**Agriculture/Rural Supercluster Blueprint**

**Global City Teams Challenge**

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# Rural America, Rural Economies and Rural Connectivity


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GLOBAL CITY TEAMS CHALLENGE

**Rural America and Rural Economies Need Broadband Connectivity**

We live in a connected world; a connection that starts with broadband internet access to the home or business. That basic connectivity fuels innovation and propels economies across the globe. Quoting a Pew Research Center study, the Federal Communications Commission (FCC) reported that two-thirds of Americans believe that the lack of a high-speed internet connection at home would be a "major disadvantage to finding a job, getting health information or accessing other key information." [1]

Despite the need for connectivity, many areas in rural America continue to lag behind urban areas in terms of broadband internet access. A 2018 survey found that more than 90% of small, locally operated communications providers offer fiber to the home, offering fiber-based broadband to nearly 60% of their customers.[2] Cable companies, as well, have been part of critical broadband deployment efforts through coax and fiber networks.[3] However, terrain and economics involved in building out fiber networks in rural America has left a "digital divide" between urban and rural areas. A "rural/rural" divide even exists between areas served by locally operated communications providers and areas served by communications providers that focus efforts on their larger, more densely populated service areas. The "rural/rural" divide illustrates the need for comprehensive policies that support broadband deployment throughout the United States. Universal service policies, as established by Congress and

[1] The FCC published these findings in an annual report released in January 2016. The FCC is required by Congress to issue a report each year describing the state of broadband deployment in the United States. *See, Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, as Amended by the Broadband Data Improvement Act: 2016 Broadband Progress Report,* FCC Docket No. 15-191, FCC 16-6, at para. 40 (2016) (available at https://apps.fcc.gov/edocs_public/attachmatch/FCC-16-6A1.pdf).

[2] Broadband/Internet Availability Survey Report, NTCA–The Rural Broadband Association, at 4, 5 (Dec. 2018) (https://www.ntca.org/sites/default/files/documents/2018-12/2018%20Broadband%20Survey%20Report_FINAL.pdf).

[3] NCTA, Cable's Story, https://www.ncta.com/cables-story (last accessed June 11, 2019).

supported further by other programs administered by the U.S. Department of Agriculture, have resulted in admirable broadband capabilities in many rural areas.

Broadband connectivity can be provided by a variety of technologies. Each platform can offer unique attributes to meet specific needs. Wired networks boast security and resilience; fiber optics are often referred to as "future proof," referring to the ability to increase capacity by adding electronic components at the physical ends of the fiber. Fixed wireless networks (described more fully in the Midco case study below) allow fiber providers to "edge out" their fiber connectivity by deploying fixed wireless equipment on local grain elevators, water towers, commercial towers, tall buildings, etc. and then backhauling that traffic to the fiber network. At the same time, mobile wireless technologies are necessary to support critical applications "on the move." Mobile and fixed broadband services work in concert to provide comprehensive access to critical applications that support rural economic development, education and health care. As noted by the FCC, fixed and mobile broadband services, while not full substitutes for each other, are each "important services that provide different functionalities, tailored to serve different consumer needs."[4] The FCC has concluded that consumers require access to both wired and mobile services.[5] However, even where a predominantly wireless solution may be a preferred solution due to terrain or other factors, wireless networks at their core require a wired infrastructure to convey traffic.[6] Properly drafted policies can account for the need for both wired and wireless technologies, and can provide much-needed connectivity to rural

[4] *Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion: 2018 Broadband Deployment Report,* Docket No. 17-199, FCC 18-10, at para. 18 (2018).

[5] *See, Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, as Amended by the Broadband Data Improvement Act: 2016 Broadband Progress Report,* FCC Docket No. 15-191, FCC 16-6, at para. 40 (2016) (available at https://apps.fcc.gov/edocs_public/attachmatch/FCC-16-6A1.pdf).

[6] "The Truth About Wireless Broadband," Foundation for Rural Service, Washington, DC (produced with assistance from John Staurulakis, Inc., Monte R. Lee and Company, and Palmetto Engineering (2011) (available at http://www.frs.org/images/The_Truth_About_Wireless_Broadband.pdf).

America. That connectivity, in turn, enables rural America to engage in and benefit from innovation – and build stronger rural economies in multiple ways:

**Telehealth**

Rural areas often lack access to healthcare resources:

> "Rural residents who live on farms, ranches, reservations and frontiers often must travel long distances to reach a health care provider. That means taking hours off from work for an initial appointment or follow-up, which causes many to delay or avoid care. Greater distances also result in longer wait times for rural emergency medical services (EMS). That can endanger patients requiring EMS treatment. "If you're bleeding, in that extra 15 minutes (before help arrives), you can die," said Gary Hart, PhD, director of the Center for Rural Health, University of North Dakota School of Medicine and Health Sciences, in Grand Forks."[7]

One solution to addressing the rural healthcare crisis is the use of telehealth:

> The range and use of telehealth services have expanded over the past decades, along with the role of technology in improving and coordinating care. Traditional models of telehealth involve care delivered to a patient at an originating (or spoke) site from a specialist working at a distant (or hub) site. A telehealth network consists of a series of originating sites receiving services from a collaborating distant site.
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> Telehealth is defined as the use of electronic information and telecommunication technologies to support long-distance clinical healthcare, patient and professional health-related education, public health and health administration. Technologies include video conferencing, the internet, store-

[7] Association of American Medical Colleges, *Health Disparities Affect Millions in Rural U.S. Communities* (Oct. 31, 2017), https://news.aamc.org/patient-care/article/health-disparities-affect-millions-rural-us-commun/ (last accessed June 11, 2019).

and-forward imaging, streaming media, and terrestrial and wireless communications.[8]

Telehealth is a well-proven solution to combatting rural healthcare needs. Patients not only have more access to healthcare providers, but also limit their travel time to attend appointments, limit their time away from work, while also continuing to work in and contribute to the local economy. The quantified findings are impressive. National average estimates of rural costs savings include:

Travel expense savings: $5,718 per medical facility, annually;

Lost wages savings: $3,431 per medical facility, annually;

Hospital cost savings: $20,841 per medical facility, annually;

Increased local revenues for lab work: $9,204-$39,882, per type of procedure, per medical facility, annually; and

Increased local pharmacy revenues: $2,319-$6,239 per medical facility, annually, depending on the specific drug prescribed.[9]

Internet connectivity is a prerequisite to providing telehealth services. While relatively low-bandwidth services can support basic monitoring, high-capacity broadband is necessary to enable synchronous video-conferencing that supports physician/patient interactions in "real-time." These connections facilitate dialogue as well as mental health, physical therapy and occupational therapy interactions.

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[8] Health Resources & Services Administration, *Telehealth*, https://www.hrsa.gov/rural-health/telehealth/index.html (last accessed June 11, 2019).

[9] Schadelbauer, Rick, "Anticipating Economic Returns of Rural Telehealth," Smart Rural Community, NTCA–The Rural Broadband Association (2017) (https://www.ntca.org/sites/default/files/documents/2017-12/SRC_whitepaper_anticipatingeconomicreturns.pdf)

**Telecommuting**

Telecommuting is becoming an increasingly common way for Americans to work, and for individuals and companies to save costs in a daily commute, office space, etc.[10] In rural America, telecommuting provides gainful employment while allowing families to remain in their communities. In a traditional family farm, for example, the husband may work the family farm while the wife telecommutes and sells insurance, provides data entry services, works in IT, etc. The family can continue to work and live where they want, while supporting their families and contributing more to their local economies.

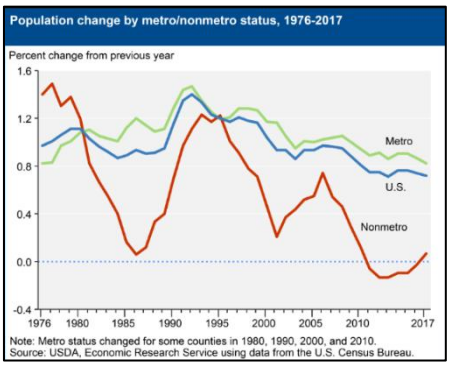


*Figure 1: Rural Flight Graphic*

Telecommuting also helps combat rural flight. As shown in Figure 1, many areas in rural America are experiencing rural flight as younger generations move to more urban areas for increased educational and employment opportunities.[11] Telecommuting offers younger people a viable job while remaining in their communities, as summarized in the following story:

> When 28-year-old Derek Gleim graduated as a computer programmer four years ago, he hardly expected he would craft a career as an IT professional in his hometown of Menasha, Wis. "I wanted to live with my parents in Menasha, where life is simple and inexpensive," he said. "But I was sure that to get that big break I had to move out to a city that's more urban; Menasha is a small, rural town."

[10] Paul C. Boyd, Ph.D, *Six Organizational Benefits of Telecommuting,* https://www.research-advisors.com/articles/ttorgbens.html (last accessed June 11, 2019).

[11] U.S. Dep't of Agriculture, Economic Research Service, *Population Change by Metro/Nonmetro Status*, https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=55975.

> He was pleasantly surprised when he landed a project manager job at Rural America Onshore Sourcing, a Louisville, Ky.-based IT company that provides business process outsourcing services using professionals who telecommute from rural areas.
>
> "Aside from his capabilities, we could hire Derek because – despite living in 'Middle of Nowhere,' Wisconsin – he had access to broadband," said Christopher Hytry Derrington, the company's CEO.
>
> Gleim said he's lucky. Although a large section of rural Wisconsin still lacks broadband, he lives in a place that has it. "Broadband is making it possible to do what I want to do, by living where I want to live," he said.[12]

Gleim's story is one of many thousands of rural telecommuters. For example, in McKee, Ky. (pop. 800), Peoples Rural Telephone Cooperative supports Teleworks USA, a recruitment tool that offers jobseeker services to bring cutting-edge telework employment opportunities to workers, especially in rural areas and small towns. It has generated more than $3 million in economic activity and connected nearly 1,500 employees with their jobs – income which can then flow back to the local rural economy.[13] A $100,000 grant from the U.S. Department of Agriculture helped Teleworks USA make a difference.[14] Rural broadband connectivity can encourage even more rural Americans to remain in their communities, work from home, and contribute to their local economies with their wages.

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[12] Digital Communities, *Giving Rural America a Competitive Edge* (Oct. 15, 2009) https://www.govtech.com/dc/articles/Giving-Rural-America-a-Competitive-Edge.html (last accessed June 11, 2019).

[13] *See, generally,* www.teleworkusa.com.

[14] "TeleworksUSA to Expand Services, Outreach in Six Eastern Kentucky Counties Thanks to New USDA Grant," Lane Report, Lexington, KY (Oct. 3, 2018) (https://www.lanereport.com/106264/2018/10/teleworks-usa-to-expand-services-outreach-in-six-eastern-kentucky-counties-thanks-to-new-usda-grant/).

**Smart Agriculture**

If sufficient connectivity exists in rural America, then farmers and ranchers can benefit from the continuing innovation of smart or precision agriculture. Smart agriculture increases yields in numerous ways: monitoring soil conditions to tailor the seeds for the soil type to yield the best harvest for certain crops; tailoring fertilizers for soil and crop type; and automating watering. Moreover, connectivity supports logistics, which is an increasingly important aspect of farming. This enables producers to align prime harvest times with transportation to market, as well as the incorporation of block chain imprints. Smart agriculture enjoys applications in livestock and dairy production, row crops and specialty crops.

The agricultural industry is producing ever-larger quantities of digital data, to the point that the term "big data" is now widely used across the industry. Many stakeholders believe that the means by which agriculture will feed the world in 2050, without bringing more land into production, will be through the better use of data and data analytics. Deployment of a variety of sensors in agricultural machinery, farm fields, grain storage, food processing, animal collars, etc. has created an era of Ag Informatics, where real-time information gathering, storage, analysis, and interpretation is enabling decision-making on the go (Buckmaster et al., 2016). The Ag Informatics needs of the 21st century demand that students are well versed in statistical platforms, shell scripting tools, data pipelines, visualizations, database technology, working on remote systems of computational clusters (rather than on desktops/laptops), computing massively in parallel, and utilizing modern software data analysis platforms and tools, such as R, Python, Hadoop, Spark, etc. Due to this explosive growth in data-driven Ag Informatics, there is a strong need for innovative training methods in data analysis. According to a recent McKinsey report, data science employment in the United States will face a shortfall of more than 250,000 qualified individuals. Globally, the situation is similar, where demand for data scientists is projected to exceed supply by more than 50% by 2018.[15]

[15] Gerskoff, A. 2015. How to stem the global shortage of data scientists. Available at: https://techcrunch.com/2015/12/31/how-to-stemthe-global-shortage-of-data-scientists/ (accessed May 6, 2019).

Smart agriculture also improves the quality of life for farming families by allowing farmers to monitor their operations remotely. Smart sensors, for example, allow farmers to monitor the cows' labor progressions remotely, instead of living in the barn during calving season. Without a need to monitor operations on the farm in person, farmers can attend family events, coach their kids' athletic leagues, pursue a higher education degree, or seek supplemental income from a part-time job. Smart sensors have also increased the safety of farming. Grain dryers, for example, are prone to explosion and collapse. During grain drying season, IoT (Internet of Things) technologies can alert farmers and help grain silo management, reducing the risk of injuries while increasing operational efficiencies.[16] By way of example, OSHA standards regulate the relative speed of feeding conveyors to bucket elevators; conveyors that run too fast can cause grain dust fires and explosions. Sensors can determine when speeds are approaching hazardous conditions, trigger alarms and stop the conveyor.[17]

Food safety is another area where smart ag, broadband as the enabling technology, and Food Safety Modernization Act (FSMA) Regulations interact for real time decision making that improves food safety under FSMA. Smart ag technology offers multiple benefits from the farmer/ process/ food chain perspective and an opportunity to meet regulatory requirements whether in food safety, environmental rules, water regulation, health of workers and animals with de minimis additional cost. Block chain technology can reduce waste by identifying the specific source of products, eliminating the need to discard entire stores of produce when the originating point of contamination is unknown.

In Sioux Center, Iowa (pop. 7,500), Premiere Communications provides broadband to the 13th largest agriculture-revenue generating county in the nation with more than $1.6 billion in annual crop and livestock sales. A sophisticated network of broadband-powered cameras

[16] "Grain Dust Explosions Up, Injuries and Fatalities Decline," Agriculture News, Purdue University (Feb 21, 2019) (https://www.purdue.edu/newsroom/releases/2019/Q1/grain-dust-explosions-up,-injuries-and-fatalities-decline.html, https://www.nytimes.com/2012/10/29/us/on-us-farms-deaths-in-silos-persist.html).

[17] Jeanne Schweder, "The Internet of Things Inside Grain Operations," Automation World (May 15, 2015) (https://www.automationworld.com/article/topics/industrial-internet-things/internet-things-inside-grain-operations).

enables livestock producers to monitor livestock through live video feeds, while advanced alarm systems send out mobile and email alerts. Broadband-enabled sensors in feeding bins can measure and dispense the exact amount of feed. Other sensors enable farmers to calibrate planting with soil conditions and track rainfall to create a mapping database of crop harvest by the acre. Farmers can download this data to their planting and combine equipment to obtain maximum yields. Equipment manufacturers connected by Premiere can transmit detailed parts specifications and drawings in real time and check inventory at each location, enabling shorter repair times.

In Westby, Wisc. (pop. 2,200), Vernon Communications Cooperative supports a grain storage facility of international food-processing and commodities trading corporation which processes five to six million bushels of corn, soybeans and soft red winter wheat every year. Approximately 180-200 local farmers can spot sell, store or contract their grain. Cloud software maintains employee time cards, vehicle log books and customer databases. Reliable broadband also enables farmers (and the company) monitor fluctuating grain prices, communicate the daily closing bid with customers through text message or email, and maintain real-time communication with headquarters through video conferencing and private chat lines.

**Education**

Technology is shaping the next generation of American jobs. Manufacturing, agriculture and health care are among sectors that are demanding more highly-skilled employees than in the past. It is projected that science, technology, engineering and math (STEM) jobs will continue to grow alongside increasing demand for workers with middle-skill abilities. Career and Technical Education, or CTE, and traditional college settings can prepare students to meet changing job markets. In rural areas, broadband can be used to support secondary and postsecondary education and training.

Regional collaboration among educators and industry can tailor training to support local markets. These efforts can improve local economic stability, as data indicate that higher wages correlate to education.[18] The nexus between STEM and agriculture is clear. Smart ag requires

[18] For a comprehensive discussion of this topic, *see* Joshua Seidemann, "Rural Broadband and the Next Generation of American Jobs," Smart Rural Community (2019) ()https://www.ntca.org/sites/default/files/documents/2019-04/SRC%20Middle%20Skills%20Web%20Version.pdf).

software coding, machine learning, data visualization, data wrangling (manipulation) and data interpretation. Thus, increasing workforce demand and explosive growth of data suggest a need for developing novel curriculum for training next generation of food, agricultural, natural resources, and human (FANH) sciences students in functional programming skills (software application) and computational skills (e.g. accessing, organizing, analyzing, and visualizing data). These skills are critical for providing leadership and communication in academia, industry, and on farm in the 21st century.

The quantification of STEM jobs depends upon how "STEM" is defined. For example, the National Science Foundation (NSF) includes social scientists in STEM jobs, but not science or engineering managers; the U.S. Department of Commerce includes science and engineering managers but does not count social scientists.[19] A University of Wisconsin-Madison report observes that the lack of standard definitions frustrates accurate analysis of the STEM market.[20]

STEM for rural areas can be defined as both pure and applied disciplines of Science, Technology, Engineering and Mathematics. Traditionally, STEM was focused narrowly on college degrees in STEM fields of study. However, the definition of STEM has expanded to different levels of education including K-12, two-year schools, 4-H and private industry.

An inclusive definition of STEM encompasses a wide range of academic and technical subjects, including, but not limited to, the physical sciences (*e.g.*, biology, chemistry, earth and environmental science, geosciences, agricultural sciences, physics, astronomy) and social sciences (*e.g.*, psychology, sociology, political science, anthropology, economics, behavioral sciences), natural and information technology (*e.g.*, computer science, keyboarding, robotics, data analytics, engineering, construction, urban planning, cybersecurity), life sciences, and mathematics education. STEM also includes health care programs that train students for careers that primarily focus on scientific research.

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[19] Stephen Sawchuk, "Is STEM Oversold as a Better Path to Jobs?" Education Week (May 22, 2018).

[20] Amanda Oleson, Matthew Hora and Ross J. Benbow, "What Is a STEM Job? How Different Interpretations of the Acronym Result in Disparate Labor Market Projections," Wisconsin Center for Education Research, University of Wisconsin-Madison at 2 (Sep. 2014) (Oleson, *et. al.*).

In addition to the subjects listed above, STEM includes career / technical education and apprenticeships, which can also be considered *Applied STEM*. This concept reflects the 21st century need for a technically proficient work force that can support major sectors of the rural economy, including precision agriculture, natural resources, manufacturing, government, recreation, and health.[21]

There are, however, consistent findings that the market for STEM jobs is robust and offers well-paying positions. The Bureau of Labor Statistics (BLS) reported 8.6 million STEM jobs in 2015, an increase of 10.5% from 2009, as compared with 5.2% job growth for non-STEM occupations.[22] BLS concludes that STEM positions constitute 10% of all U.S. jobs and on average pay almost twice the U.S. average wage.[23] These collective findings are consistent with the determination that STEM jobs are generally "far more plentiful than is generally understood, and they pay more than the typical jobs available to those with less than a bachelor's degree,"[24] and argue for attention to STEM education.

In similar vein, the number of jobs supported by CTE is subject to debate,[25] though a University of California report finds in various state studies increased earnings that range from 14% to 28% across different professions supported by CTE.[26] The U.S. Department of Education

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[21] *See,* USDA Task Force on Ag & Rural Prosperity, 2017, USDA Economic Research Service, (2017).

[22] *See,* Stella Fayer, Alan Lacey and Audrey Watson, "STEM Occupations: Past, Present and Future," Bureau of Labor Statistics, U.S. Department of Labor and ILR School, Cornell University (Jan. 2017) (https://digitalcommons.ilr.cornell.edu/cgi/viewcontent.cgi?article=2928&context=key_workplace).

[23] John I. Jones, "An Overview of Employment and Wages in Science, Technology, Engineering and Match (STEM) Groups," Employment & Unemployment, Bureau of Labor Statistics, U.S. Department of Labor and ILR School, Cornell University, at 3 (Apr. 2014) (https://digitalcommons.ilr.cornell.edu/cgi/viewcontent.cgi?article=2279&context=key_workplace).

[24] Rosenblum and Kazis at 1.

[25] One author notes that a series of studies "do not inspire much confidence in the possibility of reaching clear conclusions from correlational data about how much CTE classes cause increases in earnings." David Stern, "Pathways or Pipelines: Keep High School Students' Future Options Open While Developing Technical Skills and Knowledge," Graduate School of Education, U.C. Berkley, at 9 (2015) (Stern).

[26] Ann Huff Stevens, "What Works in Career and Technical Education (CTE)? A Review of Evidence and Suggested Policy Directions," University of California, Davis, and National Bureau of Economic Research, at 43, 44 (2019) (https://assets.aspeninstitute.org/content/uploads/2019/01/1.2-Pgs-40-54-What-Works-in-Career-and-Technical-Education.pdf?_ga=2.219392272.846192663.1553723880-249793350.1553723880).

(DOE) reports that 95% of public high school students in 2009 attended a school that either offered CTE on-campus or with a partnering school.[27] The DOE also found "the most common occupational CTE subject areas for secondary students were business, communications and design, and computer and information sciences."[28] Although in recent years overall participation in CTE participation has declined slightly, demographic differences across racial and economic categories are declining as participation from among various demographic categories is achieving greater equivalent proportionality.[29]

Rural broadband providers can play a critical role in efforts to support specialized STEM and CTE education. Broadband-enabled distance education allows all eligible students who have access to broadband to participate. Distance education can support STEM and middle-skills job education, including work-training programs, apprenticeships and focused classroom instruction to help students develop skills and lay the groundwork for economic opportunities in rural areas. This is especially important in rural areas. The American Enterprise Institute reports that in 2012, less than 66% of rural schools offered AP courses, as compared with 77%, 82% and 91% of town, urban and suburban schools, respectively.[30] The concern for ensuring educational opportunities transcends the individual welfare of students and workers and implicates overall economic growth that could be frustrated if there is a lack of skilled workers. The U.S.D.A. Economic Research Service ERS reports rural counties with low levels of educational attainment suffer poor economic outcomes as compared with counties that have higher levels of educational attainment.[31] The Bureau of Labor Statistics BLS reports that adults 25 and older

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[27] "National Assessment of Career and Technical Education: Final Report to Congress," National Assessment of Career and Technical Education, U.S. Department of Education, at 16 (2014) (https://www2.ed.gov/rschstat/eval/sectech/nacte/career-technical-education/final-report.pdf) (NACTE).

[28] NACTE at 19.

[29] *See,* NACTE at 18, 19; Stern at 7.

[30] Nat Malkus, "The AP Peak: Public Schools Offering Advanced Placement, 2000–12," American Enterprise Institute, Figure 4 and accompanying text (2016) (http://www.aei.org/publication/the-ap-peak-public-schools-offering-advanced-placement-2000-12/).

[31] ERS identifies 467 counties as "low education"—counties where 20% or more of adults 25 to 64 do not have a high school diploma; nearly 80% of these counties are rural. Average poverty rates in rural low-education counties are approximately 8% higher than all other rural counties. 40% of rural low-education counties are also persistent-

who lack a high school diploma have unemployment rates of 5.4%; those with less than a high school education have unemployment rates of 8%. Educational attainment in rural areas is increasing,[32] and students with access to broadband are realizing promising results. Youth who live in areas with broadband are found to have earned higher scores on college entrance exams such as the SAT or ACT.[33] Distance education can be a tool to correct lack of specialization that may exist in small rural and can also assist early college. Distance education can also provide flexibility for working students and accommodate ongoing family obligations.

The United States Department of Agriculture (USDA) Rural Utilities Service (RUS) Distance Learning Telemedicine (DLT) Program supports rural STEM education by funding equipment needed to connect to internet / broadband services for distance learning.[34] [] USDA also administers broadband programs that provide the broadband infrastructure necessary to connect rural educational institutions to the internet. These programs include the Telecommunications Infrastructure Loan Program, Rural Broadband Access Loan Program, Community Connect Grant Program and the Broadband Reconnect Program. The rising level of technical (Applied STEM) skills required for precision agriculture is recognized in the new USDA National Institute of Food and Agriculture (NIFA) Agriculture and Food Research Initiative (AFRI) Agricultural Workforce Training Grants.

The recent USDA Precision Agriculture and Broadband Report (May 2019) indicates that universal adoption of precision agriculture could add 18 percent in gross economic benefits to U.S. agricultural production. This has a market value estimated at $65.5 Billion. 36-percent of precision agriculture benefits depends on broadband connectivity. This translates to potential

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poverty counties. Low-education counties also indicate poverty, with poverty rates of 20% or higher, and high unemployment rates. "Rural Education at a Glance, 2017 Edition," Economic Information Bulletin 171, Economic Research Service, United States Department of Agriculture, at 5, 6 (Apr. 2017) (https://www.ers.usda.gov/webdocs/publications/83078/eib-171.pdf?v=0) (ERS Education).

[32] ERS Education at 2.

[33] Lisa J. Dettling, Sarena F. Goodman and Jonathan Smith, "Every Little Bit Counts: The Impact of High-Speed Internet on the Transition to College," Finance and Economics Discussion Series, Divisions of Research & Statistics and Monetary Affairs, Federal Reserve Board, Washington, D.C., at 27 (2015-108).

[34] *See,* Distance Learning Telemedicine Program (DLT) https://www.rd.usda.gov/programs-services/distance-learning-telemedicine-grants.

gross economic benefits of broadband infrastructure and precision agriculture adoption combined of $18 – 23 Billion or 7% of the annual value of U.S. market production.[35] That increase in production would be a substantial portion of the increase in global food production needed to meet global demand for food by 2050.

Rural broadband is supporting innovative education opportunities. Rainbow Communications of Hiawatha, Kan., demonstrates the unique complementary properties of various fixed and mobile broadband platforms. The company provides fixed fiber connectivity to Highland Community College, the oldest college in the state, enabling the college to offer numerous courses at various sites. These courses include CTE courses as well as training in precision agriculture, which relies upon mobile broadband applications, and diesel mechanics; similar to the complementary properties of fixed and mobile, and wired and wireless services, both educational components are necessary as farms rely increasingly on traditional mechanical equipment as well as evolving analytical tech and mobile guided systems. Webster-Calhoun Cooperative Telephone Association (WCCTA) in Fort Dodge, Iowa, provides broadband that enables local high school students to earn college credits through distance education. Students can take up to 23 credits of college courses through a partnership with Iowa Central Community College.

While connectivity provides all of the benefits discussed above (and many others not discussed in this paper), the next section on a case study focuses on how connectivity and innovation can drive local economies.

[35] *See,* 2017 Production Values USDA NASS and APHIS), at 23; *see, also,* A CASE FOR RURAL BROADBAND, Insights on Rural Broadband Infrastructure and Next Generation Precision Agriculture Technologies, American Broadband Initiative (Apr. 2019).

**Rural Economic Development**

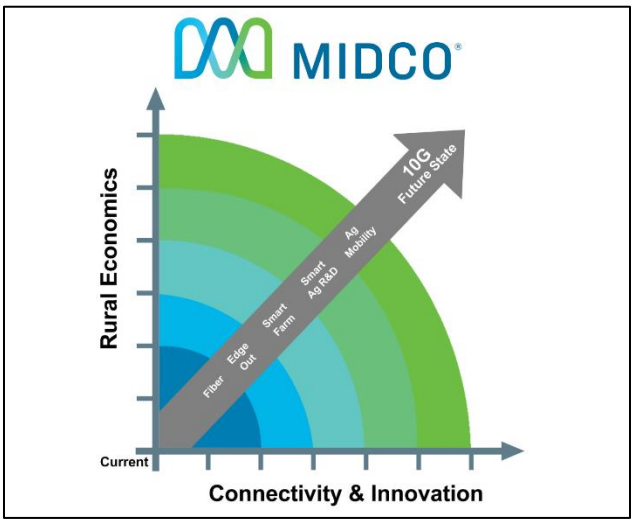


*Figure 2: Connection between Rural Economies and Connectivity & Innovation*

Broadband connectivity and innovation work hand-in-hand to boost rural economic development. Figure 2 demonstrates this relationship and the impact of the relationships on rural economics. The growing importance of broadband to local and regional economies has been highlighted for nearly a decade. In an April 2011 report, the Center for Rural Strategies (CRS) concluded that "while broadband will not bring immediate transformation to rural America, regions that lack broadband will be crippled."[36] In that discussion, a panelist observed, "Businesses that depend on information technology largely avoid being in areas where they cannot get what they need."[37] Technological leadership, however, must be combined with leadership from other local and regional vertical industries. As noted in the CRS discussion, "[a]s broadband becomes essential infrastructure, it will be taken for granted as a baseline service. Its absence may be associated with a loss of jobs, but its presence may not create jobs."[38] It is, therefore, not sufficient to only deploy the technology. The technology must be leveraged thoughtfully, creatively and collaboratively – and, even more so, enthusiastically. These efforts are best undertaken not only on local town or city levels, but also regionally.[39]

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[36] Scholars Roundtable: The Effects of Expanding Broadband to Rural Areas," Center for Rural Strategies, at 3 (Apr. 2011) (http://www.ruralstrategies.org/sites/all/files/Broadband_Investment.pdf ) (last viewed Oct. 13, 2015, 11:36) (Center for Rural Strategies).

[37] Center for Rural Strategies at 8.

[38] Center for Rural Strategies at 11.

[39] *See, i.e., "*Steel Sharpens Steel: A Conversation About Regional Thinking for Rural America," Smart Rural Community, NTCA–The Rural Broadband Association (J. Seidemann, editor) (2017) (available at https://www.ntca.org/sites/default/files/documents/2017-12/SRC_whitepaper_steele_sharpens_steel.pdf).

GVTC Communications of New Braunfels, Texas, (pop. 79,000) led the formation of the GVTC GigaRegion, a private-public partnership that leverages fiber broadband to compete for economic development and improve quality of life for residents. The partner cities of Boerne, Bulverde and Gonzales pool resources with GVTC to market the area's fiber broadband assets. GVTC, in turn, works with local municipalities and economic development agencies to recruit, retain or help businesses expand. Even smaller communities have achieved success: three new industries recently located to Metter, Georgia (pop. 4,076), thanks in large part to the fiber connections supplied by Pineland Telephone Cooperative, including: an Australian-based company that specializes in concrete pumps used in construction projects from housing to commercial and industrial; a South Korean manufacturer of the concrete pumps which expanded to the United States, opening a home office in Metter; and, a 120-year leader in quality paint applicators announced an investment of $4 million and 200 new jobs by end of year 2016. And, while noting rural success stories in landing "big fish," the impact of telecommuting, as described above, cannot be underestimated as it both *enables* people to live in rural areas and can *encourage* new residents to relocate to rural areas.

People attracted to or retained in rural communities bring expertise to the rural entrepreneurial ecosystem and can add value to other community efforts. Whether as mentors to other businesses, members of the school board or volunteers in local organizations, skilled residents can impact many aspects of a community. The City of Independence, Oregon, has used a series of meetups, events, technology deployments and entrepreneurship classes to educate and connect residents with an eye toward starting new businesses. The effort attracted Kate Schwarzler, who moved back to Oregon from Denver to be closer to her parents, and chose to start up a co-working space in the town's historic downtown. Two years later, the co-working space is home to a dozen businesses and hosts a number of meetups and entrepreneurial events. Schwarzler and members of the co-working space are helping grow the

downtown business association and are building startup events like a recent TechStars Startup Weekend.[40]

It does not take much to tip the scales in a rural community. A couple new businesses, or a few new people with the right skills can set a town on a more positive direction. This easy access and potential for a tangible impact is attractive to many people, and broadband capacity is the key asset for their recruitment. For example, Maupin, Oregon, built out a fiber to the home network in partnership with LS Networks in 2018. Now, Michael Jones, Director of Research for San Francisco-based Salesforce, is relocating there to work remotely. "I absolutely rely on high-speed internet to do my job," he says in a press release. "But when I'm not working, I want to spend time getting to know my neighbors and being on the river."[41]

Rural communities have the quality of life that modern workers desire, and these communities need the skills workers bring. However, broadband access is required to connect workers to rural environments.

**Midco Case Study**

A proven and economically feasible solution is fixed wireless internet provided by wireless internet service providers (WISPs). As technology continues to improve, WISPs have gained increasingly more attention as a solution to closing the digital divide. WISPs currently provide more than four million residential and business customers with much-needed broadband access "often in exclusively rural areas."[42]

WISPs operate by deploying broadband access equipment, known as fixed wireless equipment, on vertical assets, such as grain elevators, water towers, tall buildings, commercial towers, etc. Using radio frequency spectrum and a radio and antenna system, a WISP broadcasts the internet from a fiber-fed vertical asset to another vertical asset – known as a

[40] Oregon Business, https://www.oregonbusiness.com/article/tech/item/18734-fertile-future#itemCommentsAnchor (last accessed June 27, 2019).

[41] Oregon Business, https://www.oregonbusiness.com/article/tech/item/18734-fertile-future#itemCommentsAnchor (last accessed June 27, 2019).

[42] Wireless Internet Service Providers Association (WISPA), http://www.wispa.org/ (last access June 24, 2019).

point-to-point (P2P) connection. The P2P connection or fiber delivers internet to the vertical asset, and then the WISP uses spectrum and a radio and antenna system to provide internet to customers. They home or business must have a vertical asset and radio installed – known as a point-to-multiple or P2MP connection. Figure 3 demonstrates how a fixed wireless system operates.

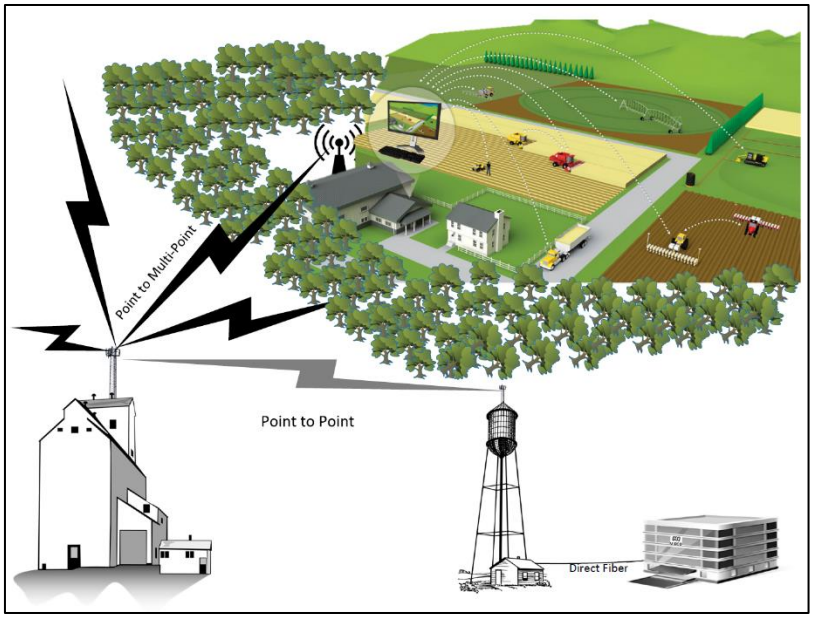


*Figure 3: Sample Depiction of Fixed Wireless Connectivity within Midco's Network*

Importantly, once the home (or business, shop, etc.) has been connected via a P2MP connection, then the customer can use the connectivity to operate IoT or smart-farming devices.

**Connectivity Example in the Rural Midwest**

One example of many successful WISPs is Midco®, a traditional cable operator and wired internet service provider that has used fixed wireless technology to serve the most rural and remote areas of its footprint. Using the Midco Edge Out℠ strategy,[43] Midco "edges out" its high-speed internet from its fiber backbone in urban areas to rural areas using fixed wireless technology. The initial fixed wireless expansion from the wired plant meets consumers' immediate needs; Midco can then leverage that expansion to justify a wired network buildout in the future. While some rural areas may support that wired build, other, more remote rural areas will continue to be served with a fixed wireless solution.

The Midco Edge Out strategy will make a substantial difference in providing broadband to rural America. For example, in 2018, Midco made a large public commitment by partnering with the FCC to expand fixed wireless to rural America through the Connect America Fund

[43] Midco has filed or is filing for a trademark of Midco® Edge Out with the United States Patent and Trademark Office, and with the applicable state agencies in our footrpint.

Phase II (CAF) auction.[44] Through CAF, Midco anticipates passing around 200,000 homes with fixed wireless technology, significantly expanding into rural America, as displayed in Figures 4 and 5 below.

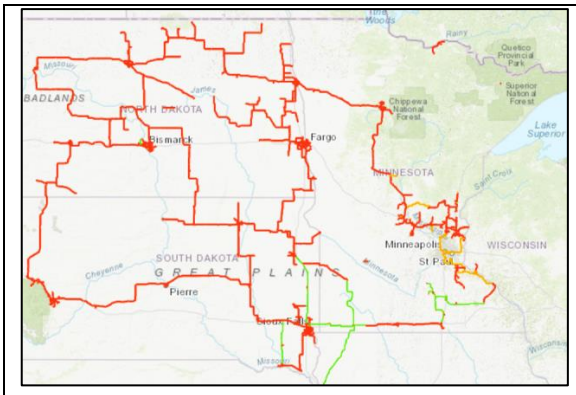


*Figure 4: Simplified Depiction of some of Midco's Fiber Network*

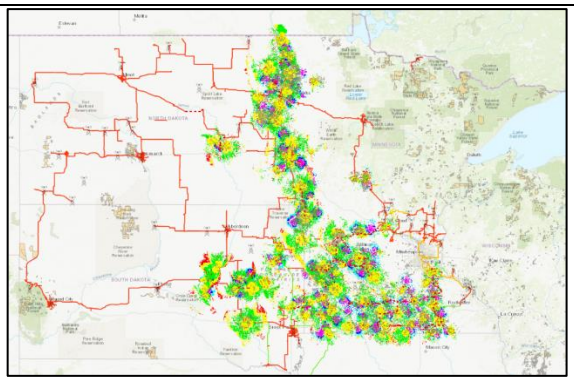

*Figure 5: Expected Fixed Wireless Coverage for Midco's Network after CAF Phase II Buildout*

Fixed wireless technology continues to advance and is on a path to fixed 5G to serve rural America. Current technology deployed by Midco (advanced mid-band LTE) can offer significant speeds at a low latency – and will only continue to improve as technology advances and the FCC releases more spectrum for fixed wireless operations. Figure 6 shows the speeds available from testing and operation completed in rural Thompson, ND, by Midco with current

[44] Midco partnered with the Federal Communications Commission by bidding on funding through the Connect America Fund Phase II (CAF) auction. Numerous other WISPs were also awarded significant CAF funding: FierceWireless, *Here are the Top 100 Winners of the FCC's $1.5 Billion Auction*, https://www.fiercewireless.com/wireless/here-are-top-100-winners-fcc-s-1-5b-caf-ii-auction (last accessed June 11, 2019) ("a large number of the top winners in the auction said they plan to use fixed wireless technology to build out telecommunications services in rural areas. Indeed, the Wireless Internet Service Providers Association (WISPA) said that member companies including Broadband Corp. of Hutchison, Minnesota; ClearSKY Systems of Verona, Illinois; GeoLinks (California Internet) of Camarillo, California; Midco (Midcontinent Communications) of Sioux Falls, South Dakota; Total Highspeed in Nixa, Missouri; and Wisper ISP of Mascoutah, Illinois were among the winners.").

technology (black font) and current technology if the 2.5 GHz band (red font) becomes available for fixed wireless providers.[45]

**Connectivity and Innovation Together**

After an ISP, WISP or other provider establishes connectivity to a rural community, the community can then begin to reap the benefits of connectivity as discussed above. For rural, agricultural communities, broadband connectivity allows farmers to deploy smart or precision agriculture (i.e., Smart Farm). Smart Farm, in turn, encourages further Smart Agriculture Research and Development to make agriculture more and more efficient; producing higher yields and freeing up farmers – all of which increases the rural economy. Through continuing research and development, the near future holds potential for agriculture mobility from fixed wireless systems – increasing rural economies even more so by producing higher yields and reducing the labor needed to operate farms currently.

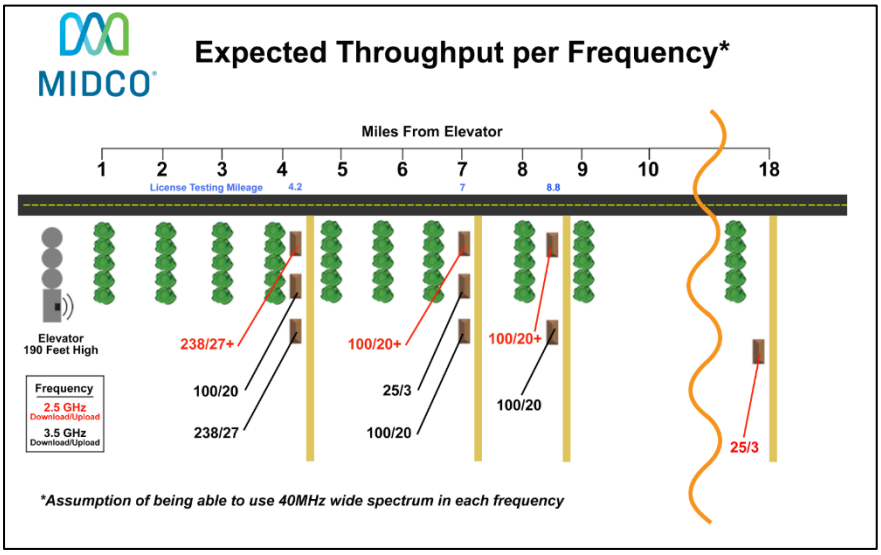


*Figure 6: Testing Results for the 2.5 and 3.5 GHz Bands in Midco's Footprint*

As connectivity and innovation continue to bolster rural economies, service providers have more opportunities to build out rural America. With the Midco Edge Out[46] strategy, for example, the company can first connect rural customers and then bring more fiber and wired networks into the most rural areas. In the future state, even the most rural areas would be able

[45] The Federal Communications Commission has a docket open to reform the rules for the Educational Broadband Service (EBS) portion of the 2.5 GHz band. *See* Federal Communications Commission, *Transforming the 2.5 GHz Band,* WT Docket No. 18-120.

[46] Midco has filed or is filing for a trademark of Midco® Edge Out with the United States Patent and Trademark Office, and with the applicable state agencies in our footrpint.

to take advantage of significant core, wired network features, such as 10G. A 10 gigabit network is a "powerful, capital-efficient technology platform that will ramp up from the 1 gigabit offerings of today to speeds of 10 gigabits per second and beyond – to consumers in the United States and across the globe in the coming years."[47] 10G holds an unknown potential for future innovation for rural America and smart agriculture

Connectivity and innovation together will boost rural economies, and the case study provided by Midco is one example of providing solid connectivity.

[47] NCTA, https://www.ncta.com/media/media-room/introducing-10g (last access June 11, 2019).