to-point* wireless broadband to remote business users in Ohio's emerging oil and gas extraction industry.⁹¹ In another proposed scenario, with county government as an "anchor tenant," 90% of Agile's local backhaul capacity is available to serve residential and commercial broadband service, which is to be provided by a retail Internet service provider or one or more 4G LTE wireless providers.⁹² This approach can be characterized as a public-private partnership for infrastructure development.

⁸⁸ Hoover, Shane, "A Canton Company, Agile Networks, is Building Reliable Broadband Access," Canton Repository, April 7, 2013. <http://www.cantonrep.com/article/20130407/News/304079895>.

⁸⁹ Agile's technology for MARCS use is described in its contract documents with the State of Ohio. See: <http://das.ohio.gov/Divisions/InformationTechnology/TelecommunicationsServices.aspx> and Contracts by Provider.

⁹⁰ Wireless Ethernet mesh refers to the ITU standard Y.1731 and compliant devices. See <http://www.itu.int/rec/T-REC-Y.1731/en>.

⁹¹ Agile Networks, Inc. company website is agilenetworks.com; see this case study: <http://agilenetworks.com/wp-content/uploads/2014/09/AgileMomentumCaseStudy.pdf>.

⁹² Heinz, Lisa, "County to Receive \$500K Loan for 911 Upgrade: Improved Communication System Should Also Help Rural Internet," *Athens News*, December 30, 2015.

8. Conclusions and Next Steps

Through nearly one hundred references, this report shares a narrative about the incomplete role of broadband in Ohio. We can limit the number of significant conclusions to a handful, agreeing that this report forms a “snapshot” of a constantly changing broadband landscape.

The primary conclusion of this report is that a digital divide persists in Ohio, that although availability (albeit through wireless coverage) is near-universal, there has been a stubborn rate of non-adoption – most recently 24%. Having a lower household income, having less education, having a physical impairment, being older, and residing in Appalachia all correlate with not adopting broadband.

A general conclusion of this research is that broadband policy at the national level has mixed results, especially when compared to the investment made by private enterprise.

There is very little objective policy research, specifically survey work, done at the State level that can inform telecommunications policy. This is one motivation for Connect Ohio to continue its research activities, which include this report. National surveys such as Pew’s lack enough samples to be actionable at the state level, which is why one thousand survey responses were needed annually. Authoritative analyses such as the recent Ohio Library Council’s “return on investment” and the work products of the Federal Reserve Bank of Cleveland are rare but appreciated.⁹³

Policy notwithstanding, there are likely irreversible trends that will continue to share broadband across the United States.

Connect Ohio’s primary role, in addition to fulling the “research gap” above, has been the neutral advocate for broadband adoption across the state. Analysis indicates that state broadband initiatives that adopted the Connected Nation approach to outreach were more successful than those that focused merely on mapping or those that approached broadband

⁹³ Howard Fleeter and Associates, The Return on Investment of Ohio’s Public Libraries & A Comparison With Other States, Ohio Library Council, April 2016.

through legislation or regulation. Connect Ohio has nurtured a substantial community of interest which has been useful for sharing information and pursuing projects—starting at the county stakeholder level.

Next Steps

One element of future work is to help providers fill-in availability gaps, which may exist despite data sent to by providers to the national broadband map project.⁹⁴ The FCC recently made several small grants to providers to increase their broadband footprint in rural areas.

The more daunting challenge for Ohio's broadband leaders is adoption, which is arguably a less technical and more social charge than availability. Behind the goal of increased adoption are improvements to Ohio's economy and for Ohio's residents.

⁹⁴ Heinz, Lisa, "Internet in Rural Athens County Slow, Inconsistent," [Athens News](#), December 15, 2015.

Postscript: Broadband Outreach

In addition to other Ohio telecommunications “firsts” such as CompuServe (1969), Lexis-Nexis (1973), and the Greater Cleveland Freenet (1986), state government has been an innovator in broadband outreach. The staff of eCom-Ohio, residing at Ohio State University, used twenty laptops to dial randomly across phone exchanges in search of modems in 2000 and produced its first broadband access map in 2001 (see Appendix B). The Ohio Department of Development’s Thomas Edison Program used the agricultural extension service model in 2002 to launch regional “Information Technology Alliances” to support the I.T. industry. The Governor’s Office on Appalachia then funded OSU’s Technology Policy Group to continue the eCom-Ohio effort, focusing on 29 Appalachian Counties. Governor Strickland launched the Connect Ohio initiative in 2007 that served as a model for similar state broadband initiatives in many states. Connect Ohio, LLC, later became the Ohio grantee in the U.S. Department of Commerce, National Telecommunications and Information Administration State Broadband Initiatives Grant program. After the end of that federal grant program, Connect Ohio has worked with the Ohio Department of Administrative Services to continue the broadband mapping, data collection, and outreach program.

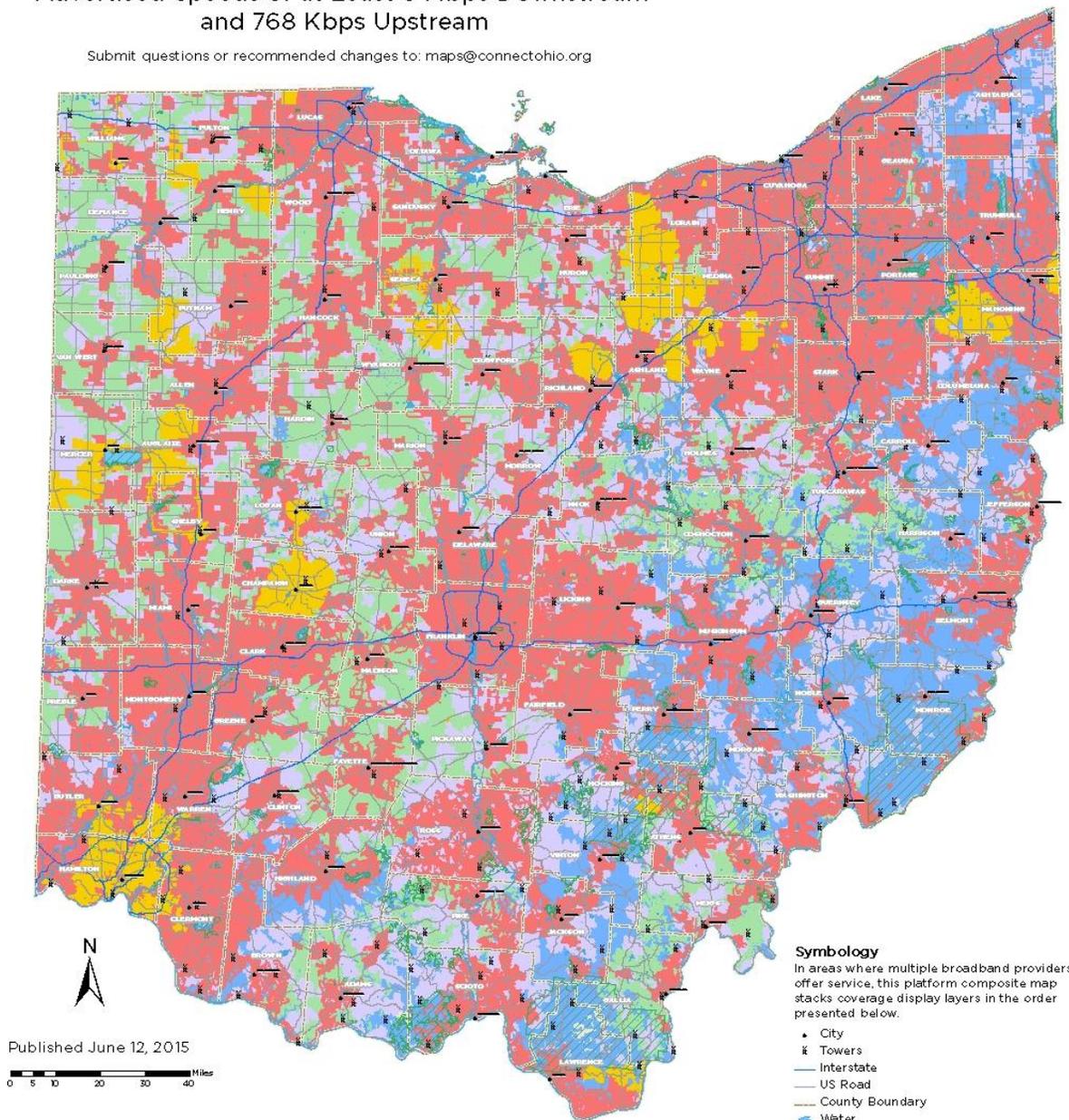
Appendix A: Connect Ohio Broadband Service Inventory Maps

Broadband Service Inventory for the State of Ohio

Advertised Speeds of at Least 3 Mbps Downstream
and 768 Kbps Upstream



Submit questions or recommended changes to: maps@connectohio.org



Published June 12, 2015



*This map is not a guarantee of coverage, contains areas with no service, and generally predicts where outdoor coverage is available. Equipment, topography and environment affect service.

This map represents areas of broadband service availability determined by ongoing, in-depth technical analysis of provider networks and accommodations for the impact of external factors on service quality. Satellite broadband services may also be available.

Symbology

In areas where multiple broadband providers offer service, this platform composite map stacks coverage display layers in the order presented below.

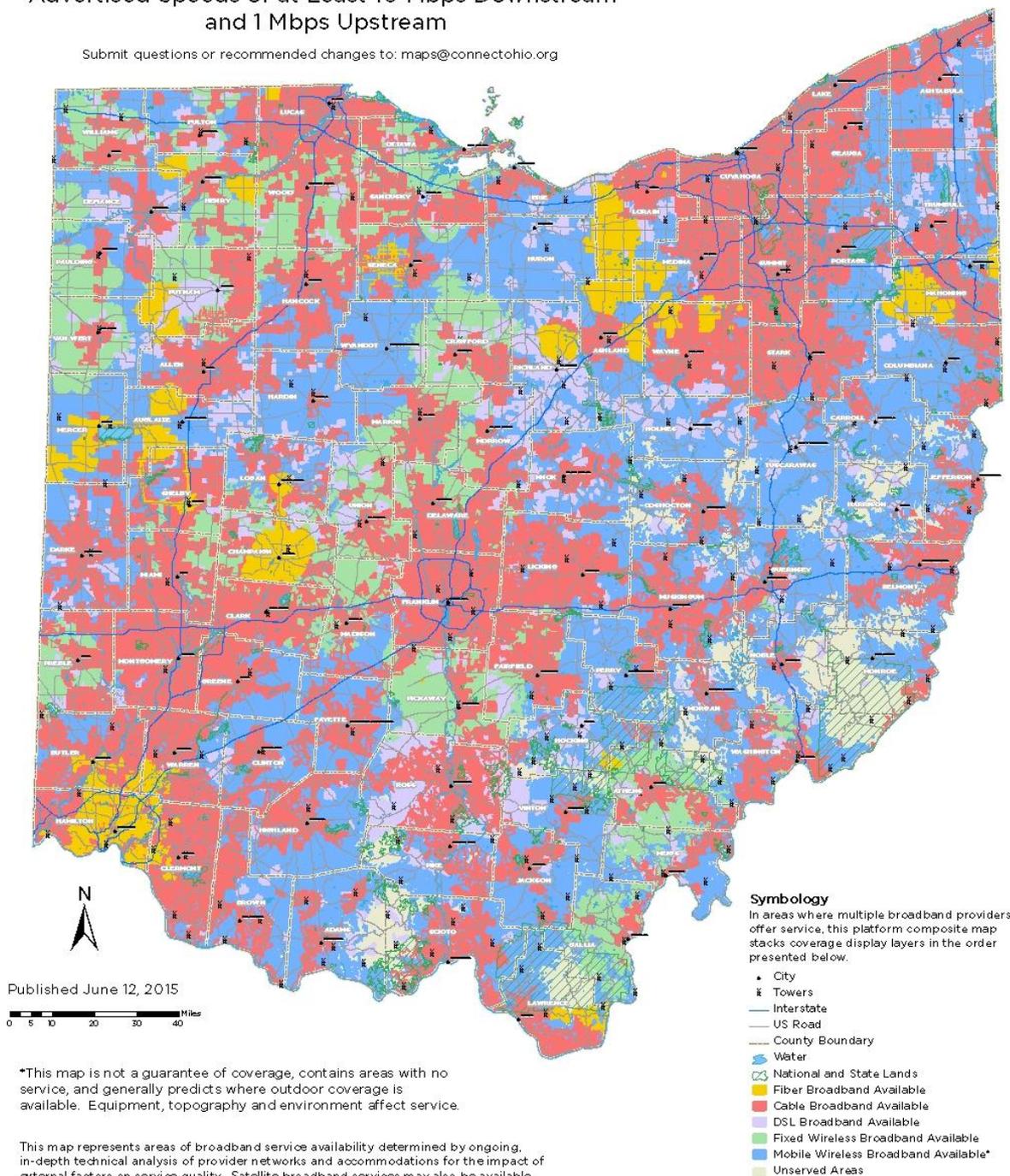
- ▲ City
- ⌘ Towers
- Interstate
- US Road
- County Boundary
- Water
- National and State Lands
- Fiber Broadband Available
- Cable Broadband Available
- DSL Broadband Available
- Fixed Wireless Broadband Available
- Mobile Wireless Broadband Available*
- Unserviced Areas

Broadband Service Inventory for the State of Ohio

Advertised Speeds of at Least 10 Mbps Downstream
and 1 Mbps Upstream



Submit questions or recommended changes to: maps@connectohio.org

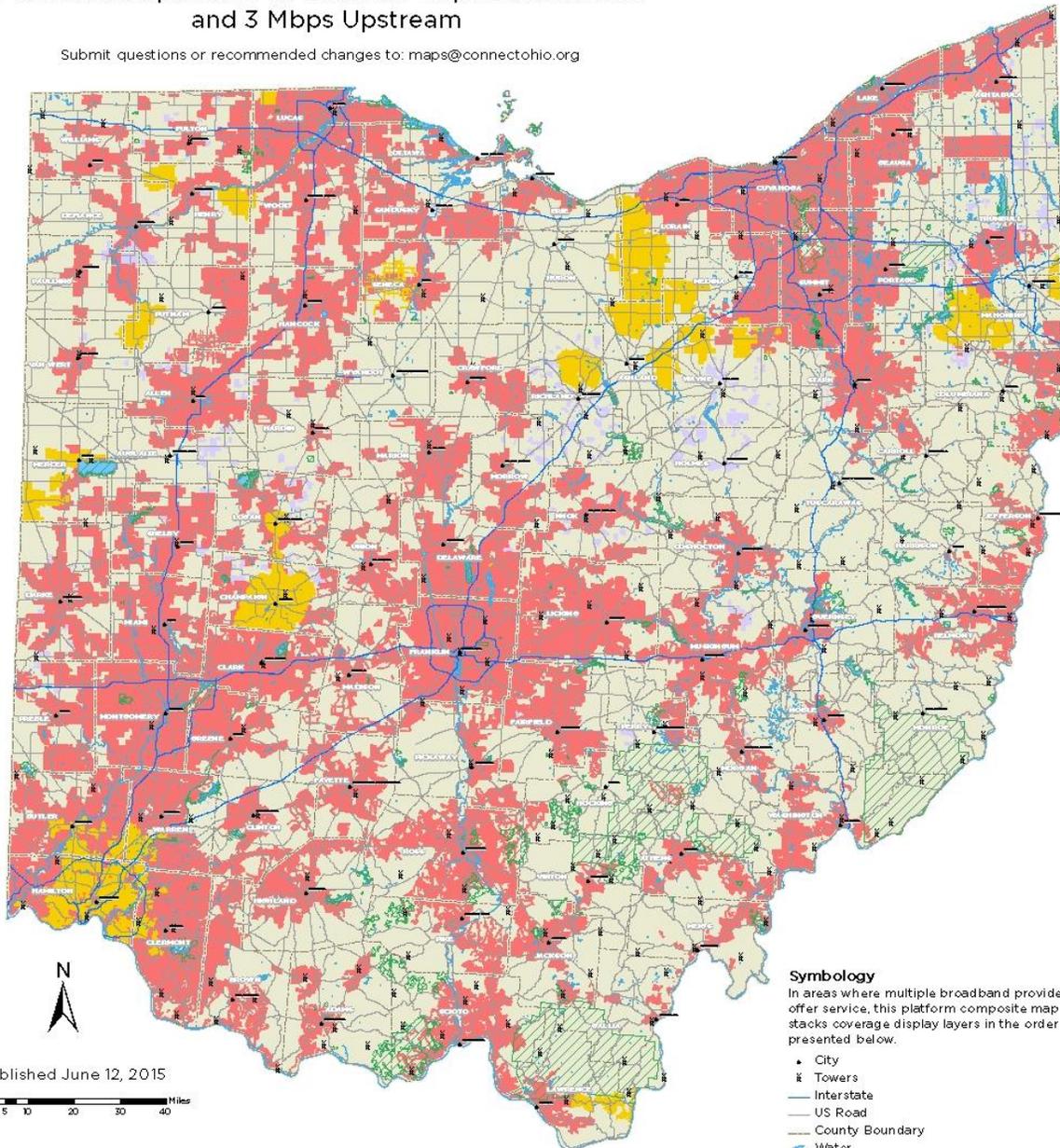


Broadband Service Inventory for the State of Ohio

Advertised Speeds of at Least 25 Mbps Downstream
and 3 Mbps Upstream



Submit questions or recommended changes to: maps@connectohio.org



Published June 12, 2015

- Symbology**
In areas where multiple broadband providers offer service, this platform composite map stacks coverage display layers in the order presented below.
- City
 - ⊠ Towers
 - Interstate
 - US Road
 - County Boundary
 - Water
 - National and State Lands
 - Fiber Broadband Available
 - Cable Broadband Available
 - DSL Broadband Available
 - Fixed Wireless Broadband Available
 - Mobile Wireless Broadband Available*
 - Unserviced Areas

*This map is not a guarantee of coverage, contains areas with no service, and generally predicts where outdoor coverage is available. Equipment, topography and environment affect service.

This map represents areas of broadband service availability determined by ongoing, in-depth technical analysis of provider networks and accommodations for the impact of external factors on service quality. Satellite broadband services may also be available.

Appendix B: Ohio Broadband Coverage in May 2001

Ohio Broadband Coverage - (c) ECom-Ohio, May 2001

