Digital Oklahoma: Harnessing the Speed of Light

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Executive Summary

The Internet can easily be counted as one of the top technological advances of the past 60 years and is the medium of future change and growth. Broadband access has the potential to improve the quality of life for all Oklahomans through enhanced communication, expanded education, better information access, improved public safety, sustainable economic development, more effective healthcare, better utilities, and a more responsive government. However, for the State of Oklahoma and its residents to benefit fully from the new digital economy, access to affordable broadband and the ability to use it is paramount.

The purpose of this report is to inform state and community leaders, planners and citizens about the Oklahoma Broadband Initiatives (OBI) findings concerning the availability and use of high-speed broadband internet services throughout Oklahoma and provide direction for future efforts to ensure that all communities in the state enjoy the benefits of current and future digitally based opportunities. For Oklahoma communities to be competitive in the global economy of the 21st century, they need:

1) More access to high-speed Internet technologies that provide at least the minimum speed of 4Mbps download and 768kbps upload,
2) To become more versed in the use and the utility of the internet for improving the quality of their daily lives, and
3) Affordable service options. The cost of high-speed internet services in Oklahoma is an issue for a significant portion of the population regardless of residence.

Access to high-speed service is not evenly distributed

When compared to the average download speeds for states and territories across the U.S, Oklahoma ranked 40th with an average download speed of 2.9 Mbps. This speed is almost two times slower than 10th ranked Louisiana (Speedmatters.org, 2010) and does not meet the minimum standard of 4Mbps download and 768kbps upload set by the FCC (2011). Further, the Internet landscape continues to shift requiring even greater speeds than the standards established in 2011. Oklahoma's access speed issues are in part due to an aging infrastructure. This has been addressed through the OCAN project which increased the states middle mile backbone with 1,005 miles of new fiber optic cable; however the gains from these efforts are yet to be fully realized. Key findings from OBI's research on the state of Oklahoma's current broadband infrastructure include:

- DSL is the major form of wireline technology used in Oklahoma for high-speed Internet services. A small proportion of Oklahoma households were able to obtain broadband services through fiber technology which were located adjacent to the states borders with Kansas and Texas and in pockets within metropolitan areas. Although new fiber infrastructure has been laid, the process of bringing fiber based high-speed Internet

services to Oklahomans residing in areas with limited or no access is likely to be a long-term endeavor.

- Differences were found between urban and rural households regarding access to wireline broadband services and the challenges associated with broadband adoption. Most urban households could access broadband services through two or more wireline providers at adequate speeds while most rural households were located in areas defined as underserved or unserved for wireline broadband services. For rural Oklahomans, the most significant challenge was access to broadband technology.
- Outreach events and survey trips provided researchers with an opportunity to speak with Oklahomans and listen to their thoughts and opinions on the topic of broadband. Whenever researchers spoke with someone associated with education in rural areas, they expressed a deep and serious need for expanded service. Residents were fully cognizant of the lack of service and the consequences for themselves and the families they served. This ranged from immediate concerns such as the amount of time needed to send test scores (according to some, this can take hours with a slow connection) to more long-term concerns (such as the digital literacy of students).
- Approximately 50% of Oklahoma's American Indian population is living in areas identified as unserved or underserved for broadband services with access to broadband services through at least two wireline providers limited to one-half of the population.
- Although a significant difference in access to wireline broadband services was not observed between Oklahoma's White and African American populations, all of Oklahoma's Historic All-Black towns are geographically located in areas identified as underserved or unserved with limited or no wireline broadband service available.
- With the pervasiveness and improvements in smartphones, mobile wireless was increasingly being used as a supplement to wireline broadband services, especially for those who could not obtain broadband services through fixed wireless or afford satellite services.
- Many of those surveyed cited having Internet access via smartphone as being sufficient for their needs and thus the reason they don't subscribe to wireline broadband. The unreliability and slow performance of cellular connections in rural areas became very apparent to research staff as they were working directly with rural Oklahomans.
- Further, many rural residents have significantly fewer options compared to residents of in metropolitan areas. Most of rural Oklahoma can only count on reliable in-network (non-roaming) service from one, perhaps two, providers while urban residents tend to have access to the four major providers and other regional providers. The faster 4G network standard has yet to be rolled out in most rural areas. Current rural 3G sites frequently lack sufficient support by high-speed backhaul resulting in slowed data transmission.

Need to increase awareness and use

It is imperative that Oklahomans change the way they relate to the Internet. In 2011, 35% of Oklahomans reported that they did not use the Internet at all with a larger percentage of rural Oklahomans (40%) reporting nonuse than those living in urban areas (33%). The percentage of rural nonusers in Oklahoma was not only greater than that of urban Oklahomans, but also greater than rural U.S. residents in general. As more services move online, residents of all age groups must use the Internet in their interactions with employers, schools, or government. It is important for Oklahomans to understand that broadband services do not serve and benefit a particular group, but are a necessity for everyone. Key issues and recommendations include;

- For urban Oklahomans, the most significant barrier to adoption appears to be lack of awareness including knowledge of services available and key differences between technologies and uses supported.
- Many rural Oklahomans did not know the breadth and depth of task and activities that can be accomplished using the Internet. A sizable portion of rural non-adopters focused on social media applications and entertainment with little knowledge of more practical daily uses such as online education, telehealth and telemedicine, economic development and interaction with local businesses, governments and utility companies.
- Older individuals in rural areas who were knowledgeable usually 1) worked in professions that made use of the Internet in some capacity, or 2) had support from younger relatives or individuals who helped them obtaining and setting up a computer and getting on line.
- Oklahomans also need to become more versed in the use and the utility of the Internet. One way to overcome the awareness barrier is to conduct long-term community outreach campaigns that inform residents about the benefits of broadband in economic development, public safety, e-learning, or e-medicine. Schools and libraries can serve as subject matter experts to carry out localized educational campaigns.
- Community education and awareness efforts need to include discussions of online safety as many Oklahomans especially parents had concerns surrounding this issue.

Cost is an issue for Oklahomans

- Residents in underserved areas for wireline broadband services were more likely to report that service choices were limited, cost was too high, customer service was poor, and actual speeds achieved were significantly lower than expected.
- The biggest adoption hurdle for residents in underserved rural areas was cost. For many non-adopters the added cost to their monthly budgets was prohibitive. Residents in these areas frequently indicated that they used public library for access which included using the libraries service like a hot spot by driving or parking close to the facility.

Highlights of Other Broadband Efforts in the State

- The fiber deployed through the OCAN phase of the initiative provided identified CAIs, which included public libraries, the infrastructure needed to support higher broadband speeds.
- Several initiatives, including "Oklahoma Optical Initiative" (OOI), Shared Services, 100 Gbps Initiative, "Oklahoma Community Anchor Network" (OCAN), "OneOklahoma Friction Free Network" (OFFN), and OneOklahoma Cyberinfrastructure Initiative (OneOCII) have produced the Oklahoma Higher Education Research Network.
- Private industry is moving to Fiber-to-the-Home (FTTH) technology to provide broadband services to subscribers.
- Small rural communities that rely on CAIs for access to broadband services could benefit from the adoption of the "Smart Communities" model to promote economic and social development in their areas.

Central Information Repository

- Finally it is recommended that Oklahoma develop a central broadband repository responsible for monitoring the technological infrastructure needs of the state, aiding in the development of community driven efforts to develop last mile build outs, increasing access to cutting edge technologies for community advancement, assisting broadband related initiatives in leveraging resources and funding, developing and supporting education and awareness campaigns designed to prepare Oklahomans for participation in current and future technological environments, and develop policies designed to address affordability issues for all Oklahomans.

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Oklahoma Broadband Initiative (OBI)

About the OBI

Oklahoma is comprised of vibrant cities and towns while remaining substantially rural throughout the majority of its seventy-seven counties. Access to technology for the provision of enhanced education, healthcare and emergency services plus job growth and development, have long been identified as one of the most essential tools a community must have to expand its economic potential and community livability. Government and education leaders, the Oklahoma Department of Commerce, state and local Chambers of Commerce, and statewide policy organizations are unanimous in their support for the need to provide a statewide network of easy and accessible broadband.

The Oklahoma Broadband Initiative's vision is to create a knowledge-based economy and ensure high quality education, healthcare and public safety services for citizens across the state. In order to realize this vision, a key component is the expansion and improvement of broadband access and the availability of this access to all communities, anchor institutions - including libraries, schools, hospitals and first responders - and all households.

The first phase of this vision was the creation of the Broadband Map for the entire state. This map depicted areas that were served, unserved and underserved. The Oklahoma Broadband Mapping Project was achieved through a partnership comprised of local, state and tribal governments, non-governmental agencies, private sector and industry representatives, and the educational community to include early, common, and higher education, career technical training and workforce development. A technical working group reviewed proposals and recommended the selection of a professional firm to collect and compile the necessary data to map broadband accessibility and to submit required data to National Telecommunications and Information Administration (NTIA) for preparation of the national broadband map.

The second phase of the Oklahoma Broadband Initiative was the formation of public/private partnerships with vendors to deploy infrastructure to provide broadband access to community anchor institutions such as hospitals, universities, libraries, and public safety. In this phase, the demand for better access to broadband infrastructure is addressed. The process included:

1) Analyzing the mapping data,
2) Defining the challenges and opportunities to adoption of broadband,
3) Collecting consumer data concerning the use of broadband in underserved and unserved areas, including information technology capabilities,
4) Identifying priorities and strategies for expanding broadband in underserved and unserved areas, and
5) Developing a consumer education and awareness initiative to increase the adoption and utilization of broadband throughout Oklahoma.

The state submitted and was awarded a Broadband Technology Opportunity Program (BTOP) grant of $74 million. Key to this application was the coordination of data, mapping information, strategic focus and user interests. Leadership from the public and private sectors worked in a collaborative way to combine resources for the expansion of broadband services.

Why Broadband

> *"These foundational information and communications technology (ICT) products make up a global digital infrastructure (GDI) that is the central nervous system of not only innovation, but economic development and social interaction" (Miller & Hoffman, 2010, p.1.)*

The Internet can easily be counted as one of the top technological advances of the past 60 years (Kuttner, 2012). Researchers argue major shifts in the global marketplace are in part due to the Internet's entry into the public sphere. Rapid adoption of the Internet by all major sectors of society as a foundational element of standard operations and service delivery has created an interconnected environment in which physical geography and associated costs are less of a barrier to growth and mobility (Oxford Economics, 2011). Additionally, Atkinson & Stewart (2012) argue that the ability of the U.S. as a whole and its constituent states to remain top global competitors is dependent on "having a workforce and jobs based on higher skills; robust global connections; dynamic firms, including strong, high-growth startups; industries and individuals embracing digital technologies; and strong capabilities in technological innovation" (p. 3). In order for Oklahomans to enjoy success in the new world economy and avoid degradation in quality of life, development of a world class digital infrastructure and the ongoing education and training of its citizens are paramount.

In 2012, Oklahoma ranked 47th in the nation on the *State New Economy Index* out performing only three other U.S. states, including Arkansas, West Virginia and Mississippi. The new economy index is comprised of 26 indicators designed to capture key elements needed by states to successfully compete in the new global economy (Atkinson & Stewart, 2012). This index does not measure a state's current economic performance or policies, rather the capacity and resources needed to compete in an economy focused on innovation and technology. This represents a seven point drop from Oklahoma's ranking in 1999, with 12 of the 26 indicators ranked at or below 40th place by 2012. One indicator showing a significant decline is the states broadband telecommunications infrastructure which was originally ranked 14th in 2002 but dropped to 42nd by 2012 (Atkinson, June 2002); (Atkinson & Stewart, 2012).

Infrastructure

At the inception of the Oklahoma Broadband Initiative (OBI), Internet technology was advancing rapidly with those dependent on older forms of technology being left behind in terms

of speed, bandwidth, end user costs and ultimately the competitive advantages and services provided through the Internet. Global rankings of average Internet connection speeds in 2010 for 46 countries and geopolitical areas placed the U.S. 11th behind South Korea, Hong Kong, Japan, the Netherlands, Czech Republic, Switzerland, Belgium, Canada, Denmark and Norway (see Table 1 below) (Akamai, 2010, 4th Quarter). It should be noted that a country's broadband competitiveness varies by the aspect of technology being measured, with the U.S. ranking as high as 2nd globally by some (connectivityscorecard.org, 2010). This variance is largely due to connectivity infrastructures owned by private interests as opposed to those relied on by consumers, including most small and medium businesses. Predominantly, U.S. and Oklahoma broadband issues lie within the realm of consumer infrastructure where technology, consumer adoption, and digital skills lag significantly behind that of global leaders (Georgia Technology Authority, Sanborn Mapping Company, & Geographics, 2011).

Table 1. Average Connection and Download Speeds by Select Countries

Ten Fastest Geopolitical Areas Compared to U.S.		**Avg. Connection Speeds (in Mbps)**
United States		5.1
Ten Fastest Countries		
South Korea		13.7
Hong Kong		9.4
Japan		8.3
Netherlands		7.0
Czech Republic		5.7
Switzerland		5.6
Belgium		5.5
Canada		5.5
Denmark		5.3
Norway		5.2

Note. From "Connectivity Scorecard: Countries," by Rajala Counsulting, 2010, *c onnectivityscorecard.org*

A 2010 report of average download speeds for states and territories in the U.S. ranked Oklahoma 40th with an average download speed of 2.9 Mbps, almost two times slower than 10th ranked Louisiana (see Table 2 below) (SpeedMatters, 2010). The Federal Communications Commission (FCC) established a minimum national speed goal of 4Mbps download and 768kbps upload as the minimum speeds qualifying as broadband (2011)[i]. Based on the estimates provided by SpeedMatters.org, average speeds obtained by Oklahomans in 2010 did not meet the minimum standard set by the FCC. Further, the Internet landscape continues to shift requiring

even greater speeds than that set by the FCC for users to take advantage of key web-based services needed to support and enhance an individual's quality of life.

Table 2. Average Connection and Download Speeds for U.S. by State

Ten Fastest U.S. States Compared to Oklahoma		**Avg. Download Speeds (in Mbps)**
Oklahoma		2.9
Ten Fastest States		
Delaware		13.4
New Jersey		8.6
Maryland		7.6
New York		7.5
Rhode Island		7.0
West Virginia		6.0
New Hampshire		5.5
Kansas		5.3
Arizona		5.2
Louisiana		5.2

Note. From "A Report on Internet Speeds in All 50 States," by Speed Matters, 2010, *speedmatters.org*.

Estimates obtained in 2011 from the U.S. Current Population Survey (CPS) indicate that the majority of Oklahomans accessed the Internet at home through cable modems (50.87%) and DSL (32.43%) (see Table 3 below). However, dial-up Internet was still being used in the home by an estimated 2.51% of urban and 6.02% of rural residents in the state. This represents a slightly greater percentage of Oklahomans than U.S. residents overall (2.04% urban, 5.86% rural) (see Table 3 below).

Table 3. Households Using the Internet in Home

	No Internet Use		**Dial-Up**		**Broadband**	
	U.S.	**Oklahoma**	**U.S.**	**Oklahoma**	**U.S.**	**Oklahoma**
Location	**%**	**%**	**%**	**%**	**%**	**%**
All Areas	30.27	35.35	2.82	3.74	77.95	62.46
Urban	29.34	32.76	2.51	3.74	70.29	65.17
Rural	34.02	40.00	5.86	6.02	60.23	57.41

Note. From "Computer and Internet Access in the United States," by U.S. Census Bureau, 2011, *Current Population Survey*

Table 4. Type of Internet Technology in the Home for Oklahoma and U.S., 2011

	DSL		Cable Modem		Fiber Optic		Mobile Broadband		Satellite	
	U.S.	Oklahoma	U.S.	Oklahoma	U.S.	Oklahoma	U.S.	Oklahoma	U.S.	Oklahoma
Location	%	%	%	%	%	%	%	%	%	%
All Areas	34.03	32.43	50.62	50.87	6.29	2.18	11.41	13.74	2.86	6.99
Urban	31.67	27.34	53.93	62.06	6.91	1.37	11.25	13.94	1.67	2.73
Rural	44.95	44.9	35.25	23.45	3.39	4.14	12.17	13.25	8.38	17.44

Note. From "Computer and Internet Access in the United States," by U.S. Census Bureau, 2011, *Current Population Survey*

When considering residential location, Oklahomans demonstrate the same basic divide as the nation in regard to the type of Internet technology used in the home. Specifically, DSL was used in the home by most rural residents (44.9%) with cable modem being the dominant technology used in urban areas (62.06%) (see Table 4 above). Oklahoma households used satellite services more frequently than their U.S. counterparts, with 6.99% of all Oklahoma households identifying this as the main technology used with the largest proportion of satellite users in rural areas of the state (17.44%). Overall slightly more than 2% of Oklahomans have access to fiber optic technology with 4.14% of rural respondents and 1.37% of urban respondents reporting use of this technology in the home. Interestingly, more households in rural Oklahoma reported access through fiber optics than those in urban Oklahoma and U.S. rural households. However, urban Oklahoma households report access through fiber optic connections at a much lower rate than urban U.S. households in general and the U.S. as a whole. Given the U.S. global speed ranking of 11th, it is not surprising to find that the use of fiber technology is limited in the U.S. overall.

The issue of broadband speed is crucial, as it dictates to a large extent what is possible in terms of services received, business/financial transactions, communications and new innovation with a given broadband connection. End-user broadband infrastructure in the U.S. is a mix of technologies varying widely in speeds. The most common wireline technologies are Cable and Digital Subscriber Line (DSL) which explains the reliance of U.S. and Oklahoma consumers on these forms of technology (see Table 4 above). According to a worldwide survey conducted by the Organization for Economic Co-operation and Development (OECD, 2012), cable modem services tend to offer faster average advertised speeds when compared to most other commercially offered Internet technologies. However, it is not the fastest transmission standard; that distinction lies with fiber optics. Fiber speeds outpace both DSL and cable, offering more than five-times the average advertised speed of DSL and over twice that of Cable (see Table 5 below).

Table 5. Average Advertised Speed by Technology Worldwide

	DSL		Cable Modem		Fiber	
Speed in Mbps	Download	Upload	Download	Upload	Download	Upload
Average Advertised Speed	16.5	2.1	44.1	3.6	89	12.8

Note: From "OECD Communications Outlook," by Organization for Economic Co-operation and Development September, 2012

The emphasis on Internet speed has emerged largely within the last decade. When internet access first debuted in the 1960's (The Internet Society, 2012), access to the Internet was a novelty. Dial-up connections remained the norm for many years, and access was limited to research and government institutions. Today, the Internet is woven into the fabric of human activity for the majority of, if-not-all, societies. Key daily operating procedures of individuals, governments, organizations and businesses have become reliant on the connectivity and services made possible through the Internet. As dependence on the Internet grows, so does the volume of users and the demand for high-speed broadband connections. According to the 2013 Pew Home Broadband Report, 37% of all adults in the United States used the Internet at home; 34% used a dial-up connection while only 3% used broadband in 2000. In 2004, the number of adults online had climbed to 54%. Dial-up still dominated at 30%, compared to 24% using broadband. By 2010, Pew found that 69% of U.S. adults were online, and dial-up usage had plummeted to 5% (see Figure 1 below). Consumer and organization's growing need for speed, coupled with continued technological innovations, have driven the shift to faster broadband connections. The transition of the Internet from novelty to foundational service has solidified the requirement of more advanced connections.

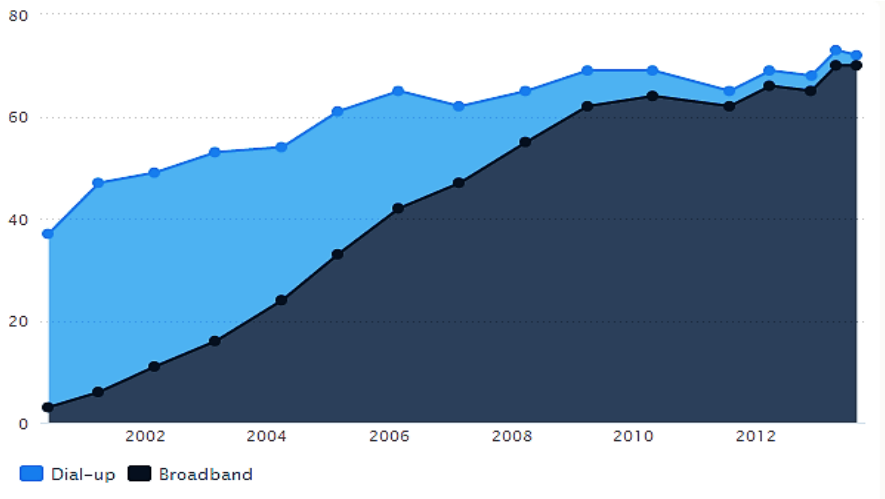


Figure 1. **Trends in usage of dial-up and broadband connection technology by adults in the U.S**

Note. From "Trends in Usage of Dial-up and Broadband Connection Technology by Adults in the U.S., 2000-2014.," by Pew Research Group, 2013, *PEW Internet Project Home Broadband Report P. 2.* Reprinted with Permission

The most valuable and innovative Internet based applications require speeds beyond the minimum established (FCC, 2011). In Table 6 below, typical Internet based software applications are listed by connection speed generally required to operate the application successfully (Washington State Broadband Office, 2010). When considering the information provided, the inadequacy of Oklahoma's 2010 average speed of 2.9 Mbps becomes clear. At an average download speed of 2.9Mbps, Oklahomans are able to engage in basic telecommuting such as remote desktop access as well as the streaming of standard definition videos, web browsing, accessing email and basic Voice over Internet Protocol (VoIP) applications. Applications not supported by slower speeds include video conferencing, higher definition video, file sharing, cloud-based services, telemedicine and distance education.

Table 6. Down and Upload Speeds Associated with Connection Technology and Software Applications

Download Speed	Upload Speed	Applicable Connection Technology	Typical Applications
768 kbps to 1.5 Mbps	256 kbps to 896 kbps	Satellite Cellular Fixed Wireless DSL Cable Modem Fiber Optics	Basic Email Voice Over Internet Protocol (VOIP) Web Browsing You Tube Video
1.5 Mbps to 3 Mbps	356 kbps to 1 Mbps	Satellite Cellular Fixed Wireless DSL Cable Modem Fiber Optics	Remote Surveillance Telecommuting Streaming Music Standard Definition Video
3 Mbps to 6 Mbps	356 kbps to 1 Mbps	DSL Cable Modem Fiber Optics	Enhanced Definition Digital Video File sharing (small/medium)
6 Mpbs to 10 Mbps	768 kbps to 2 Mbps	DSL Cable Modem Fiber Optics	Video On-Demand Remote Diagnosis (basic) Gaming
10 Mpbs to 25 Mbps	2 Mbps to 5Mbps	DSL Cable Modem Fiber Optics	Telemedicine Remote Education
25 Mpbs - 100 Mpbs	5 Mpbs to < 100 Mbps	Cable Modem Fiber Optics	HD Surveillance Smart/Intelligent Bldg. Control Educational Services
> 1 Gbps	≥ 1 Gbps	Fiber Optics	Multiple Educational Services Research Applications Remote Supercomputing

Note. "Down and Upload Speeds Associated with Connection Technology and Software Applications," by Program (2010), p. 45. Reprinted with permission.

However, many Internet-based software applications cannot be used simultaneously without affecting the quality of service or slowing to an unusable speed. Generally, homes or businesses using Wi-Fi based technology to share connections among multiple users are likely to experience congestion, which can result in the degradation of service quality. An example of the increased speed requirements to successfully run multiple applications with multiple users on the same connection is provided in Table 7 below (Washington State Broadband Office, 2010).

Table 7. General Download Speed Requirements for Internet Connection Technology by Number of Users and Type of Use

Users & Devices (Simultaneous use by User(s) and/or Devices (i.e. desktop, laptop, table or game console)	**Light Use** (Basic functions Only)	**Moderate Use** (Basic functions plus ***one*** high-demand application.)	**High Use** (Basic functions plus ***multiple*** high-demand applications running.)
1 user on 1 device	1 to 2 Mbps*	1 to 2 Mbps*	6 to 15 Mbps
2 users or devices	1 to 2 Mbps*	1 to 2 Mbps*	6 to 15+ Mbps
3 users or devices	1 to 2 Mbps*	1 to 15 Mbps	15+ Mbps
4 users or devices	1 to 15 Mbps	6 to 15 Mbps	15+ Mbps

Source: Modified from the FCC, Household Broadband Guide, 2013, http://www.fcc.gov/guides/household-broadband-guide

In addition to speed, the issue of capacity is growing in importance. The Cisco Visual Networking Index Forecast predicts that demand from Internet traffic is expected to reach 1.6 zettabytes (~1.6 billion gigabytes) worldwide by 2018 (Cisco, 2014). To put this rate of growth into perspective, consider that worldwide Internet traffic from 1984-2013 totaled 1.3 zettabytes. Current research suggests that fiber has virtually limitless capacity and would meet broadband needs for the foreseeable future and beyond (Ross & Zager, 2013). Figure 2 below provides a graphic illustration of the bandwidth capacity for fiber compared to tradition landline telephone, T1 lines, wireless, DSL, and Cable. However, as discussed previously the proliferation of fiber for use by most consumers is extremely limited in the U.S. overall, and more specifically in Oklahoma (CPS, 2011). To meet speed and capacity demands both today and in the future, it is critical that more infrastructure be fiber optic based (Saleh & Simmons, 2011). In response to this growing problem, the key strategy of the OBI has been the Oklahoma Community Anchor Network (OCAN), which increased the states middle mile broadband infrastructure.

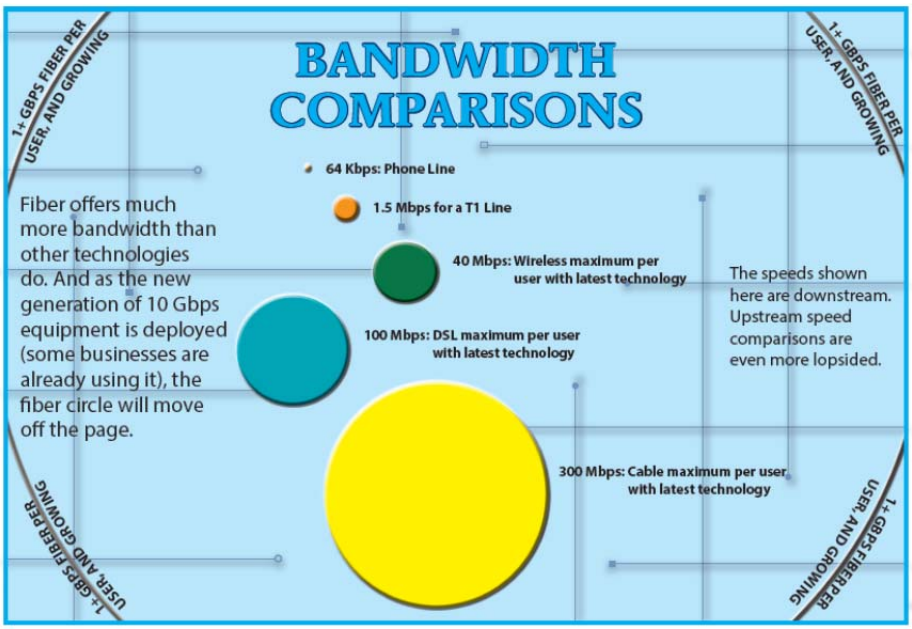


***Figure* 2. Bandwidth comparisons by technology**

Source: Reprinted with permission from "What Fiber Broadband Can Do for Your Community," by The Fiber to the Home Council, 2013, August. BroadbandCommunities Magazine, Fall 2013: p. 5.

Adoption

Internet infrastructure is not the only issue Oklahoma must address in order to gain a competitive edge in the era of innovation and technology. It is imperative that Oklahomans change the way they relate to the Internet. In 2011, 35% of Oklahomans reported that they did not use the Internet at all, with a larger percentage of rural Oklahomans (40%) reporting nonuse than those living in urban areas (32.8%). The percentage of rural nonusers in Oklahoma was not only greater than that of urban Oklahomans but also greater than the average for rural U.S. residents as a whole.

Further, estimates obtained from three years of CPS surveys indicated that between 2007 and 2010, fewer Oklahomans reported having any form of Internet access in their homes when compared to U.S. residents in general. The state ranked 47th out of 50 states and the District of Columbia in 2007 with only 57.8% of Oklahomans reporting access to the Internet in their homes (see Figure 3 below). Oklahoma's Internet access rates have steadily increased reaching 71.4% of Oklahomans with household Internet access by 2010, and a corresponding national rank of 42nd [ii].

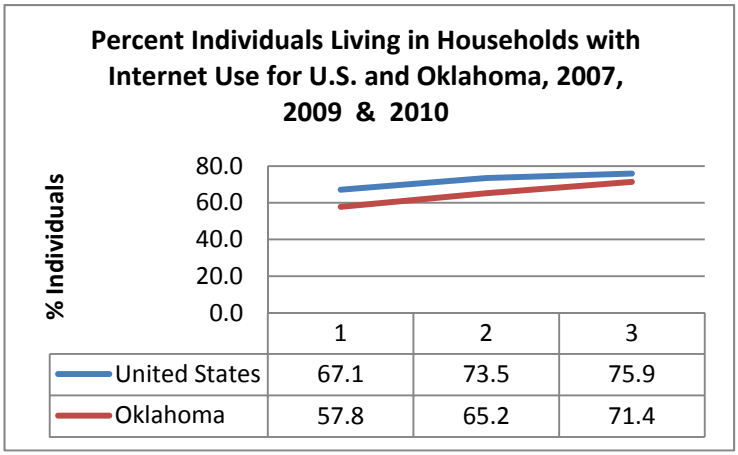


***Figure* 3. Percent of individuals living in households with Internet use for U.S. and Oklahoma, 2007, 2009 & 2010**

Note: "*Current Population Survey*," by U.S. Census Bureau, 2007, 2009, & 2010

The primary reason given by Oklahomans for not having high-speed Internet service *at home* was that they did not need it (46.11%). Respondents further reported that service was too expensive (25.80%), they used it elsewhere (6.13%), service was not available (5.22%), lack of adequate computer equipment (5.10%), and privacy or security concerns (.40%). A larger proportion of rural nonusers indicated that they used the Internet elsewhere (6.93%) and that service was not available (11.05%) than their urban counterparts. Fewer rural Oklahoma residents indicated their reason for not having Internet service at home was because they did not need it (40.95%) than their urban counterparts (50.11%) (see Table 8 below). This may in part be due to the greater density of private establishments in urban areas that provide wireless hotspots free of charge to their customers.

Table 8. Main Reasons Given by Oklahomans for not Having High-speed Internet Access At Home, 2011[iii]

	Don't Need (%)	Too Expensive (%)	Use Elsewhere (%)	Service Not Available (%)	No Computer/ Inadequate (%)	Privacy/ Security Concerns (%)	Other Reason (%)
All Areas	46.11	25.80	6.13	5.22	5.10	0.40	11.23
Urban	50.11	26.06	5.50	0.69	5.80	0.72	11.12
Rural	40.95	25.47	6.93	11.05	4.21	0.0	11.38

Although the annual increase of Internet availability in Oklahoma households is a good sign, the percentage of Oklahomans who report not using the Internet in any capacity was still high and the proportion of households with access to high-speed Internet remained precariously

low. When considering the uses for broadband, entertainment is frequently at the forefront of people's minds. Video streaming, social networking, and online gaming dominate the conversation. These are indeed broadband reliant, are used by many, and have been a part of the push for better broadband. Nevertheless, they are poor examples of the true utility and necessity of broadband in the 21st century. The Internet is the medium of the future, and broadband access has the potential to improve the quality of life for all Oklahomans through enhanced communication, expanded education, better information access, improved public safety, sustainable economic development, more effective healthcare, better utilities, and a more responsive government.

Overall current research indicates that 1) Oklahomans need more access to high-speed Internet technologies that provide greater speed and capacity, 2) Oklahomans need to become more versed in the use and the utility of the Internet for improving the quality of their daily lives, and 3) the cost of high-speed Internet services in Oklahoma is an issue for a significant portion of the population regardless of residence. The Oklahoma Broadband Initiative was born from the desire of Oklahoma leaders in government, education, health, public safety, commerce and telecommunications to address these issues and others. This report provides an overview of the state's broadband Internet capabilities, unmet need, and service issues based on information provided by thousands of Oklahomans from across the state as well as the work of the OBI over the past four years.

Strategies

A partnership among governments, industries, and academics led by the Office of Secretary of State was convened to determine the state's strategy and desired outcome for the broadband project. With financial support from a five year NTIA mapping, planning and infrastructure grant[iv] totaling $77,813,453.00, a three pronged strategy was devised to assess and improve the accessibility of broadband Internet services throughout Oklahoma and included the (1) development of the Oklahoma broadband map and a web-based interactive map gallery that provides information on service and technology availability, population demographics and vendor coverage at the census block level for the State of Oklahoma, (2) improved access of rural Oklahomans to high-speed Internet services by enhancing the state's middle mile infrastructure (OCAN), and (3) increased rural adoption of broadband Internet services through outreach. The State of Oklahoma, through a competitive bid process, selected the Sanborn Map Company (Sanborn) to collect the necessary vendor data, prepare biannual submissions to the NTIA and build a publicly accessible interactive web-based map gallery. Additionally, the state tasked the University of Oklahoma, Center for Spatial Analysis (OUCSA) to independently verify Sanborn's findings, validate mapping products and conduct outreach to rural Oklahomans regarding the importance of broadband Internet services to their communities, businesses, families and themselves as individuals.

Building the State Map

In this phase of the initiative, the main goal was to collect broadband data (information about where broadband is available and what kind of broadband is available, e.g. speed, type of technology, etc. as well as infrastructure location from individual providers), process it to a consistent central data repository and data model, validate the data against multiple sources of information and integrate it into a statewide delivery system. The federal initiative also required each state to provide public access to non-confidential data through an interactive mapping site. Finally, this initiative also required the collection and processing of data related to Community Anchor Institutions (CAIs) (i.e., schools, colleges, hospitals, and governmental facilities) and included the location of the entity as well as information about broadband subscription at these institutions.

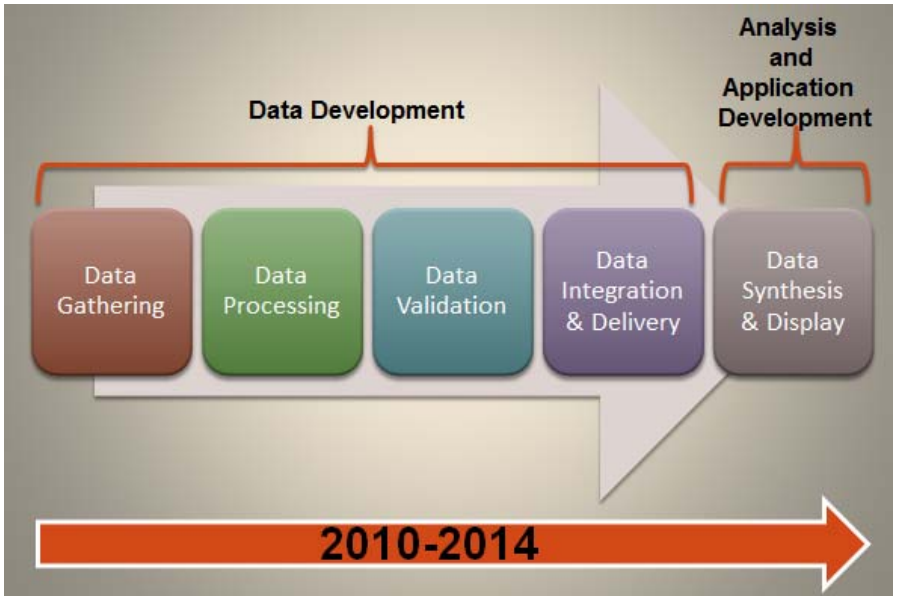
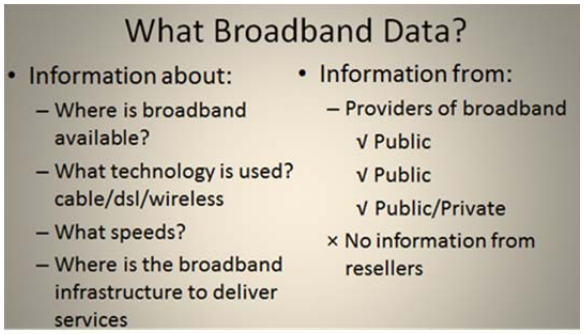


Figure 4. Sanborn data processing procedure

The NTIA defines broadband as "available to an end user at an address if a broadband service provider does, or could, within a typical service interval (seven to ten business days) without an extraordinary commitment of resources, provision two-way data transmission to and from the Internet with advertised speeds of at least 768 kilobits per second (kbps) downstream and at least 200 kbps upstream to the end user at the address" (NTIA Notice of Fund Availability, 2009). Previously envisioned as a map showing availability at each individual address location, this requirement was later relaxed to show broadband availability by census blocks and street segments for wireline service. Census blocks were used as the smallest geographical unit to represent broadband availability for blocks less than two square



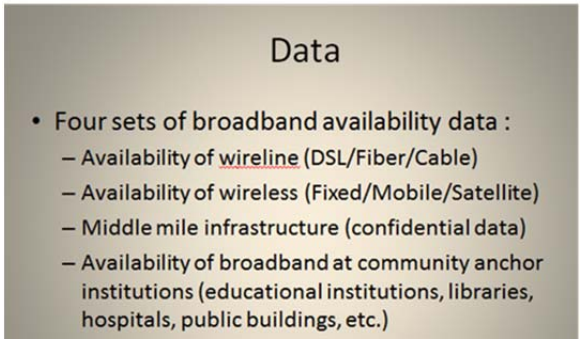


Figure 5. Provider data collected by Sanborn

miles and street segments were used for blocks greater than two square miles. The caveat with this approach is that if one house is served on a block or a street segment, the whole block/street segment is considered served.

Various types of data were collected and updated twice a year (current as of June 30 and December 31st of each year) for five years (2010 - 2014). After each collection phase, data was used to update Oklahoma's online interactive broadband map (http://broadbandmapping.ok.gov/OKmap.html), and provided to the NTIA to be included in the National Broadband Map (www.broadbandmap.gov).

Sanborn contacted broadband service providers identified from multiple sources such as FCC 477, Wireless Internet Service Providers Association (WISPA), Rural Utilities Service (RUS) website, Cable Association lists, and through other sources such as web research, planning meetings, and state outreach. Data on broadband availability and infrastructure was collected by Sanborn from providers that met the NTIA's definition of broadband (which excluded information from broadband service resellers). At the beginning of the program, many providers were uncertain about whether or not to participate and Sanborn explained the benefits of participation to convince them to become a part of the program. In order to keep data confidential, non-disclosure agreements (NDA) were signed with providers if requested. Sanborn also developed an application to track information on all interactions, contacts, and data provided by providers so that a history of discussions with any provider could be generated if needed. In addition, Sanborn created a web-based Provider Portal which allowed data providers to provide information online such as service area, speeds, and information about infrastructure. This Provider Portal was also used to show providers their processed data so that they could make sure no mistakes were made while processing. The above steps were critical in achieving the high rate of participation from broadband service providers in Oklahoma which included both national providers as well as small, rural and/or local providers.

The following table represents the trajectory of the level of participation from broadband providers in this program from Submission 2 (S2) to Submission 9 (S9). The final submission was in progress at the time of this writing.

Table 9. Trajectory of Provider Participation for Oklahoma (Submissions 1 – 9)

		Spring 2010 (S1)	Fall 2010 (S2)	Spring 2011 (S3)	Fall 2011 (S4)	Spring 2012 (S5)	Fall 2012 (S6)	Spring 2013 (S7)	Fall 2013 (S8)	Spring 2014 (S9)
Provider Status	Total Universe of Possible Providers	118	122	130	134	138	193	199	205	217
	Providers Not Participating	21	21	14	14	11	14	15	14	21
	Shell (a subsidiary of another provider, whose area is represented by another providers data)	19	20	21	21	21	27	29	35	40
	Non-providers		8	11	12	14	26	28	37	36
	Resellers	17	9	8	9	9	12	13	15	19
	Difficulty Contacting		0	4	2	2	24	20	10	7
	Actual Providers	101	105	107	111	113	131	138	143	155
Totals	Actual Providers Participating	80	84	90	97	102	117	123	129	134
	% of Participation	79.2%	80.0%	84.1%	87.4%	90.3%	89.3%	89.1%	90.2%	86.5%

The number of providers has continuously increased with each submission as shown in Figure 6 below. It should be noted, that in many submissions, mergers and acquisitions between providers (a very common occurrence in this industry) may mask the actual increase in the number of participating providers. For example, at the beginning of the project, Nextel and Sprint were two distinct organizations but merged into one entity which resulted in an overall decrease in the number of providers but service availability for both companies is still represented in the data.

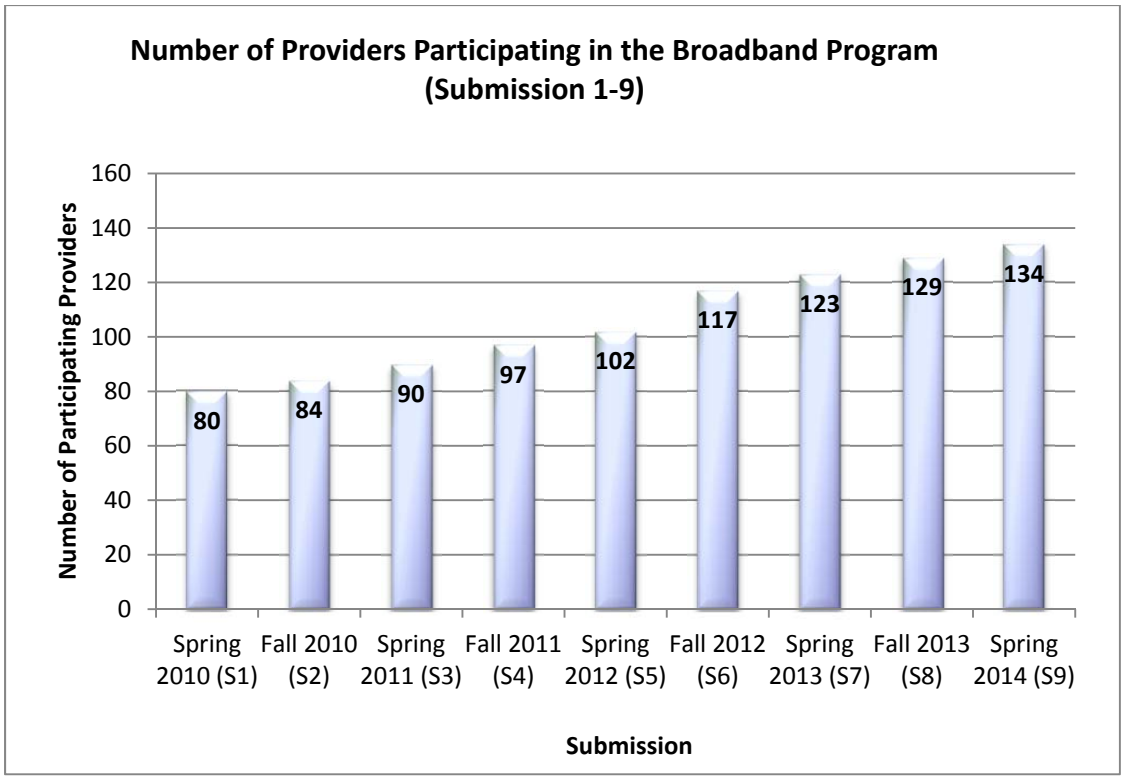


Figure 6. Number of providers participating in Oklahoma broadband program (Submissions 1 - 9)

A list of providers and their participation status in the latest submission is provided in Appendix 3. Even if some companies were identified as non-providers or resellers in previous submissions, Sanborn continued sending out data request letters to these providers in case their status changed in any way. Not all providers supplied updates in every submission. For example, approximately, 43% of providers submitted new or updated data in submission 9 (S9) with the remaining 57% requesting the reuse of data from previous submissions. This is in contrast to 37% of providers submitting new or updated data in S8 and 43% providing updated data in S7.

Sanborn took various steps to validate the data provided by broadband providers including both quality control (QC) and data verification. The following are the steps taken by Sanborn to verify the data before, during and after data processing:

1) QC checks of data were made on three different occasions including at the time data were received, during processing and after processing was completed. Data was checked for the completion of all data fields, the validity of reported speeds and the associated technology and the accuracy of provider details.

2) Spatial checks against publicly and commercially available broadband datasets which included:
   a) DSL Exchange Boundaries: This data was provided to Sanborn by the state and shows the exchange boundary for each DSL wireline provider. When providers gave data that fell outside the exchange boundary, the areas were tagged for further review with the providers. Many providers asked Sanborn to remove all blocks and road segments that were outside the exchange boundaries based on the validation findings. In the last submission, Sanborn flagged about 8,000 blocks and road with these issues.
   b) MediaPrints – this dataset was available from a third-party commercial provider called Budco and shows the franchise boundaries for cable and fiber providers and also overbuild areas (where more than one provider has coverage). Any provider data that were outside the franchise boundary for that provider were tagged for further verification. In the last submission Sanborn flagged about 1,350 blocks and roads based on this check.

3) Speed tests and other data collection for verification - Over the course of the last five years, Sanborn collected speed test data using a locally hosted speed test application from Ookla, a global leader in the broadband testing sector and the implementation of web-based network diagnostic applications. Speed tests were collected through the Oklahoma Broadband Interactive Map developed by Sanborn for this project, and through a web-based Community Anchor Institution (CAI) application where users were provided credentials (username and password) to submit information about broadband availability at schools, colleges, public safety institutions, libraries and other institutions. In addition, the Federal Communications Commission (FCC) deployed a publicly accessible speed test application and made the resulting data available to all states. Sanborn incorporated the FCC speed test data into their validation process in order to verify the speeds reported by broadband providers. While not completely indicative of data accuracy, speed test data were used to get a general understanding of service offerings.

4) Sanborn also incorporated feedback received through the online interactive map and findings from OUCSA's independent validation activities. Sanborn provided non-confidential data to OUCSA after each submission for additional verification and validation. Any conflicts noted in the data by OUCSA based on their independent validation and outreach work were confirmed as valid by Sanborn and then given to providers to validate and correct via the Sanborn Provider Portal. Generally feedback from these sources included issues surrounding speeds and boundaries, missing provider(s), or areas of no service.

5) Verification by providers – Validated data and any feedback were uploaded on the Sanborn Provider Portal for participating providers to review. Providers were asked to review outcomes from both data processing and data validation. Issues pertaining to a particular provider were highlighted and shown in the portal for those providers only. Issues that were

global and could not be assigned to a particular provider were shown to all providers (e.g. there are no providers in this area, or someone tried to get service here and heard x from Provider A, y from Provider B, etc.). Sanborn made additional telephone calls to providers who had issues.

6) Sanborn also did a significant amount of data validation at the state level and used change maps to determine if significant anomalies (such as an unusual expansion or reduction in service, unusual speeds for the type of region, or mismatches in technologies and corresponding speeds) appeared in the data from previous submissions.

Independent Verification and Validation

OUCSA's role in the mapping process was to conduct verification and validation activities independent both technically, procedurally and managerially of the work done by Sanborn. An independent validation increases the likelihood that the resulting products are accurate and meet desired requirements. In contrast to Sanborn's focus on service providers, OUCSA's verification efforts targeted consumer level data collection and processing, as well as data integration and mapping. As stated earlier, Sanborn provided biannual provider reported coverage areas and technology information to OUCSA investigators for review and comparison to survey responses from individual Oklahomans.

The data verification process used by OUCSA focused on improving the consistency and completeness of service availability data including geographic coverage area and metadata documentation provided by service providers for the State of Oklahoma. OUCSA's verification work, analysis and outreach complimented that of Sanborn. The cooperative work between OUCSA and Sanborn increased the project's ability to identify and incorporate data from providers new to the Oklahoma market while removing or modifying data from providers who discontinued services to Oklahoma consumers or changed the nature of their business.

For optimal data integration and mapping, OUCSA ensured that appropriate geographic references for the State of Oklahoma (including coordinate system, datum, and units) were used and essential data elements were in compliance with requirements and standards set forth by the NTIA and the Oklahoma Geographic Information Council (OGIC). Specifically, interactive web based maps available through the project's official website (http://www.ok.gov/broadband/) adopted a Web Mercator projection while outreach and educational maps utilized the Digital Atlas of Oklahoma spatial reference specifications.

By cross-referencing georeferenced consumer data with data reported by service providers to Sanborn, OUCSA independently validated the number of ISP's providing service to state residents, supported technologies, and actual Internet access speeds at three spatial scales: (1) census blocks smaller than two square miles, (2) road segments within census blocks greater than two square miles, and (3) individual addresses. The speed of available mobile wireless

technology was validated by triangulating geographic locations surrounding Oklahoma cities and towns where mobile wireless technologies were available and conducting in-field speed tests using the mobile application developed by the FCC and Ookla.

The georeferenced consumer data used for validation was collected by OUCSA using surveys to collect information on broadband Internet availability, Internet use at home and in the workplace, home and work addresses, type of broadband technology, service providers, challenges to adoption or current use, and any issues related to speed and reliability. Traditional mail service, online, telephone, and face-to-face survey methodologies were employed. Respondents were also encouraged to go online and complete an online speed test using the application hosted on the official Oklahoma Broadband Initiative website. In addition to respondent speed tests, survey staff conducted in-field wireless speed tests throughout the state.

Individuals were selected for participation in the mail-out survey in two ways: (1) a stratified statewide random sample of Oklahoma voter registrations with oversampling in rural counties, and (2) targeted mailings to individuals residing in geographic locations identified as having limited data regarding service availability or as areas in question through comparisons of Sanborn and OUCSA data. Mailing addresses for targeted surveying through the postal service were obtained from Oklahoma voter registration databases. Areas were identified as questionable when service provider data indicated broadband services were available in an area and independent consumer surveys indicated that services were not available (i.e. false positive), or provider data indicated that broadband services were not available in an area and consumer surveys indicated that services were available (i.e. false negative).

Telephone surveys were conducted with identified community anchor institutions (CAIs) which included libraries, schools (K through 12), universities/colleges, healthcare providers, public safety agencies, and other community support organizations. Face-to-face interviews with business owners and employees of publicly accessible organizations were conducted in rural areas where little or no validation information was available or service provider data from Sanborn indicated the area was under or unserved. OUCSA also used face-to-face interviews at targeted outreach opportunities. While in the field conducting targeted face-to-face surveys, speed tests of mobile wireless technologies were tested across one or more of the four largest mobile wireless carriers available in the State of Oklahoma (i.e. AT&T, Verizon, Sprint, and T-Mobile). Testing locations were georeferenced through the use of handheld Garmin GPS 72H devices.

The same questionnaire used for face-to-face and mail-out surveys was deployed online with a link provided to the project website so respondents could test their connection speed. Respondents were recruited for participation in the online survey through online social media posts on Facebook, Twitter, WordPress and Reddit, and established email networks for higher

education facilities, Councils of Government (COGs), Geotech groups, state government, agricultural extensions centers, and the OKGIS listserv. Completed surveys and speed test results were geocoded to latitude and longitude points using the physical addresses provided by the respondent or obtained during field tests. In order to validate the availability of broadband service, geocoded points from surveys and speed test were overlaid with vendor data.

Individual addresses were validated with respect to the reported technologies available and providers in the area. In reviewing technologies, emphasis was placed on identifying false positive and negative locations for technology. The determination of mobile wireless broadband availability was based on actual speed tests conducted in the field and categorized according to the definition adopted by OBI. Specifically the initiative determined that underserved locations included locations where one or more providers are available with download speeds greater than 768kpbs, but less than 3 Mbps or only one provider was available with download speeds equal to or greater than 3 Mbps. Unserved locations were defined as having no providers serving the area or one or more providers in the area, but all offering download speeds less than 768kbps. Individual surveys were also used to verify the number of ISP's reported for an area. An area was identified as a false positive if survey responses indicated one or no ISP's were available to provide services for a specific address, but information provided by vendors indicated two or more vendors served the area.

Data were validated to the census block and road segments buffered by five feet to approximate coverage areas. Blocks and road segments associated with conflicted data were identified as potentially problematic blocks and road segments. Conflicted areas are those where false positives or negatives were found between individual consumer reports and vendor reports. Confidence was evaluated by the ratio of conflicted points to the total number of collected points within the census block or road segment. Conflicted areas were reported to Sanborn who conducted in-depth follow-ups with vendors to address the conflict.

Infrastructure Expansion

Under the USF/ICC Transformation Order, the FCC is responsible for ensuring the universal availability of networks capable of providing broadband and voice services to community anchor institutions including "schools, libraries, hospitals and other medical providers, public safety entities, institutions of higher education, and community support organizations that facilitate greater use of broadband by vulnerable populations, including low-income, the unemployed, and the aged" (Wireline Competition Bureau, June 1, 2012, Background section, para 1). Oklahoma was awarded funds for the Oklahoma Community Anchor Network (OCAN) project to expand the state's middle mile network to rural and underserved areas in Oklahoma. This project resulted in the laying of 1,005 additional miles of fiber optic cable, connecting 33 anchor institutions in underserved and unserved areas of the state. The new fiber was strategically placed to take advantage of state highway right of ways

and reach 35 of the Oklahoma's 77 counties which house 89% of the state's population. This key middle mile infrastructure allows private sector entrepreneurs and cooperatives to bring last mile services to under and unserved communities in Oklahoma.

Communities can access the expanded middle-mile network through OneNet, a division of the Oklahoma State Regents for Higher Education (OSRHE) designed to serve local and state governments, tribal organizations, research centers and laboratories, colleges, universities, public and private schools, libraries, hospitals and clinics, military bases and nonprofit organizations. Given OneNet's role as the state's ISP, educational institutions, health care providers, public services and nonprofits will have the opportunity to connect to the network through OneNet. Partnerships between OneNet and telecommunications providers are being developed. Ultimately the middle mile expansion is expected to extend services to commercial and residential users, provide opportunities for small businesses, and expand economic growth in Oklahoma's rural communities.

Adoption, Outreach & Education

Engaging Oklahomans at a grassroots level was necessary for the OBI to collect consumer level information on knowledge and use of broadband Internet services as well as increase awareness of Broadband and its applications. Thus, outreach and education was a foundational aspect of the project. The outreach and education goals adopted by the Oklahoma Broadband Planning Advisory Board were to inform, change attitudes, and drive action around four key messages including:

1) Encourage public acceptance of Broadband as a required utility for individuals and communities to successfully conduct day to day operations and to achieve healthy and sustainable growth,
2) Increase public literacy on the benefits and uses of broadband, key strategies for staying safe online, and group-specific benefits,
3) Educate communities and individuals about the new fiber route (OCAN) in Oklahoma and its timeline for completion, and
4) Increase community awareness of successful strategies for building critical last mile infrastructure including the development of Smart Communities and regional and tribal partnerships.

The initial step was to develop a Broadband Planning Advisory Board that included representatives from stakeholder groups who could provide direction and access into identified target groups. This board collaborated with OUCSA, Sanborn and OCAN staff to identify key groups and organizations, devise a dynamic and multimedia approach with a clear and consistent image for OBI as an organization, and identify conferences and key events for OUCSA staff to attend. The Broadband Advisory Board and statewide leaders identified the following groups and

organizations as targets for OBI's work: private enterprises, education, public safety, healthcare, municipalities, tribal governments, existing and potential private consumers, under/unserved Oklahomans, low-income Oklahomans, senior citizens, as well as individual Oklahomans of African America, Native American and/or Hispanic/Latino descent.

Prior to mounting the media campaign or beginning any outreach activity, OBI focused on branding through a logo and affiliation with recognizable institutions, including the State of Oklahoma and the University of Oklahoma. At events, materials were displayed alongside branded table coverings and an informational board which charted OCAN progress and presented maps on varying topics such broadband coverage and costs to stimulate questions and discussions with attendees.

The media campaign focused on the four key messages listed above and is best described through the media resources employed. First, the use of traditional media; considering the target population groups, especially unserved and underserved Oklahomans, it was evident that a traditional media and outreach approach was needed. This was supplemented as needed with new media. The primary strategies used to achieve the project's education and awareness goals included a targeted media campaign and extensive outreach efforts including attending presentations, seminars, and workshops, and direct promotion at events in targeted rural areas. Additionally, outreach was conducted during research excursions to rural communities in Oklahoma. OUCSA attempted to obtain information about broadband use and availability from local residents or businesses for all 597 census identified communities and census designated places in Oklahoma. The combination of face-to-face surveying and outreach activities provided a natural venue for discussions about broadband, the distribution of materials, and interaction with community leaders and stakeholders with the hope of increasing opportunities for educating community members about the importance of broadband. For a complete list of all locations visited and events attended, see Appendix 1.

The media campaign entailed the development, acquisition and distribution of brochures and printed educational materials designed to address issues and concerns of particular interest to targeted populations. Materials designed by OUCSA were supplemented with judicious additions from other projects and agencies as well. Specifically, educational and awareness products used in the project include:

- Why Broadband? – A brochure presenting an overview of broadband as a service and highlighting the various ways in which it may affect the life and livelihood of the reader.
- Oklahoma Broadband Initiative – A brochure outlining the nature, mission and plan of action for the OBI.
- What is a Smart Community? – A brochure defining and highlighting key benefits of living in, working in and/or becoming a smart community.

- Become an Oklahoma Silver Surfer – A brochure on ultra-relevant topics to current and potential broadband users over the age of 50.
- Broadband Service at Home – A brochure guiding consumers through the often unfamiliar process of shopping for, and selecting broadband service.
- Get Older Adults Online (GOAL) – A brochure providing a short overview of broadband benefits to aging adults, with a heavy focus on Internet safety.
- Foreign Lottery - Information on avoiding a common Internet scam, the foreign lottery win. Provided by the United States Postal service partnered with AARP.
- Heads Up. Stop. Think. Connect. – A booklet giving guidance and recommendations for school aged children on Internet safety and being a responsible Internet user. Provided by the Federal Trade Commission (FTC).
- Laptop Security Tips – A bookmark with quick tips on securing portable electronics. Provided by the FTC.
- Living Life Online – A magazine-like publication targeting teens with age appropriate information disguised as entertainment. Provided by the FTC.
- Net Cetera, student version– Presented in video and PowerPoint formats, presents guidance and recommendations for school aged children on Internet safety and responsible Internet usage. Translated into Spanish, Chinese and French. Based on materials developed and provided by the FTC
- Net Cetera, adult version – A PowerPoint with information about how to effectively discuss common Internet-related pitfalls with children and bridge the gap between parents and their digitally native children.
- Broadband & Law Enforcement – A brochure detailing what broadband service is and discussing it current and future roles in law enforcement.
- Pens – A durable, useful item. It carries the lasting chance for impressions beyond initial interaction.
- Notepads – A companion to the pens, these offer contact information in addition to branding information.

It was imperative to include new media (including social media), as its inclusion is the hallmark of a complete campaign and was an essential compliment to traditional media efforts. The OBI managed accounts on Facebook, Twitter, and Reddit. A Wordpress blog was also employed to share original publications requiring more formality and space than social media affords. For example, Facebook truncates long posts, and Twitter limits posts to 140 characters by design where as Wordpress allows for traditional publication-style method of sharing information. A Gmail account was also used by all research assistants to contact agencies as needed. New media played a secondary role for OBI, supplementing a robust traditional media campaign with extensive outreach efforts. This was a natural role for new media as it is not an ideal medium to reach many of the previously mentioned target groups. That is, Internet based

messaging is not an effective marketing tool for use with Oklahomans who have little or no access to broadband Internet services or are unfamiliar with the finer points of Internet technology. Therefore, Internet based tools were used to interact with peer agencies in other states, broadband –centric organizations and business, monitor news outlets, and connect with interested academics and professionals. These sites also proved useful for collecting anecdotes from broadband users, online surveys, and to serve as the face of the OBI. This final role is essential given the collaboration of the OBI, CSA, Sandborn, OMES, and other involved agencies. As the project transitions from CSA, this online presence is crucial for maintaining a unified voice even as the management of the information and accounts changes hands.

New media efforts also included two digital Internet safety education programs based on materials from the Federal Trade Commission's (FTC) NetCetera program. These programs came in two varieties, one for young Oklahomans promoting best practices for broadband use and safety and the other for their caregivers, to guide their roles in their child's Internet activities. To extend the program's use to the foreign language classroom and ensure usability by ESL Oklahomans, the program for young Oklahomans was translated by bilingual OUCSA staff members into three additional languages: Spanish, French, and Chinese. Primarily, each program exists in PowerPoint format to be presented with accompanying printed materials. To extend their reach and usability, a YouTube channel has been developed (http://goo.gl/zhGqCJ) to distribute these educational presentations in narrated video format to students, their families, and educators. It is intended that these videos can be used for presentations and classroom education long after grant funds are no longer supporting outreach efforts. Their free online availability demands little in terms of resources, making them ideal for use in computer literacy classes.

Finally, OUCSA developed the Oklahoma Broadband Service and Cost Mapping Application. The mapping application is a web-based Geographic Information System (GIS). It is intended for use by a number of broadband consumers as well as community and city leaders. This includes: residents, businesses, planners and policy makers. The program provides broadband coverage and service cost information for the State of Oklahoma online. The application is a convenient yet powerful tool providing consumers with the necessary objective information to guide a number of activities. Users are able to obtain information about broadband service providers, average service costs, provider technologies and much more. Additionally, users can search by address to obtain information specific to the area of interest. For example, an Oklahoman who is relocating can input their new address and assess broadband information specific to the new home site including average prices, service providers, and technology types. Links are provided to available service provider's websites as well. Instead of visiting multiple sites, some of which may not provide all the needed information, consumers have a one-stop-shop to compare broadband in a multitude of ways. The maps provide the consumer an engaging, interactive and highly informative graphics to guide their experience. Community planners, businesses, developers, and other advanced users are afforded a plethora of potent tools in addition to those available for the consumer. The application allows them to

conduct measurements, queries, and create buffer areas. With this application, community and business developers can search for OCAN hub stations or community services organization based on customized criteria. The broadband provider coverage found in the mapping application was extracted from the June 2013 National Broadband Map (National Telecommunications and Information Administration & Federal Communications Commission, 2013). Service charge information for the providers was collected through exhaustive secondary web-based research and direct phone contacts between 2012 and 2013.

Validation and Analysis of Study Data

In this section, analysis of the data collected by Sanborn and OUCSA will be presented beginning with a discussion of the spatial distribution of data gathered. The data presented throughout this report was not collected using scientific sampling methods, but reflect an effort to obtain a complete canvas for the state in regard to broadband use and availability information. Therefore, unless otherwise stated in relation to a specific analysis, the data should be viewed as descriptive indicators of the current state of broadband in Oklahoma without the any implication of statistical precision.

Geographic Distribution of Community Anchor Institutions and Community Survey Responses

As a part of the independent validation process, field researchers targeted areas in rural Oklahoma where information from Internet service providers and local stakeholders indicated residents were under or unserved. At least one data point was obtained for 591 of the 597 (98.99%) areas identified by the Census (U.S. Census Bureau, 2013a) as a being community, town or city in the state. As a result, a total of 9,691 individual validation points were obtained through the various survey strategies employed by the project, including 4,192 (43%) from community anchor institutions (CAIs) and 5,499 (56%) from local business owners and community residents (see Table 10).

Table 10. Distribution of Data Points from Independent Validation

Methods	Number of Validation Points
Total Validation Points	**9,691**
CAI Points	**4,192 (43%)**
Telephone Obtained CAI Points	3,470
Other-way Obtained CAI Points	722
Community Surveys Obtained Points (Home & Work)	**5,499 (56%)**
Face to Face Obtained Points	3,260
Mail-out/On-line Obtained Points	2,239
Mobile Wireless Speed Test Points	**711**

Telephone surveying was the primary method used to collect data from CAIs. If staff were unable to contact CAIs over the phone, field researchers would follow up with face-to-face interviews when visiting communities. Additional information for broadband availability and use in public schools was provided by the Oklahoma State Department of Education (OSDE) when surveyors were unable to obtain the data directly. Broadband data on two geographic locations was collected per survey -- the respondent's residence and their place of employment. Information from community business owners and residents in rural communities was obtained from face-to-face surveys gathered during field trips to communities and/or booths sponsored at local community events (see Appendix 1). Tests of mobile wireless technologies were taken while surveyors were in targeted communities resulting in 711 tests of up and download speeds.

Validation points were collected in both urban and rural Oklahoma with a focus on areas where little or no information regarding broadband service availability or performance was known. For the purposes of this study, the definition for urban areas as defined by the U.S. Census Bureau (U.S. Census Bureau, 2010b, 2013b) was adopted and includes densely settled core census tracts and/or census blocks that have 2,500 residents or more, along with an adjacent territory containing non-residential urban property as well as territories with low population density which links densely settled outlying territory with the densely settled core. Of the total validation points, 56.6% were obtained from either CAIs or community surveys located in rural Oklahoma, while 43.4% were in urban areas. A majority of validation points were collected from CAIs (54.8%) and community surveys (58.1%) in rural areas followed by 45.2% from urban CAI's and 41.9% from community surveys for urban residents (see Table 11.).

Table 11. Urban and Rural Distribution of Validation Data by Type of Collection Method

	CAI Points		**Community Surveys Obtained Points**		**Mobile Wireless Speed test Points**	
	Urban	Rural	Urban	Rural	Urban	Rural
Number of Validation Points	1897	2298	2307	3192	48	662
Percentage (%)	45.2	54.8	41.9	58.1	6.8	93.2

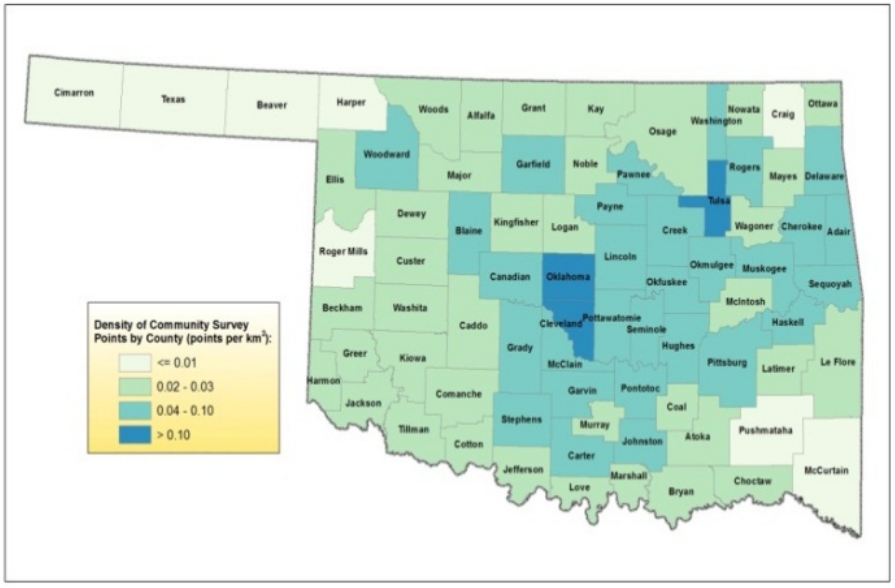


Figure 7. **Density of community survey point data by county, 2011 - 2014**

The geographic distribution of validation points obtained through community surveys represents the spatial distribution of households by county in the state. Oklahoma, Cleveland, and Tulsa counties had the highest density of validation points obtained through community surveys while Cimarron, Beaver, and Pushmataha had the lowest point density (see Figure *7*). The geographic distribution of validation data points from community surveys is significantly and positively correlated with the number of households by county (see Figure 8).

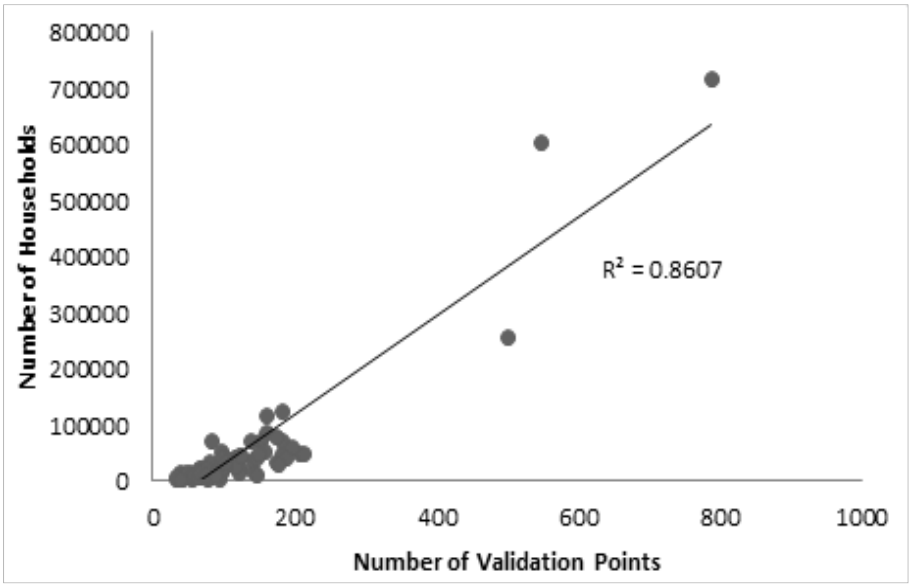


Figure **8. Number of validation points and households by county**

From the original list of 5,038 Oklahoma CAIs compiled by state officials at the beginning of the initiative, 97 were identified as inactive over the course of the project leaving a total of 4,941 active CAIs. The majority of the active CAIs were successfully contacted and provided information about broadband availability and use with most counties achieving a response rate of 85% or greater.

The green points displayed on the map in Figure 9 represent the location of CAIs that did not provide information. Although a larger number of non-responding CAIs were located in eastern Oklahoma than western Oklahoma, the western part of the state has a lower density of active CAIs in general. The counties of Cherokee (45%) and Murray (33%) had the highest percentage of CAIs that did not provide information with rural fire departments representing the largest group of non-responders. Overall the pattern of dispersion for missing CAI data does not suggest a systematic bias in nonresponse.

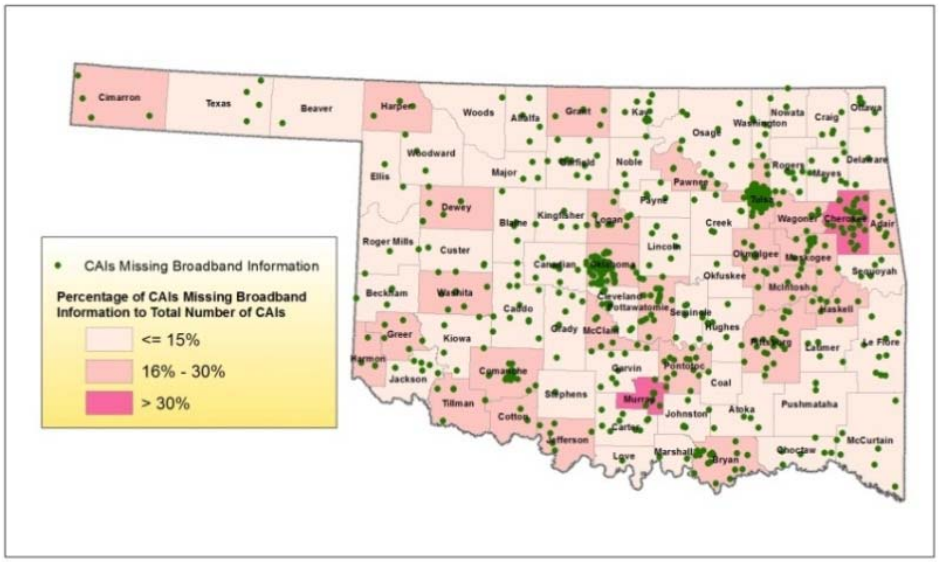


***Figure* 9. Percent of CAIs not providing information on Broadband by county, 2011 - 2014**

Given the need for better information regarding wireless services in rural Oklahoma, over 90% of speed tests for mobile wireless services were collected in rural areas with the remaining tests (6.8%) obtained from urban locations. However, this was an unfunded activity added on to the original project design; therefore, data collection was limited to the mobile service coverage of the providers used by OUCSA research staff with the majority of the resulting speed test data concentrated in rural Western Oklahoma (see Figure 10). Future validation work for mobile wireless services are needed for the state.

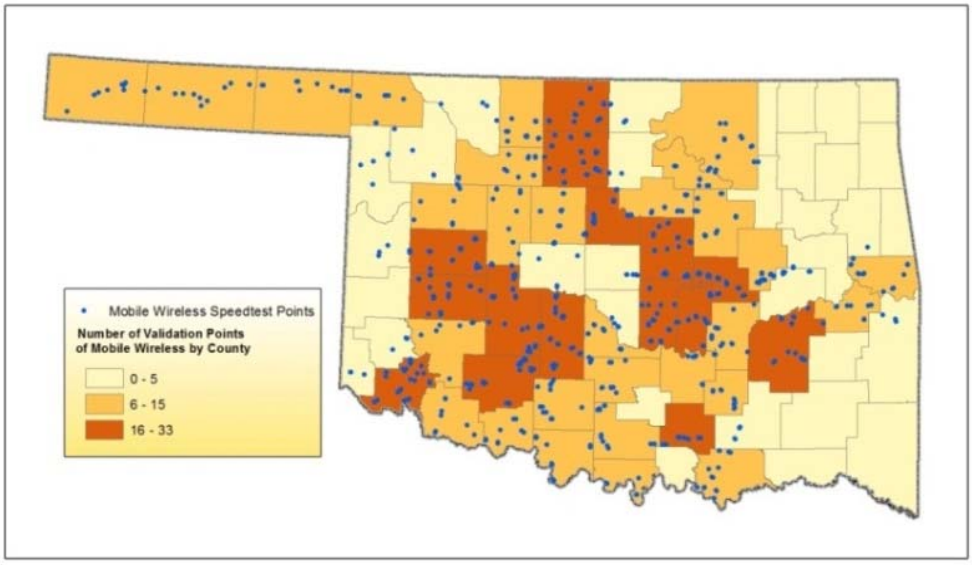


***Figure 10*. Points representing mobile wireless speed tests in Oklahoma, 2011 - 2014**

As shown in Figure 11, locations where researchers were unable to obtain information include Cardin, Faxon, Jefferson, Lambert, Picher, and Tamaha. Two of these locations, Picher and Cardin, are part of a tri-state federal superfund site (Matthews & Wood, 2007; McMullin, 2007), and were declared uninhabitable due to environmental hazards and associated health conditions from lead and zinc mining (Fairchild, 2013). The towns were mandatorily evacuated in 2009 with three people remaining in Cardin and 20 in Picher as of 2010 (Shepherd, 2014; U.S. Census Bureau, 2010a).

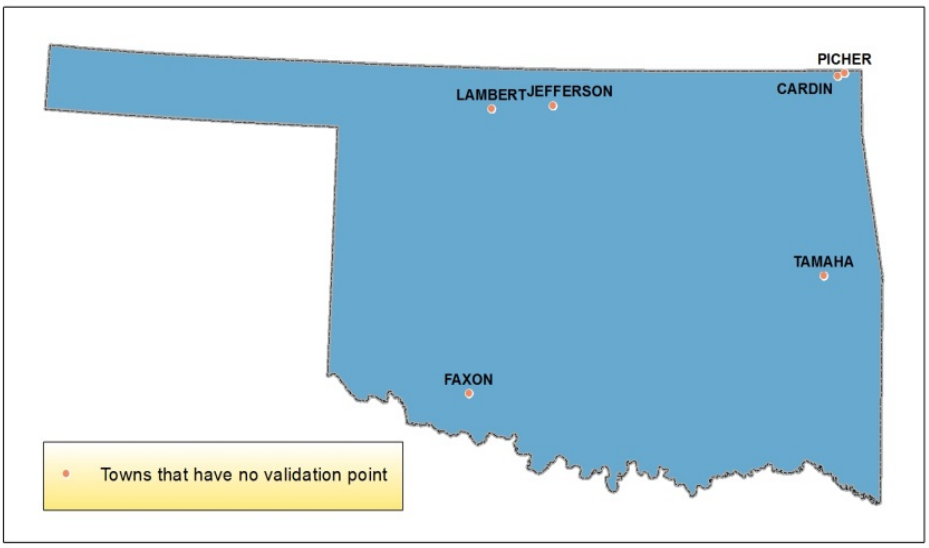


***Figure 11*. Oklahoma cities and towns where independent validation data was not collected**

The communities of Lambert and Jefferson are very sparsely populated with fewer than 20 total residents resulting in both locations being listed by hobbyist on a popular website for U.S. and Canadian ghost towns (www.ghosttown.com). Both areas are predominately agricultural, with total land areas of approximately 0.11 square miles for Lambert and 0.3 square miles for Jefferson. Tamaha and Faxon have slightly larger populations with approximately 176 and 136 inhabitants respectively according to the 2010 U.S. Census. Being located on the banks of Robert S. Kerr Lake on the Arkansas River Navigation System, the economy of Tamaha is primarily based on tourism from vacationers. Faxon is predominantly agricultural, with approximately 0.3 square miles of total land area. Although Jefferson, Faxon and Tamaha were noted as having viable retail commerce in the early twentieth century (Hyder, 2007; Savage, 2007; Wilson, 2007), publically accessible storefront enterprises were not identified during survey trips to these communities.

Validation of Service Provider Data

Analysis of updated service provider data from Sanborn was conducted by OUCSA every six months throughout the project period (December, 2011, June, 2012, December, 2012, June, 2013, December, 2013, and July, 2014). Key issues being monitored were the occurrence of false positive and negative coverage. The data found in Figure 12 and Figure 13, demonstrate the results from the kernel density analysis used to count the number of false positives and false negatives per square kilometer using a probability function of nearby observations to smooth the density surface (deSmith, Goodchild, & Longley, 2013).

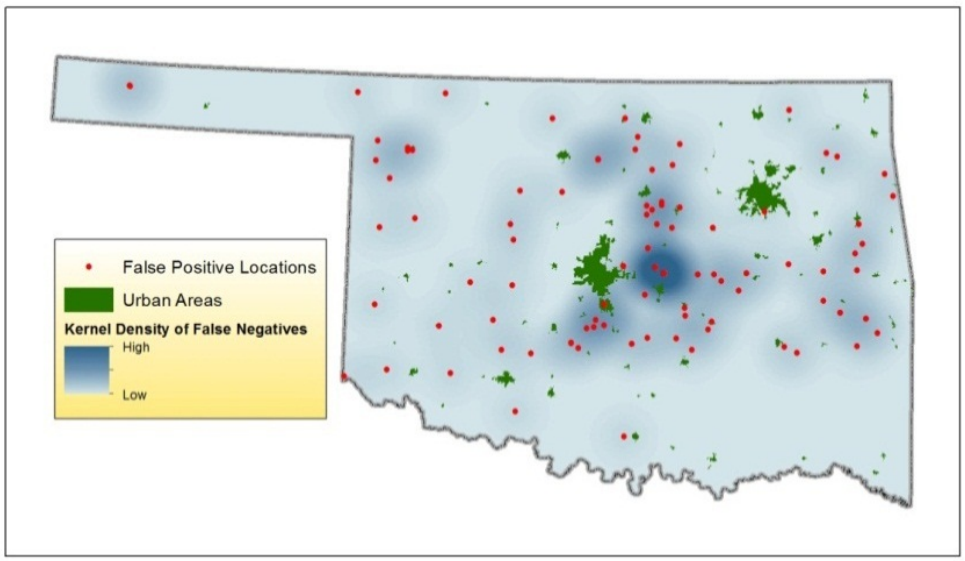


***Figure 12*. False positive coverage locations identified in Oklahoma, 2011 - 2014**

During the project period, 114 locations were identified as false positives, where service provider data indicated that broadband services were available but results from Oklahoma consumer survey responses were to the contrary. The identified false positive locations cover 96 census blocks. As shown in Figure 12 above, false positives were dispersed randomly over the western part of Oklahoma with none found in southeastern Oklahoma. The pattern of validation points suggested that false positives were more likely to occur in suburban areas near the Oklahoma City metropolitan area.

An additional 427 locations were identified as being false negatives, where service provider data suggested that broadband services were not available but reports from community residents were to the contrary (see Figure 13). False negative locations covered 312 census blocks. Results from an analysis of validation points found that false negative locations were more likely to occur in rural areas. The pattern of false negative locations suggested that service providers underreported broadband coverage in the southwestern and eastern parts of Oklahoma.

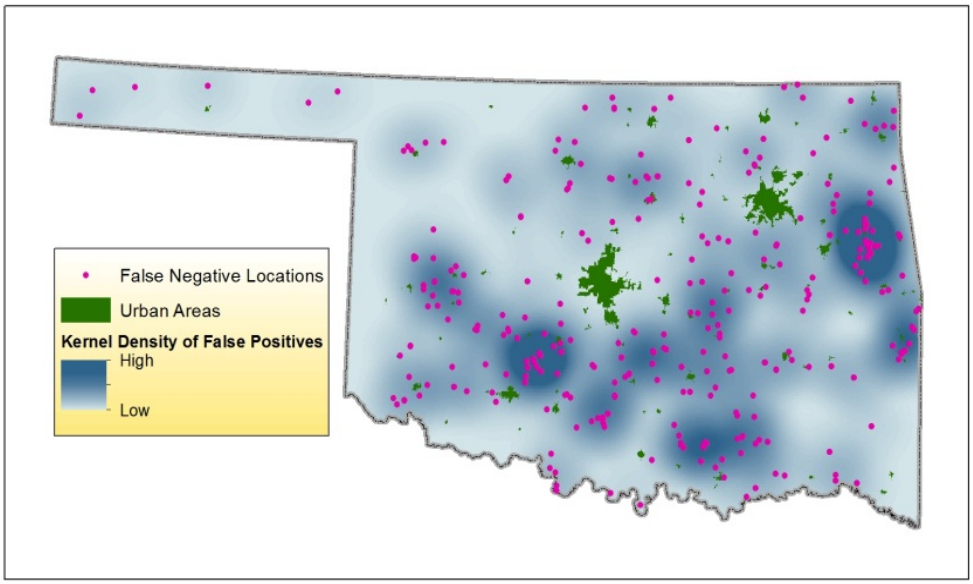


Figure 13. **False negative service locations identified in Oklahoma, 2011 - 2014**

Mobile wireless coverage was validated by in-field speed tests on mobile devices. As shown in Figure 10 (p. 28), speed tests of mobile wireless in this study were more heavily concentrated in western rural Oklahoma and were limited by personal cellular services used by research staff. Results from these speed tests suggest that the coverage of cellular services was potentially overestimated by service providers in rural western Oklahoma. Speed test results identified 549 false positive locations of mobile wireless, where actual download or upload speeds of the mobile Internet services provided were below the minimum speeds established for broadband (i.e. download speed of at least 768 kbps and upload speed of at least 200 kbps) but were shown as available in service provider coverage area maps for mobile wireless. False positive points, represented by red points on the map in Figure 14, appear to be dispersed randomly in the western part of rural Oklahoma.

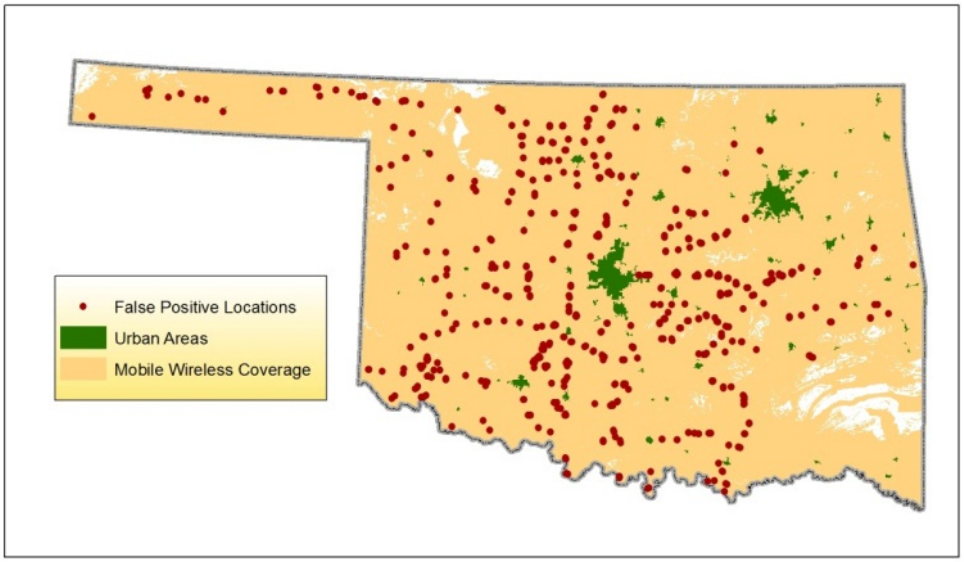


***Figure 14*. False positive locations of mobile wireless coverage identified in Oklahoma, 2011 - 2014**

Spatial Dispersion of Broadband Transmission Technologies in Oklahoma

Currently Oklahomans have access to broadband service through various wireline and wireless technologies including DSL, cable, fiber, fixed wireless and satellite with most of the land area in the state (96.4%) reportedly covered by mobile wireless broadband service. However, mobile wireless services are generally known for providing slower speeds in the range of several hundred kbps (Commission, n.d.); thus, Internet services provided through mobile wireless technologies were not defined as broadband in this study. It should be noted that with the full realization of 4G capability, wireless providers may come to be treated as equals to wireline providers concerning speed and reliability (Commission, 2011). Validation results for broadband coverage in Oklahoma suggest that 32% of the state's land area is covered by various wireline and wireless broadband technologies while 68% of the land area is covered via wireless technologies alone (see Table 12).

Table 12. Wireline and Wireless Broadband Technology by Total Land Area and Number of Households in Oklahoma, 2013

Transmission Technology	Land Areas (km^2)	Percentage of Statewide Land Area	Number of Households	Percentage of Statewide Households
Wireline & Wireless Technologies	58,518.05	32%	1,272,926	87%
Only Wireless Technologies	122,518.73	68%	187,524	13%

Using the assumption that households are equally distributed across census blocks, findings from the mapping project suggest that approximately 87% of households in Oklahoma could have access to broadband via both wireline and wireless technologies, while 13% of households would be limited to service provided through either fixed wireless technologies or satellite. Coverage from wireline broadband technologies was clustered around urban areas. Most urban households (99%) had access to broadband with both wireline and wireless technologies. Most rural households (69%) could only obtain broadband via wireless technologies, while 31% of rural households had access to broadband via both wireline and wireless technologies. As for the geographic distribution of broadband coverage, more land area in the western part of Oklahoma could obtain access to broadband via both wireline and wireless technologies than eastern Oklahoma (see Figure 15).

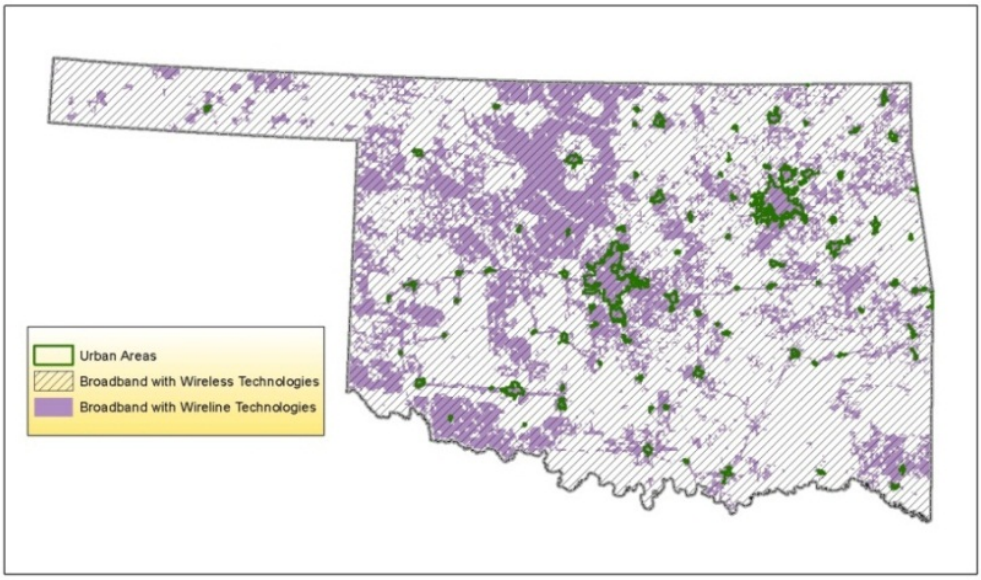


Figure 15. **Spatial dispersion of wireless and wireline broadband technologies in Oklahoma, 2013**

Analysis of the validated coverage data indicates that 80% of Oklahoma households are located in areas where DSL technology is available. However, DSL coverage tends to be concentrated in urban areas resulting in availability to a majority of urban households (92%) compared to 56% of rural households (see Table 13).

Table 13. Broadband Transmission Technology by Total Land Area and Number of Households in Oklahoma, 2013

Transmission Technology		Land Area (km^2)	Percentage of Total Land Area	Number of Households	Percentage of Total Households
DSL	All Area	51,667.55	29%	1,174,200	80%
	Urban Area	2,847.59	83%	903,515	92%
	Rural Area	48,819.97	27%	270,685	56%
Cable	All Area	9,023.95	5%	1,042,070	71%
	Urban Area	3,056.78	89%	935,553	96%
	Rural Area	5,967.17	3%	106,517	22%
Fiber	All Area	7,892.32	4%	101,791	7%
	Urban Area	427.09	12%	70,908	7%
	Rural Area	7,465.23	4%	30,883	6%
Fixed Wireless	All Area	114,396.33	63%	1,223,482	84%
	Urban Area	3,032.22	89%	888,765	91%
	Rural Area	111,364.12	63%	334,717	69%
Satellite	All Area	181,037.34	100%	1,460,450	100%

DSL coverage also tends to be focused in the central and northwestern parts of Oklahoma and sporadically distributed in the southwestern and northeastern parts of the state (see Figure 16). As for the panhandle area and southeastern Oklahoma, broadband services with DSL technology only cover limited areas around major towns.

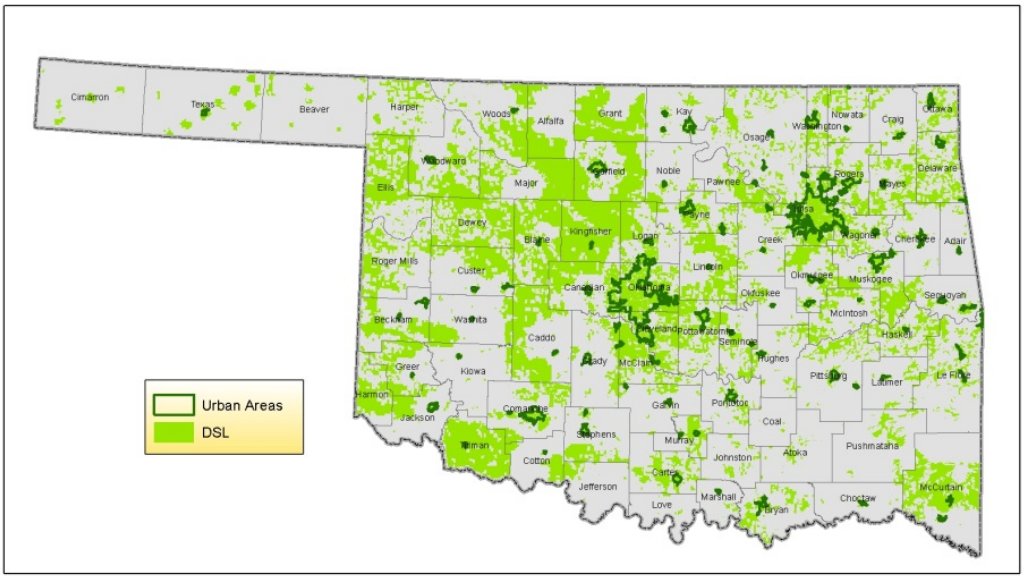


Figure **16. DSL broadband coverage in Oklahoma, 2013**

Cable broadband coverage is also highly clustered in urban areas (see Figure 17). Validated coverage data indicates that approximately 96% of urban households in Oklahoma are likely to have access broadband services via cable technology (see Figure 17.) However, only 22% of rural households fall within the coverage areas for cable broadband services and are more frequently located near urban areas.

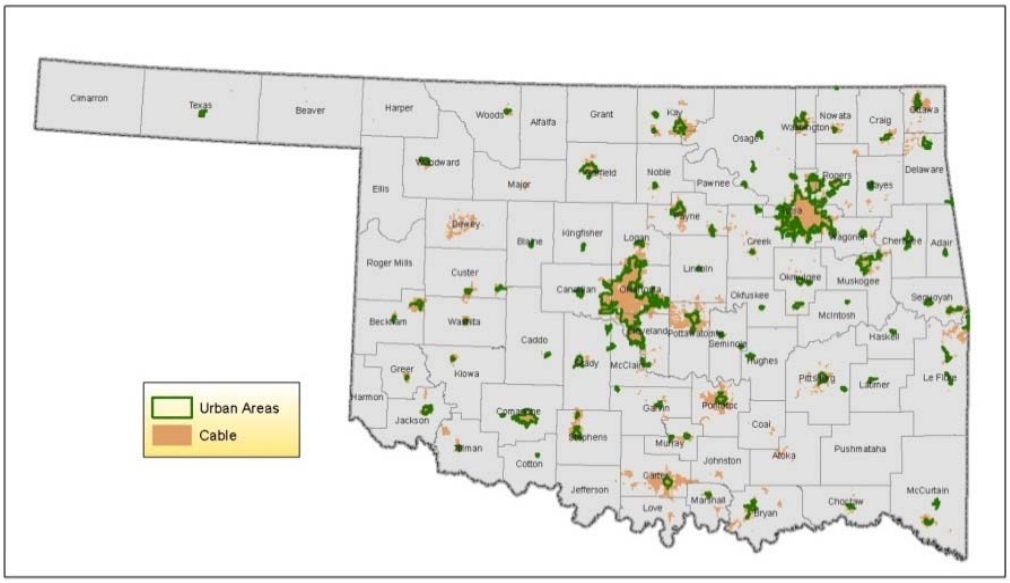


Figure **17. Cable broadband coverage in Oklahoma, 2013**

Prior to the OCAN project, Oklahoma had limited fiber coverage. Validated coverage data suggests that only 4% of the land area in Oklahoma was covered by fiber based broadband service which corresponds to approximately 7% of Oklahoma households. However, the coverage areas for fiber technology do not follow the urban/rural divide seen in the coverage areas of other wireline technologies for the state. Results from the spatial analysis of validated coverage data indicate that 7% of urban households in Oklahoma had access to broadband services through fiber technology compared to 6% of rural households (see 17 above).

Broadband services via fiber technology appear to have improved slightly with increases in coverage areas along the new OCAN fiber route and several rural Oklahoma communities along the Texas and Kansas borders (see Figure 18).

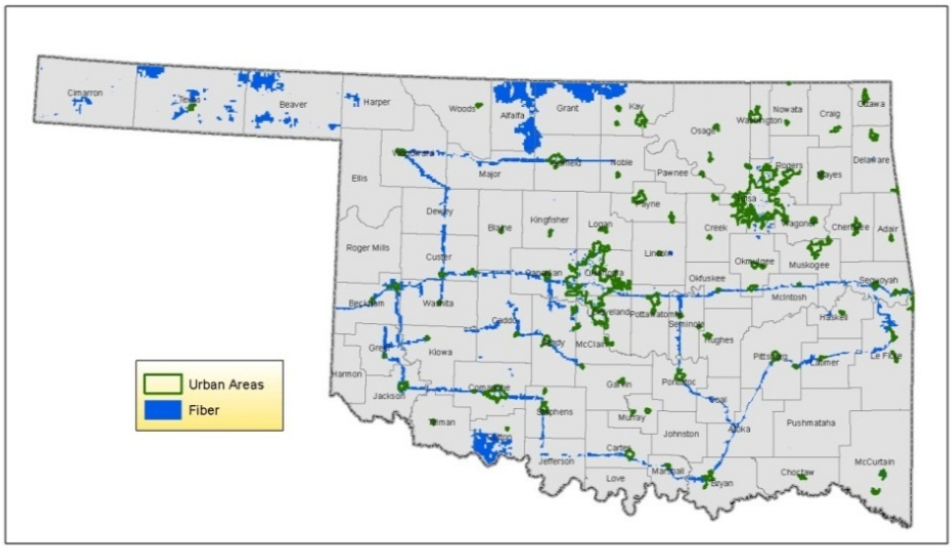


Figure 18. **Fiber broadband coverage in Oklahoma, 2013**

Generally, satellite broadband service is available to all areas in the state with approximately 4% of Oklahoma households reliant on satellite as the only form of available service. Rural households most likely to be limited to satellite technology are located in northern, eastern, and southeastern areas of the state (see Figure 19). However, consumers reported that they did not subscribe to satellite service due to high costs and inconsistent, unreliable service that is often affected by Oklahoma weather conditions. In 2010, only 7% of

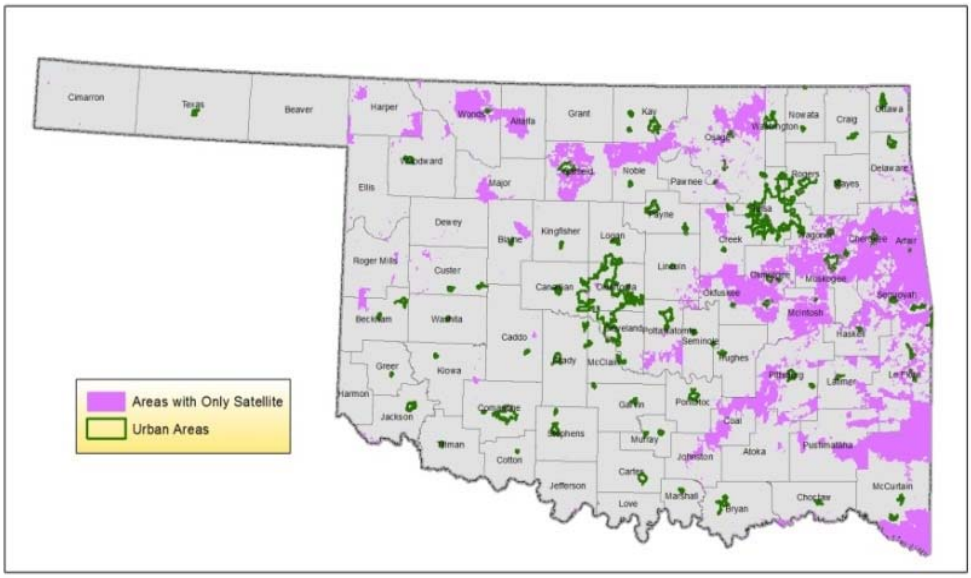


Figure 19. Areas with broadband services only via satellite, 2013

Oklahoma residents reported using these services at home (U.S. Census Bureau, 2011b)

Study results indicate that 84% of Oklahoma households have access to broadband services via fixed wireless technology (see Table 13 , pg. 33) with 84% of urban and 69% of rural households falling in the coverage area. Geographic pockets of the state where fixed wireless broadband services were not available include eastern and northwestern Oklahoma (see Figure 20). For most of these residents access to broadband Internet was limited to satellite technology.

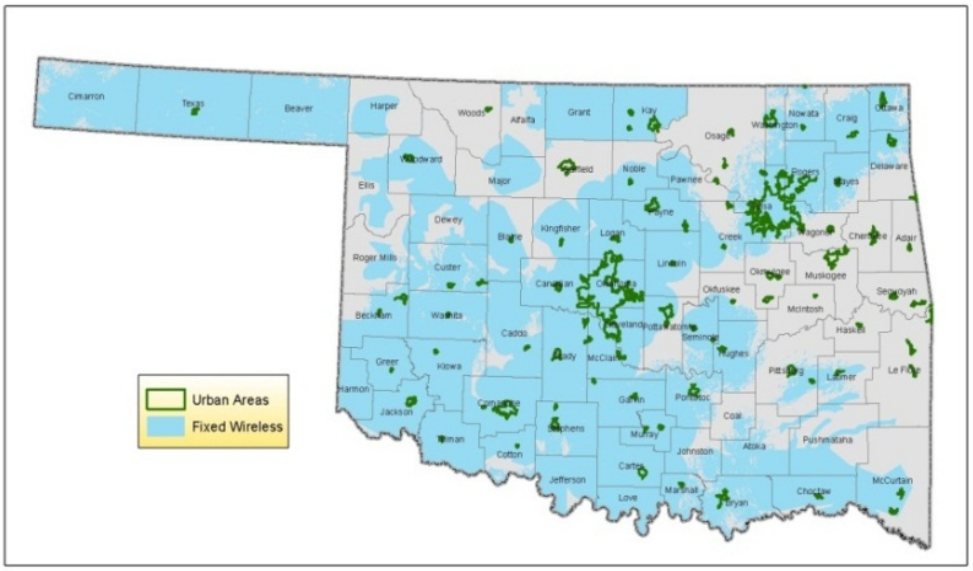


***Figure 20*. Fixed wireless broadband coverage in Oklahoma, 2013**

Annual Changes of Broadband Coverage

Over the five years of the broadband project, several changes in coverage can be seen, some based on new service or real changes in service, and others based on corrections to data or the addition of providers previously not participating. In this report, we discuss changes that occurred within the last year (Dec 31, 2012 to Dec 30, 2013) because these changes are the most relevant. Annual maps from the initial project years may show changes that are more reflective of increased participation in the project by already existing providers for the state (but were not on the map) rather than the presence of new areas of broadband. In comparing data submitted to NTIA on April 1, 2013 (current as of Dec 31, 2012) with that submitted on April 1, 2014 (current as of Dec 31, 2013), there is a significant expansion in fiber coverage (see Figure 21).

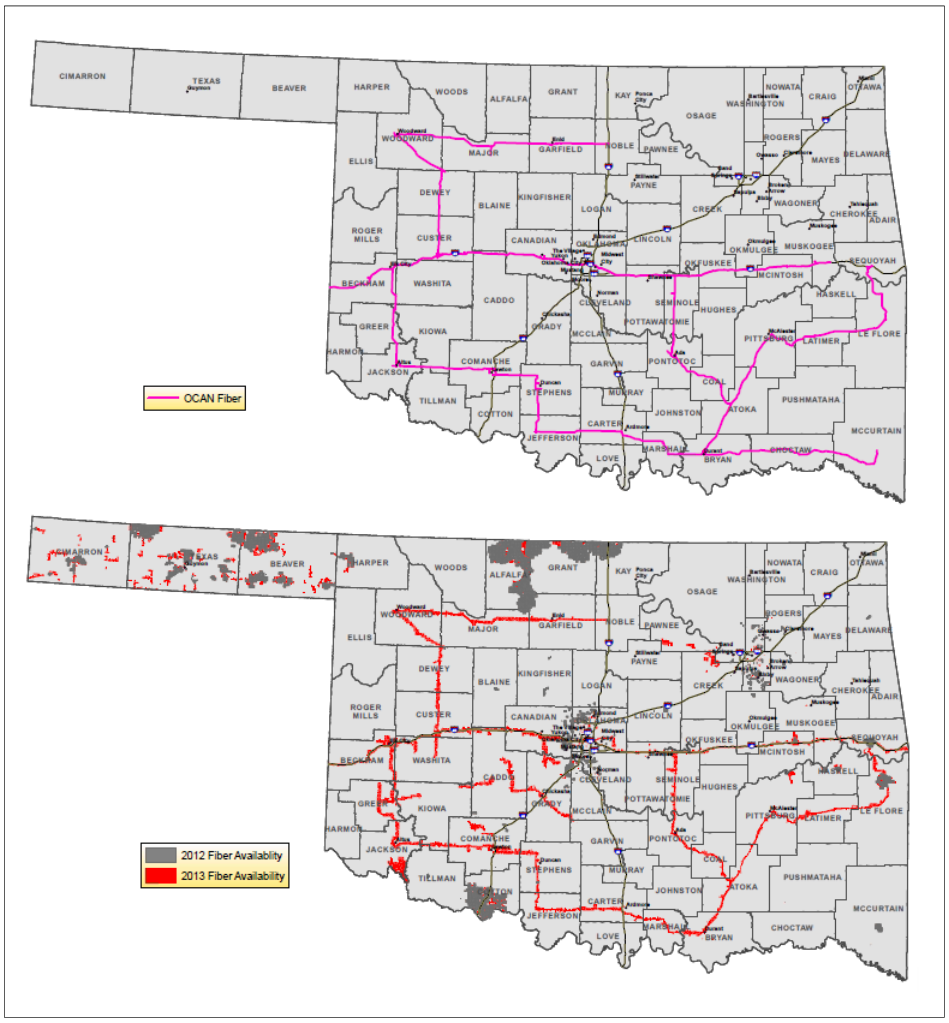


***Figure 21*. Increase in fiber access, 2012 - 2013 (a) OCAN fiber network (b) changes along OCAN fiber network.**

This is largely attributable to the new fiber laid as a result of the OCAN project funded by the Broadband Technology Opportunity Program (BTOP) grant. More information about this program is available at http://www.ok.gov/broadband/OCAN_Overview.html. Companies such as Dobson Technologies (Dobson Telephone Company) have established a partnership with the State of Oklahoma through which they own and maintain a part of the OCAN fiber network. This public-private partnership with OCAN allows companies like Dobson to use and provide services through the OCAN fiber network. In order to extend services to under and unserved areas of the state, private companies are allowed to develop and provide services to both business and general consumers through these partnerships.

Although there has been a slight growth in Oklahoma's cable service coverage around existing cable service hubs, there have been very few new areas of cable service added. However, areas with cable have seen improvements in speeds. In regard to DSL coverage, there

has been no perceptible difference in coverage over the last year in Oklahoma with most changes involving the refinement of data (data corrections by providers, additional participation from providers, etc.) rather than a larger trend that is impacting the state.

There has been some increase in the terrestrial fixed wireless network from December 2012 to December 2013 (see Figure 22). This expansion is observed in the northeastern parts of the state. The mobile wireless networks have filled in some service gaps in the state as shown in the maps below.

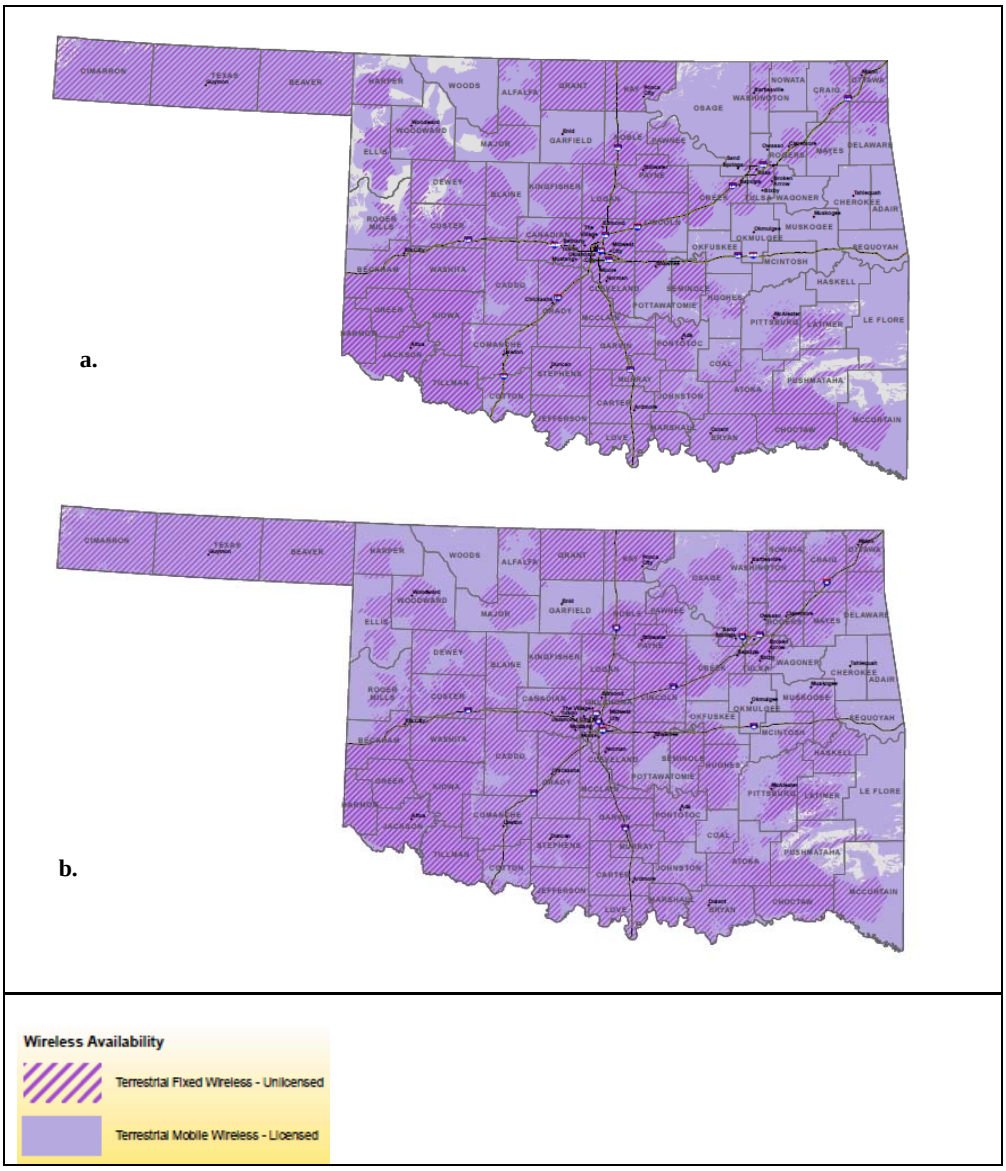


***Figure 22*. Wireless availability (terrestrial fixed and mobile wireless) in December, 2012 (a) and December, 2013 (b)**

Although significant changes in coverage of wireline services were not observed, Oklahomans have seen increases in speeds as shown in the Figure 23. Speeds of wireline broadband services have increased in the panhandle counties and in eastern counties including Haskell, Latimer, Le Flore, Muskogee, Pittsburg and Sequoyah.

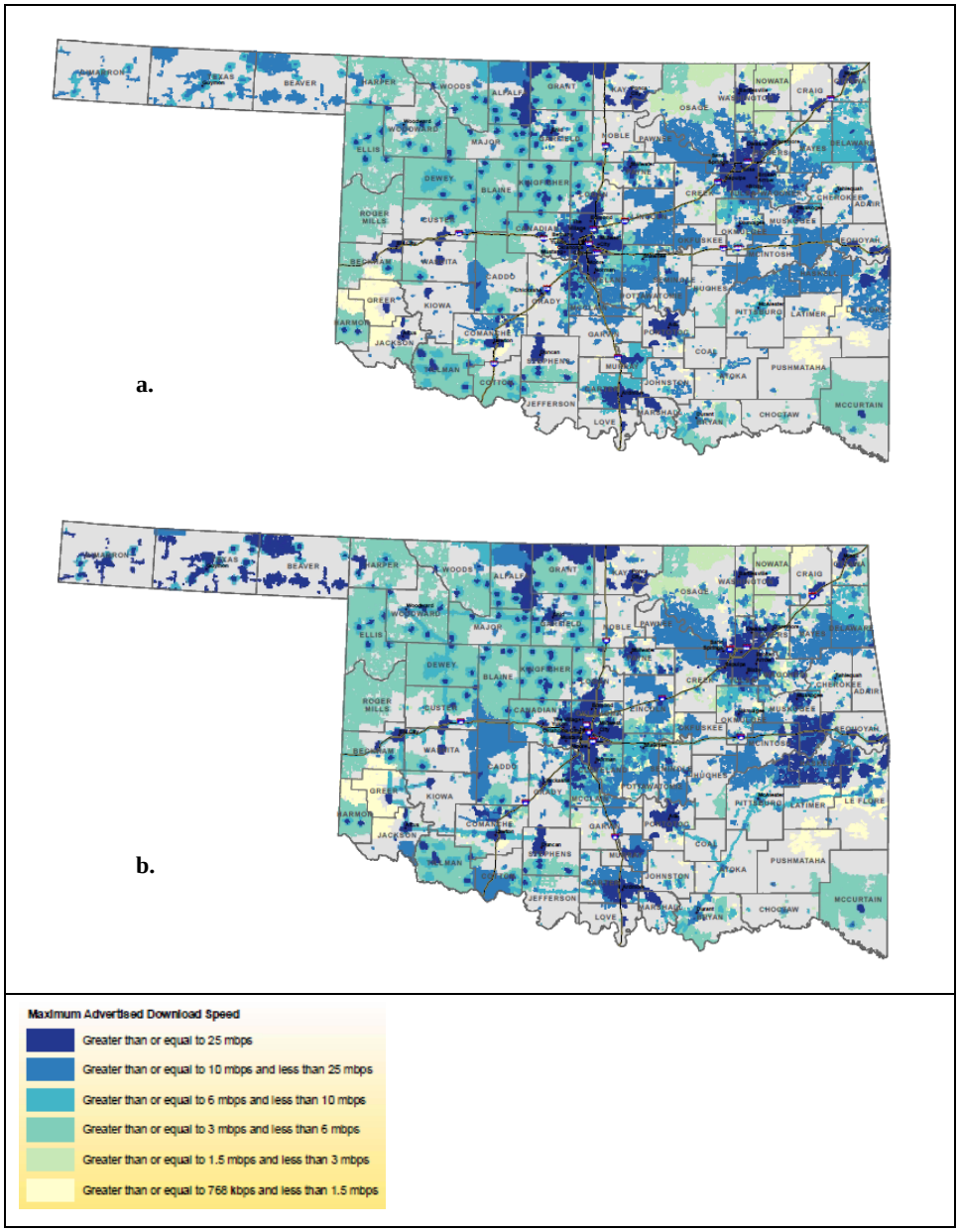


***Figure* 23. Wireline speeds in December, 2012 (a) and December, 2013 (b)**

As for wireless services, the larger changes were seen not in availability and area covered, but in increased speeds. The darker blue areas in Figure 24 below show the spread of higher speeds across the state with some of the largest gains in parts of southeastern Oklahoma.

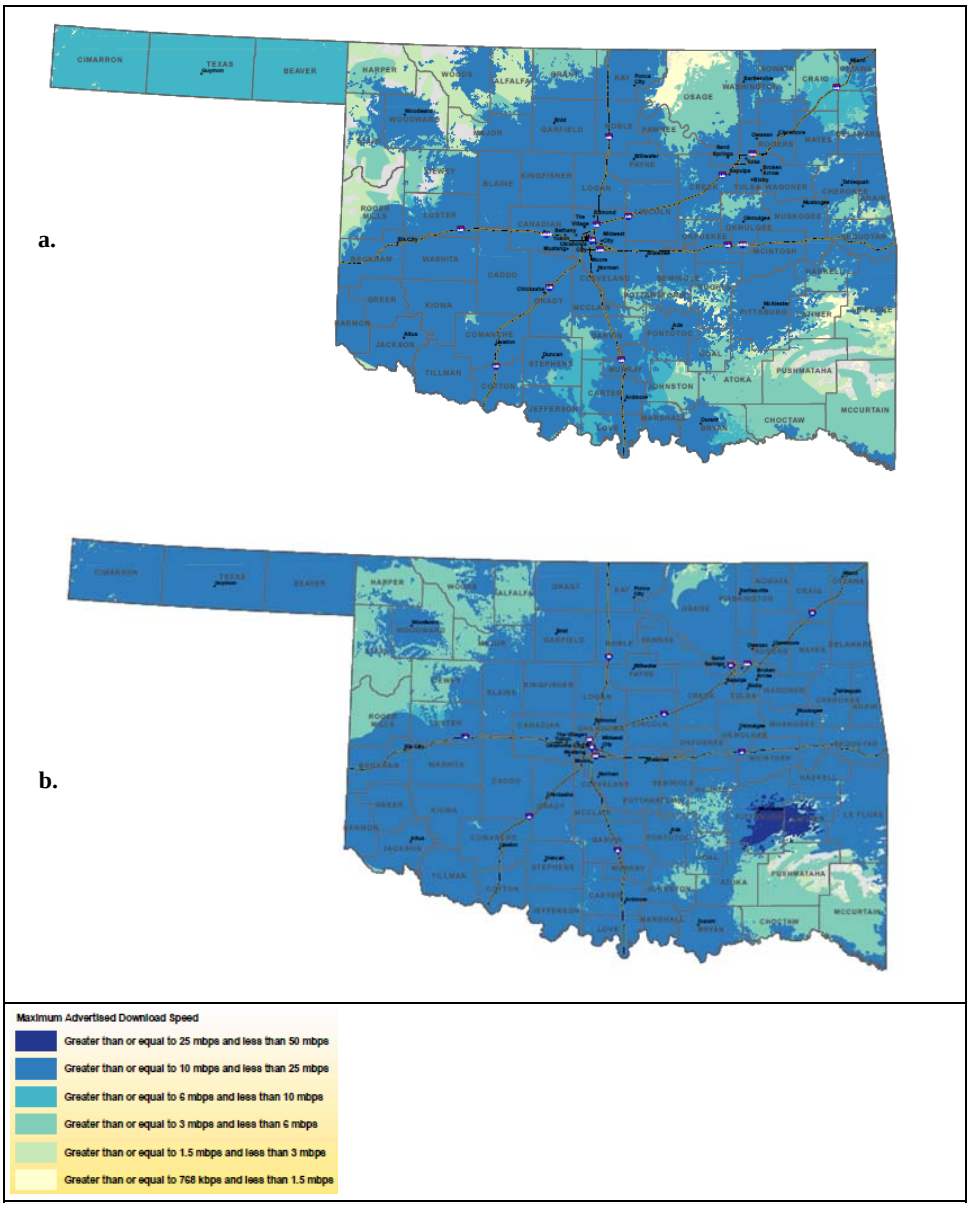


Figure 24. Wireless maximum advertised speeds in December, 2012 (a) and December, 2013 (b)

Served, Unserved, and Underserved Areas of Oklahoma

The criterion for served, unserved and underserved were established by the State of Oklahoma. Areas were defined as **served** if two or more providers served the area and at least one provider offered download speeds greater than or equal to 3Mbps. **Underserved** areas were identified as locations served by one or more providers with download speeds between 768kbps

and 3 Mbps, or only one provider serving the area with download speeds greater than or equal to 3 Mbps. **Unserved** locations are those in which ***no*** providers were identified as serving the area or the providers that did serve the area offered download speeds less than 768 kbps. For the purpose of this analysis, only wireline services were included; therefore, some areas identified as unserved or underserved by wireline service may have access to wireless services that could provide viable options for broadband at the speeds and criteria mentioned above. At the beginning of this project, wireline service was considered as the only viable high-speed option and was the only parameter used to determine served/underserved/unserved. With improvements in wireless speeds, these technologies should be considered in such analysis in the future.

As required by NTIA, the distribution of areas served, unserved, and underserved by broadband in Oklahoma was measured and aggregated at the census block or street segment level. For census blocks less than two square miles in size, broadband coverage was delineated as the census block boundary if some level of broadband availability was identified. For census blocks greater than two square miles in size, wireline provider data was collected and aggregated by street segments to delineate the coverage at a more detailed resolution for unpopulated areas. It should be noted that the information presented regarding served, underserved and served areas are estimates. For instance, if a single household is served by a provider on a block or a street segment, the whole block or street segment is consider served by that provider which is likely to result in an overestimate of coverage.

Geographic Distribution of Served, Unserved, and Underserved Areas and Households

The estimates and density calculations provided in the following section are based on block level household data and assume that households are equally distributed within census blocks (see Appendix 4, Table 24) (U.S. Census Bureau, 2010c). As shown in Table 14, over two-thirds (69%) of households in Oklahoma were located in areas defined as being served with wireline broadband technology. An additional 21% of households were located in areas defined as being underserved and the remaining 10% of Oklahoma households were located in unserved areas with no wireline services available.

Table 14. Number of Households in Served, Underserved, Unserved Areas in Oklahoma, 2010

	Urban	Rural	All Area	Percentage
Served	895,802	107,795	1,003,597	69%
Underserved	75,276	232,036	307,312	21%
Unserved	7,514	142,027	149,541	10%

The gap between urban and rural Oklahoma households in regard to wireline technology provides a clear demonstration of the often referred to digital divide in which disparity exists in access, use, and knowledge of key information technologies (National Telecommunications and Information Administration, 1995). As shown in Figure 25, most urban Oklahoma households (91%) have access to broadband services through two or more wireline providers with download speeds greater than or equal to 3 Mbps, while only 22% of rural households were located in areas defined adequately served. Further 48% of rural Oklahoma households were located in areas that were identified as underserved with an additional 30% in areas defined as being unserved. This compares to 8% of urban households in underserved areas and only 1% located in unserved areas.

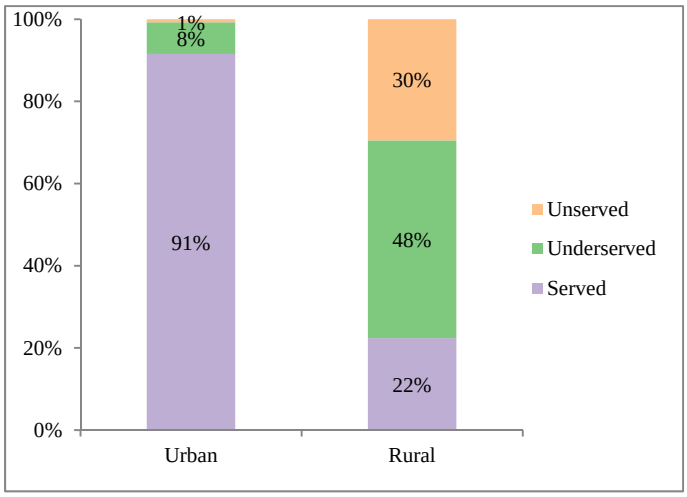


***Figure 25*. Urban rural households in served, underserved, and unserved areas in Oklahoma, 2010**

Regional estimates for Oklahoma's councils of governments (COGs) indicate that the largest unserved populations with over 20% of the households unserved by broadband are located in the Eastern Oklahoma Economic Development District (EOEDD), the Southern Oklahoma Development Association (SODA) and the Kiamichi Economic Development District (KEDD) (see Appendix 4, Table 25).

These three regional councils of governments also have the largest percentage of underserved households and consequently the lowest percentage of served households in Oklahoma. Not surprisingly, the area around Oklahoma City is the best performing area, with 87-88% of the households served. The Indian Nations Council of Governments (which includes the City of Tulsa) ranks a close second in the percentage of households served, also with about 87% of the households served. These findings indicate that the COGs serving the two major metropolitan areas are well served but thereafter, there is a sharp drop in the percentage of households served. The percentage of households served is in the 50% range for most of the other COGs. Maps showing served, underserved and unserved areas for each COG were created each year and the latest maps from Submission 8 (data current as of June 30, 2013) are provided in Appendix Figure 48 to Figure 58. These maps show the pattern of served, underserved and unserved areas for each COG region, as well as pockets of served areas in urban areas.

Racial and Ethnic Disparities in Wireline Broadband Services

Accessibility of wireline broadband services for Oklahoma racial and ethnic groups was examined at the census block level (U.S. Census Bureau, 2010c). As shown in Figure 26, the racial composition of Oklahoma residents as of 2010 was predominantly White (75%) followed by American Indian (9%), African American/ Black (8%), multiracial (6%), Asian (2%) and some other race (0.2%) (U.S. Census Bureau, 2010d). Oklahomans who reported their racial identity as "two or more races", most often identified as "White and Black or African American," and "White and American Indian." For the purpose of brevity and ease of discussion, the term multiracial will be used interchangeably with the census racial category "two or more races" throughout this document.

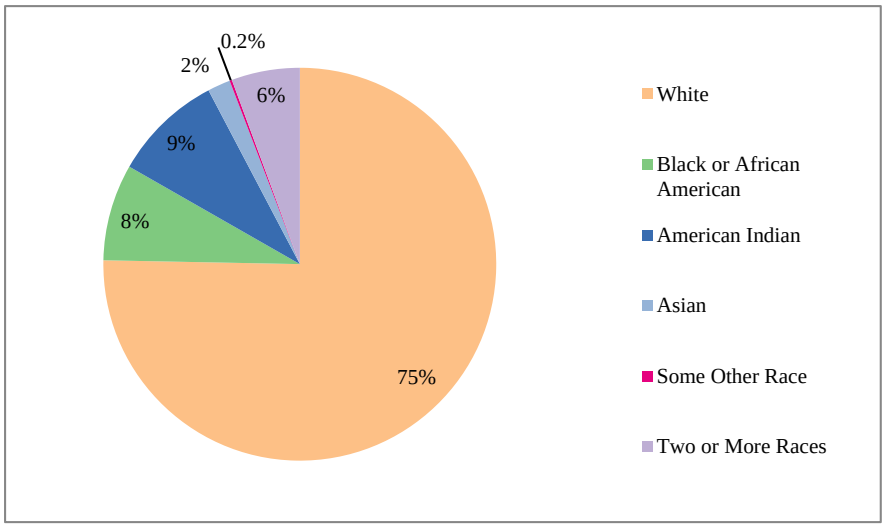


Figure 26. Racial composition in Oklahoma, 2010

Racial groups used in the following analysis included Hispanic, White, African American/Black, American Indian, Asian, and two or more races. The residence for most of the state's Hispanic (84%), African American/Black (90%) and Asian (91%) respondents were clustered in urban areas (see Figure 27). The residence for White, American Indian and multiracial respondents tended to be evenly spread across urban and rural Oklahoma.

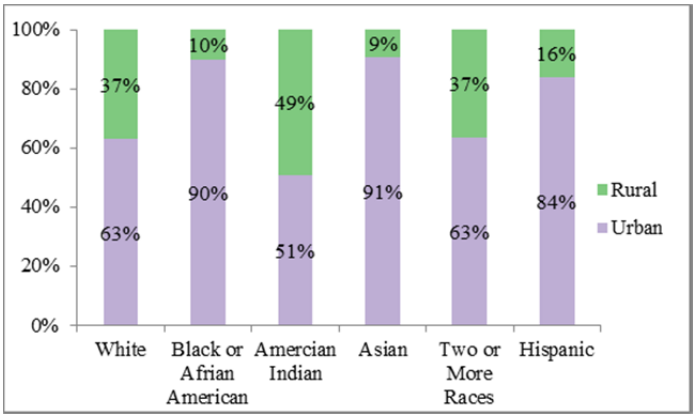


Figure 27. Urban and rural population by racial and ethnic groups in Oklahoma, 2010

Results from spatial analysis for White Oklahomans suggest that 66% of this population resides in areas identified as served via wireline broadband technology followed by 23% in areas classified as underserved, and 11% in areas without access to wireline broadband technology (Figure 28). Since African Americans and Asian Oklahoma residents tend to cluster in urban areas, a higher percentage of Black/African American (86%) and Asian (86%) residents lived in areas served by at least two wireline providers that provided adequate download speeds.

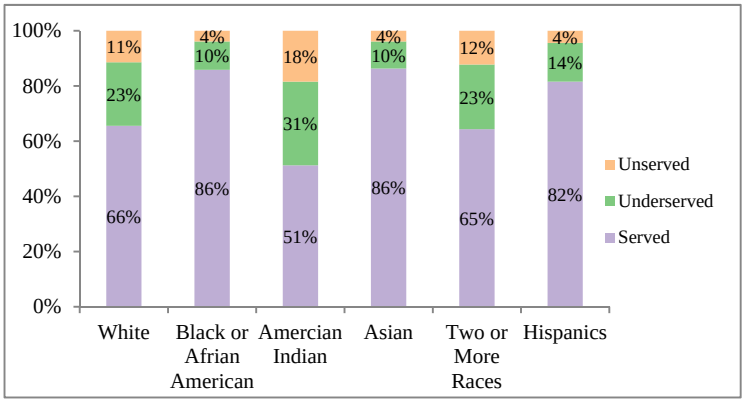


Figure 28. **Served, underserved, unserved population by racial and ethnic groups in Oklahoma, 2010**

However, American Indian residents tend to be located in areas classified as underserved (30%) and unserved (18%) by wireline technology. Only 51% of the state's American Indian population had access to broadband services through at least two wireline providers. Similar to their African American counterparts, Hispanic residents tend to reside in urban Oklahoma and demonstrate a similar residence pattern to African Americans in regard to the availability of wireline services with 82% residing in served areas followed by 14% in underserved, and 4% in unserved areas.

Given the results above, it is not surprising to find a rural – urban divide between Oklahoma residents in regard to wireline technology. When comparing racial/ethnic group differences within urban and rural areas of the state, a discrepancy was only found for American Indians. Asian Oklahomans appear to have the greatest level of wireline service availability with 92% of urban Asian residents and 33% of rural Asian residents residing in areas identified as being served by at least two wireline providers with adequate download speeds. For Whites,

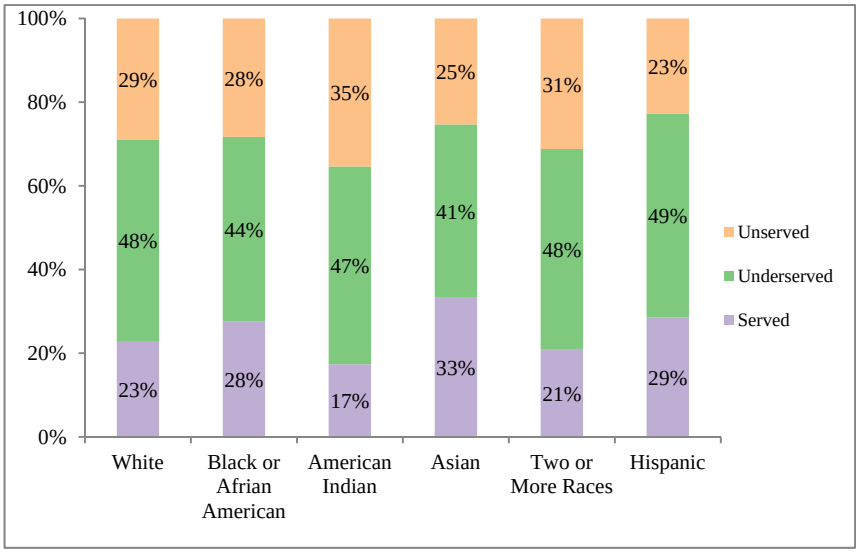


Figure 29. **Served, underserved, unserved population by racial and ethnic groups in rural Oklahoma, 2010**

African Americans and Hispanics, approximately 90% reside in urban areas classified as being served compared to over 20% of their rural counterparts. A higher proportion of both urban and rural American Indian residents in Oklahoma lived in areas identified as under and unserved than their counterparts from other racial or ethnic groups (see Figure 30 – Figure 31).

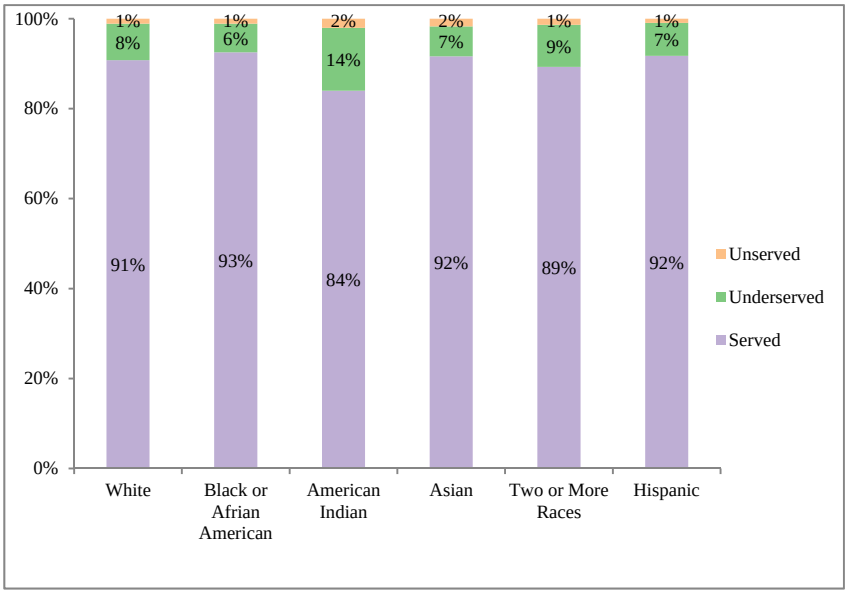


***Figure 30*. Served, underserved, unserved population by racial and ethnic groups in urban Oklahoma, 2010**

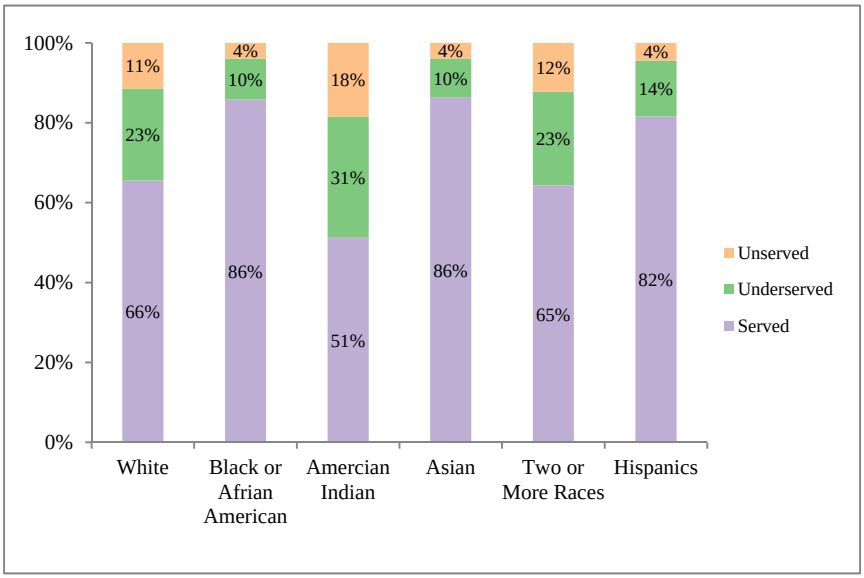


***Figure 31*. Served, underserved, unserved population by racial and ethnic groups in Oklahoma, 2010**

At the time of the 2010 Decennial Census, Oklahoma's American Indian population was clustered in eastern and central Oklahoma. A high population density of American Indians with no access to wireline broadband services was found within the tribal jurisdiction of the Cherokee Nation in the northeastern part of Oklahoma (see Figure 32).

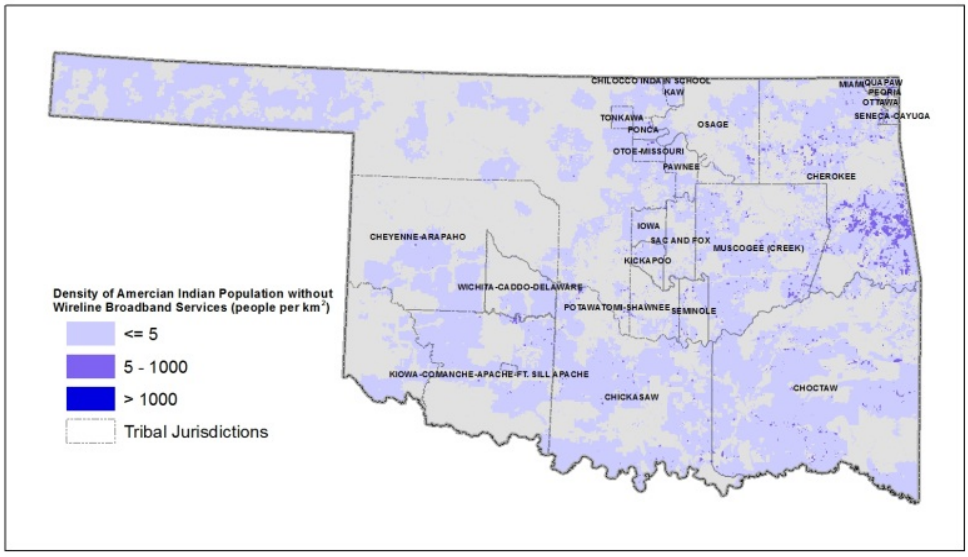


Figure 32. **Population density of American Indians without wireline broadband services in Oklahoma, 2010**

Although a divide was not found between African Americans and Whites in Oklahoma as a whole, the state's historic All-Black towns (HBT) are located in areas identified as being underserved or unserved by wireline technology. There are currently 12 operating HBTs in Oklahoma (see Figure 33) where African American populations cluster (Tulsa City-County Library, 2014). Within the municipal boundaries of these towns, 55% of the residents reported a primary racial identification of "Black or African American" on the 2010 Census. In most of the HBTs, the African American population is still the dominant population group although this is not the case in Brooksville, Taft, Lima, or Boley as of 2010 (see Table 15). A key finding is that none of the census blocks in these

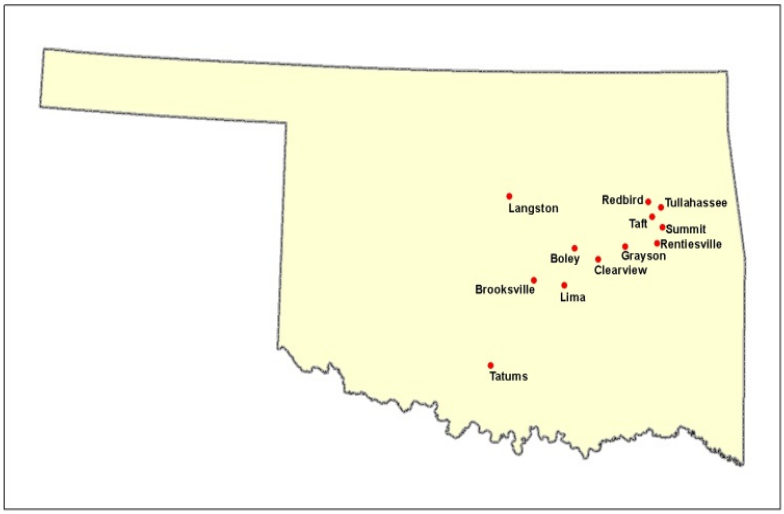


Figure 33. **Historical Black towns in Oklahoma, 2014**

HBTs were identified as being served by wireline broadband services. Only 46% of the residents in these towns were located in areas classified as being underserved, with the majority (54%) residing in areas without wireline broadband technology available for use.

Table 15. Percentage of African American Population in Oklahoma Historic All- Black Towns by 2010

Historic All-Black Towns	Percentage of Blacks to Total Population	Historic All- Black Towns	Percentage of Blacks to Total Population
Brooksville	20%	Grayson	50%
Taft	29%	Rentiesville	59%
Lima	34%	Tullahassee	66%
Boley	39%	Redbird	68%
		Clearview	73%
		Summit	75%
		Tatums	78%
		Langston	90%

Underserved, and Unserved Households

Median annual household income in served, underserved, and unserved areas was examined by census tract and was extracted from the American Community Survey (U.S. Census Bureau, 2008-2012). Income analyses are limited to the census tract level due to limitations in the data provided by the Census. Census tracts are defined as "relatively permanent statistical subdivisions of a county or equivalent entity…with an optimum size of 4,000 people" (U.S. Census Bureau, https://www.census.gov/geo/reference/gtc/gtc_ct.html). Estimates of median household income were missing in two census tracts near Oklahoma City (13 households) and Lawton (24 households) (Figure 34). Since the median household income for Oklahoma households was $44,891, tracts were divided into three tiers with incomes equal to or less than $34,999 included in the lowest tier, incomes of $35,000 to $64,999 comprising the middle tier, and incomes greater than or equal to $65,000 in the highest tier (U.S. Census Bureau, 2008-2012).

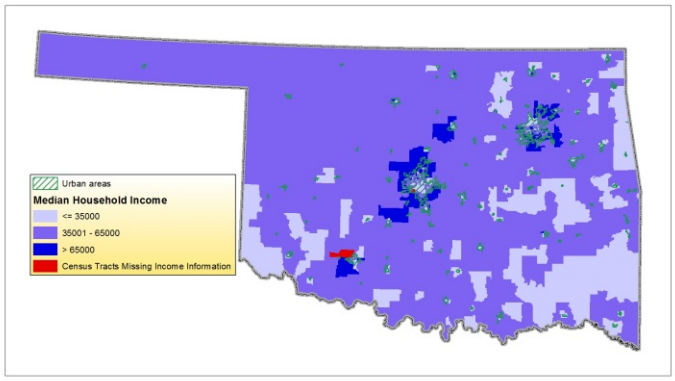


Figure 34. **Median annual household income by census tract in Oklahoma, 2008-2012**

When comparing wireline service coverage by income levels, areas without wireline broadband coverage were more likely to be in 1) rural areas located in low tier median income tracts, 2) middle tier income tracts in northeastern rural Oklahoma, and 3) certain pockets of high income tracts located near metropolitan areas. Underserved households were spread across the state while served households were clustered in urban areas across all three income levels. As for high median income tracts, 84% of the households in these tracts were in coverage areas served by at least two wireline providers with download speeds greater than or equal to 3 Mbps, while 16% of these households were located in areas identified as being underserved or unserved (see Figure 35). Served households were clustered in urban areas (see Table 16). The distribution of households in high tier income tracks located in underserved areas was unremarkable as they were located in both rural (63%) and urban (37%) areas.

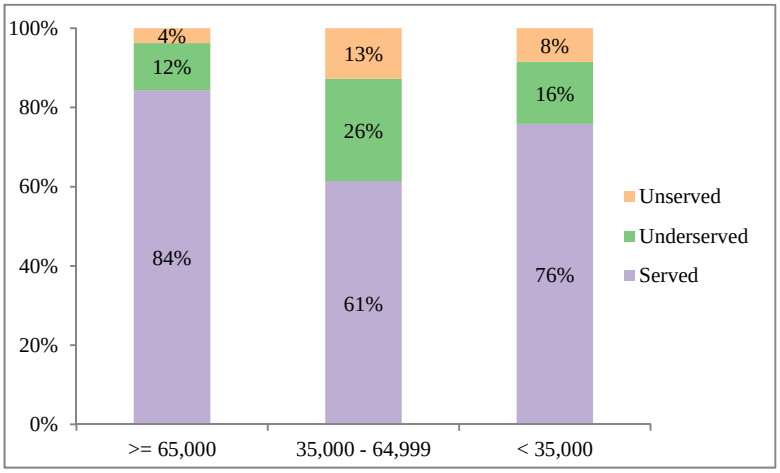


***Figure 35*. Served, underserved, and unserved households by median annual household income classification in Oklahoma, 2010**

Table 16. Served, Underserved and Unserved Households by Median Annual Household Income Classification in Urban and Rural Oklahoma, 2013

	Low Tier Median Income (<=$34,999)		Middle Tier Median Income ($35,000 to $64,999)		High Tier Median Income (>=$65,000)	
	Number	%	Number	%	Number	%
Served						
All Area	287,938		525,767		189,879	
Urban	267,877	93	454,411	86	173,471	91
Rural	20,061	7	71,326	14	16,408	9
Underserved						
All Area	59,474		221,104		26,734	
Urban	23,370	39	41,886	19	10,020	37
Rural	36,104	61	179,218	81	16,714	63
Unserved						
All Area	32,127		109,008		8,382	
Urban	2,586	8	3,663	3	1,265	15
Rural	29,541	92	105,345	97	7,117	85

Conversely, unserved high tier income households in rural tracts were more likely to cluster along fringe areas outside major metropolitan regions including Tuttle and the eastern parts of Moore and Owasso (see Figure 36).

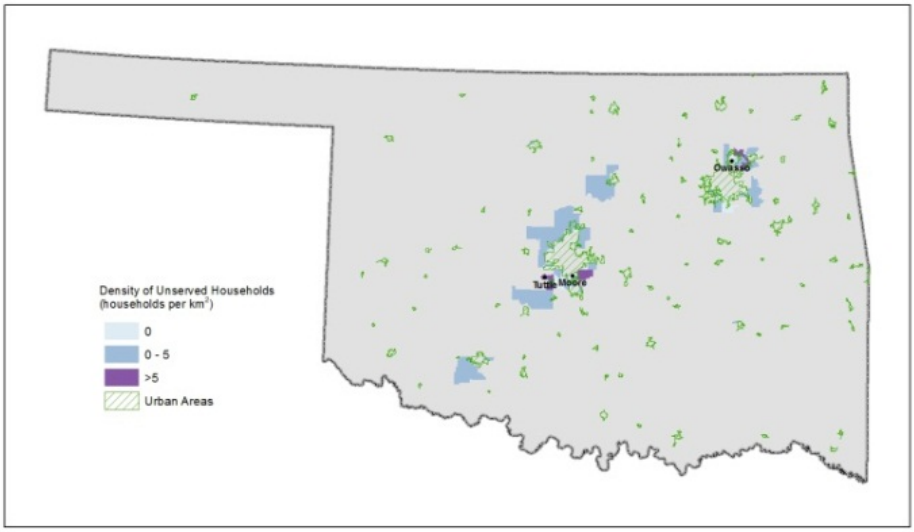


Figure 36. **Density of unserved households in Oklahoma census tracts of a high income tier, 2013**

For middle tier income tracts, 61% of households were located in areas identified as served with an additional 26% in underserved areas and 13% in unserved areas (see Figure 37). More underserved households (81%) were located in rural middle tier income tracts than in urban (19%). Most unserved households (97%) in middle tier income tracts were clustered in rural areas, particularly in the northeastern part of the state (see Figure 37). Compared to census tracts in the middle income tier, a higher percentage of households in low tier income tracts were located in served areas (76%) and a lower percentage of households in underserved (16%) and unserved areas (8%). The analysis suggests that served and underserved households in low income tracts were clustered in urban

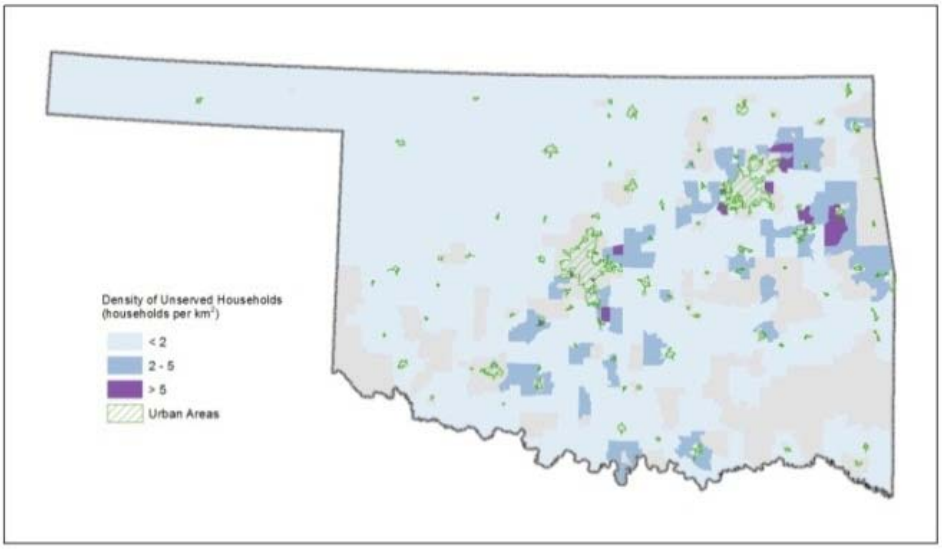


Figure 37. **Density of unserved households in Oklahoma census tracts of a middle income tier, 2013**

Oklahoma, particularly inside the Oklahoma City and Tulsa metropolitan areas. Unserved households were spread unremarkably across rural areas in low tier income census tracts.

Overall the fairly consistent distribution observed between urban and rural households across high, middle and low income tracts indicates that the geographic coverage of broadband services is significantly associated with urban locations rather than income level. Urban households tend to be located in areas served by at least two wireline providers at adequate download speeds, while rural households are usually located in areas classified as being underserved and unserved. Ultimately however, household income has an impact on the affordability of broadband services, which will be discussed in a subsequent section.

Accessibility to Broadband by Community Anchor Institutions (CAIs)

CAIs play an important role in providing public services. Access to high-speed, reliable Internet service is crucial for organizations to provide quality and timely services. In order to determine the ability of Oklahoma's key public organizations to leverage the resources provided through the Internet, the broadband initiative collected access information from state libraries, schools (K through 12), universities, colleges, post-secondary institutions, healthcare providers, public safety organizations, other local governmental entities, and other nongovernmental community support groups. Overall, researchers were able to obtain information from 85% of the identified active Oklahoma CAIs (see Figure 38). Most of the CAIs contacted used broadband technology (92%), including all of the libraries, universities, colleges, post-secondary institutions, and non-government community support groups, and over 95% of public and private schools (K through 12), healthcare service providers, and local government entities (see Table 17). Additionally, 67 CAIs had broadband connections through at least two providers, most of which were located near the metropolitan areas. However, 25% of the public safety institutions contacted did not access the Internet through broadband technology.

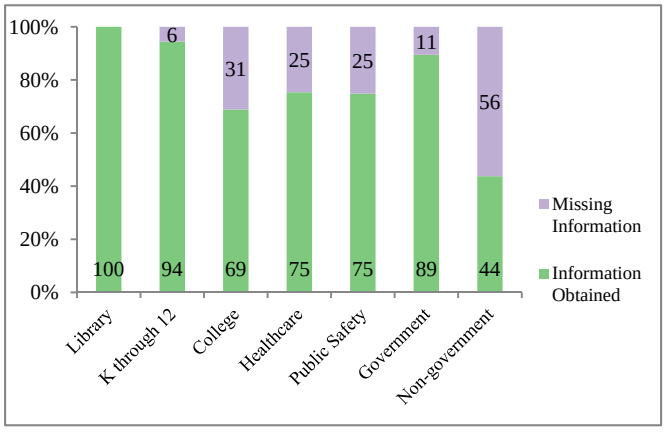


Figure 38. CAIs Contacted, 2010-2014

Table 17. Broadband Usage of CAIs Contacted, 2010-2014

Type	Use Broadband		Not Use Broadband	
Library	212	100%	0	0%
School, K through 12	1807	99.9%	1	0.1%
University, college, or other post-secondary	53	100%	0	0%
Medical, healthcare provider	321	97%	9	3%
Public safety institution	1000	75%	331	25%
Other governmental entity	440	98%	11	2%
Other non-governmental community support	7	100%	0	0%

Challenges to Broadband Adoption in Oklahoma

Broadband Adoption in Oklahoma

When compared to U.S. residents in general, fewer Oklahomans reported having any form of Internet access in their homes. Estimates for 2012 obtained from the CPS (U.S. Census Bureau, 2014) suggest that 79.3% of U.S. residents reported access to Internet at their homes. Oklahoma ranked the 41st out of 50 states and the District of Columbia with 74.8% of Oklahomans reporting access to the Internet at their homes (See Table 18).

Table 18. Percentage of Individuals Living in Households with Internet Service for Oklahoma and Neighboring States, 2012

	% of individuals living in household with Internet use
U.S.	79.3
Colorado	85.7
Kansas	80.7
Missouri	75.4
Oklahoma	**74.8**
Arkansas	74.8
New Mexico	73.9
Texas	72.6

Source: U.S Census Bureau, 2014.

A second indicator of adoption is subscription ratio. Subscription data focuses more directly on broadband adoption (i.e. proportion of households actually subscribing to broadband) rather than availability. Additionally, this information differs from that of the CPS survey in that

it is a measure of paid subscription rates for specific speed tiers; whereas, the CPS represents self-reports from individuals about Internet access in general and does not address speed tiers. As of June 30, 2013, the adoption rate by Oklahomans of high-speed Internet services remained low according to subscription data gathered by the FCC (available at http://transition.fcc.gov/wcb/iatd/comp.html). The subscription ratio (or the proportion of households in each state that subscribes to wireline broadband) suggested that only 40% of the households in Oklahoma subscribe to broadband speeds of 3 Mbps or more for download and 768 kbps upload. This places Oklahoma in the bottom quartile of all states in the nation. Similar to findings from the CPS survey, Oklahoma subscription rates are only slightly better than those of Arkansas and significantly behind the .67 subscription ratio achieved in Colorado (see Table 19). With broadband being an engine of economic development and necessary factor for many businesses that make location decisions based on broadband availability, this information points to the challenges Oklahoma faces to improve the uptake of broadband services and efforts needed.

Table 19. Subscription Ratios for Oklahoma and Neighboring States, 2013

State	Connections (thousands)	Households (thousands)	Subscribership Ratio
Colorado	1352,	2029	0.67
Kansas	551	1124	0.49
Texas	4123	9241	0.45
Missouri	1041	2400	0.43
New Mexico	349	809	0.43
Oklahoma	**588**	**1486**	**0.40**
Arkansas	403	1165	0.35
Total	65041	119999	0.54

Note: Connections refers to residential fixed connections at least 3 Mbps downstream and 768 kbps upstream. Source: FCC 477 data available at http://transition.fcc.gov/wcb/iatd/comp.html

As stated earlier, the OBI conducted a community survey designed to identify the broadband usage patterns of Oklahomans both at home and work. Surveys were collected from 2012 to 2014 and resulted in the participation of a total of 3,520 Oklahoma residents from across the state. From these surveys, researchers obtained broadband usage data on 5,499 homes or places of work in Oklahoma. Fifty-eight percent

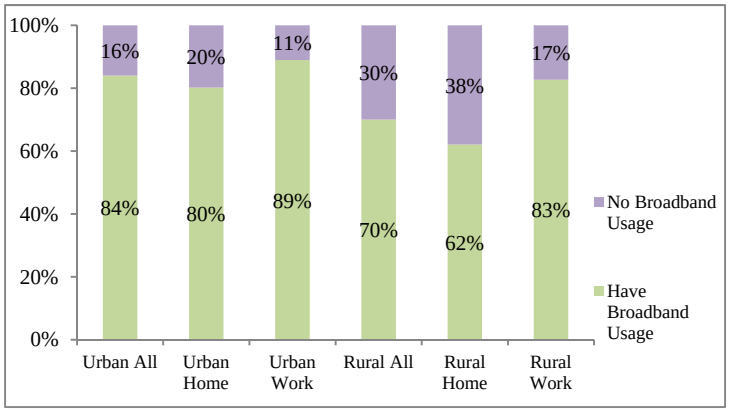


***Figure 39*. Broadband usage at home and work in Oklahoma communities, 2010-2014**

of the responses came from rural community residents and 42% from urban residents. Survey results indicate that 82.7% of the respondents use broadband services either at home or work, but a significant gap between urban and rural use in the home was observed. As shown in Figure 39, 80% of urban survey respondents reported usage of broadband services at home compared to 62% of their rural counterparts. Findings from this survey compare favorably in regards to findings by the Census Bureau for rural Oklahomans. Specifically the U.S. Census Bureau found that 65% of urban households in Oklahoma and 57% of rural households reported broadband usage in the home (U.S. Census Bureau, 2011b). Although the OBI survey results suggest there may have been an increase in home usage in urban areas, a convenience sampling procedure was used and is not statistically representative of populations; therefore, results should be used judiciously.

As for challenges to broadband adoption in Oklahoma, one of the most significant factors was the availability of broadband. For Oklahomans who reported that they did not use broadband either at home or work, 34% of the respondents indicated that broadband was not available (see Figure 40 below) with an additional 23% of the survey respondents without service reporting they had no need for the Internet. Affordability was another key factor. Of respondents who reported they did not use broadband, 17% stated their failure to do so was due to cost. Another trend identified was the use of mobile wireless as a supplement to wireline broadband services. Results from the community surveys suggest that 12% of Oklahomans that were without broadband in their home relied on mobile wireless for Internet service. Only a small portion (3.5%) of survey respondents indicated that they were satisfied with dial up services. Other respondents reported that only one provider offered broadband service in their community, but they were not satisfied with the service (i.e. low actual speeds obtained and unreliable service) or that they used broadband in other places such as public libraries.

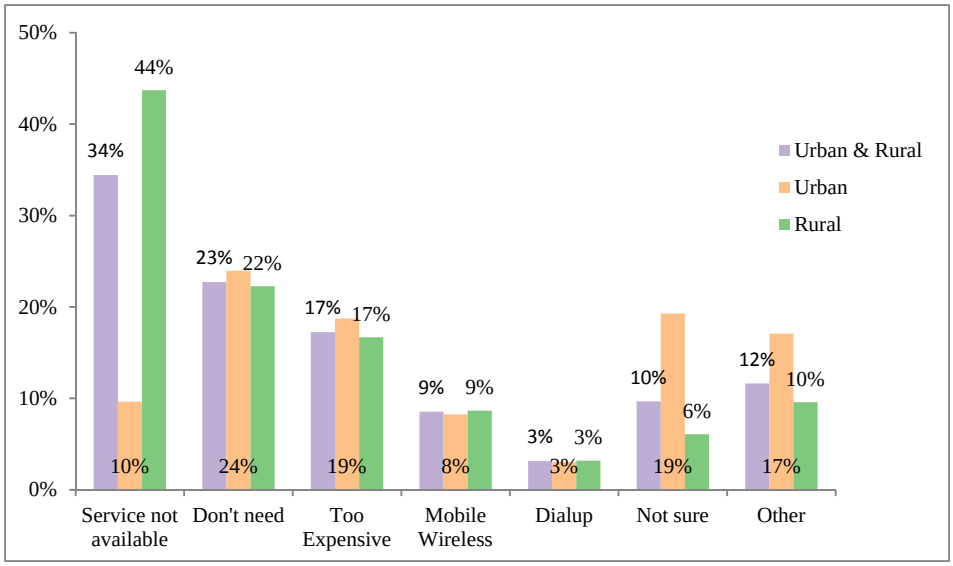


Figure 40. **Reasons for not using broadband**

Broadband adoption issues vary by rural and urban residential locations. For urban Oklahomans, the most significant barrier to adoption appeared to be a lack of awareness regarding service availability and the actual lack of access was the greatest challenge for rural Oklahomans (see Figure 40). The cost of broadband services was the common barrier for both urban and rural Oklahomans, which may explain why mobile wireless has become a crucial source of service for Oklahoma residents. Overall the results from the community survey and field contacts indicated that for the most part Oklahomans understand the need and have a desire to use high-speed Internet services. Discussions with rural Oklahomans indicate that they are also very much aware of the difference in technologies and what fiber services could do to enrich their lives. However, affordability along with access remain significant challenges to broadband adoption in the state. Additionally, with almost 25% of Oklahomans indicating they don't need Internet service, it is clear that education on the depth and breadth of services available through the Internet is sorely needed.

Broadband Availability

Broadband access is the most significant challenge to broadband adoption for rural Oklahomans. Community surveys found that 44% of non-adopters in rural Oklahoma reported that broadband services were not available. Fixed wireless and satellite broadband plays an important role in the delivery of broadband services for rural Oklahoma households. Spatial analysis of validated coverage data indicate that 30% of rural households were not able to obtain broadband services through wireline technology in 2013. Approximately 10% of rural households could only get broadband services via satellite. However, broadband service through fixed wireless and satellite technologies is susceptible to outages caused by weather disruptions during heavy rain, ice, snow, and even sun interference as well as physical obstructions such hills or trees located between subscribers and the ground station. Satellite communication also suffers from high network latency due to long-distance transmission (National Telecommunications and Information Administration, 2013). Although all Oklahoma households are technically able to obtain broadband services through fixed wireless or satellite technology, performance is limited by latency and environmental interference, which challenges their widespread usage.

Oklahomans need greater access to technologies that provide consistent high-speed Internet service. Fiber transmits data by tens, or even hundreds of Mbps, which far exceeds DSL and cable. However, only 7% of Oklahoma households were able to obtain broadband service through fiber technology with limited availability adjacent to the Kansas and Texas borders and in pockets within metropolitan areas. Bringing high-quality broadband services to Oklahomans living in areas with no access to broadband through wireline technology will be a long-term and challenging task. In support of the work done by OCAN, OBI and other broadband supporters in the state, it appears broadband coverage through fiber technology has increased somewhat along the new fiber route. The continuation of efforts to leverage public and private partnerships for

last-mile construction will be required for the expansion of high-quality broadband services to underserved and unserved Oklahomans.

Broadband Affordability

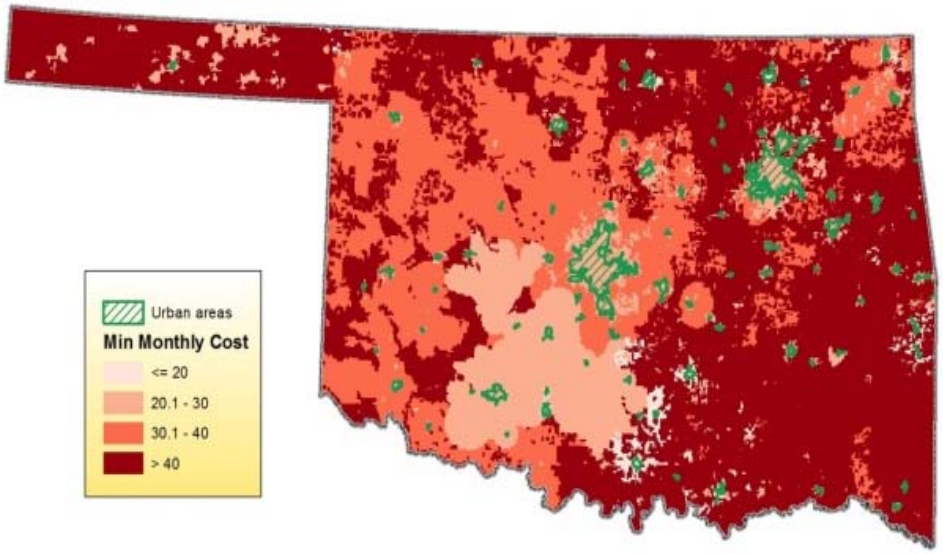


Figure 41. **Minimum monthly cost of broadband services by census block, 2013**

Besides limited broadband access, affordability is another significant barrier to broadband adoption. An analysis of the affordability of broadband technology for Oklahomans was conducted using broadband provider coverage extracted from the National Broadband Map as of June 2013 (National Telecommunications and Information Administration (NTIA) & Federal Communications Commission (FCC), 2013) and information collected on provider service costs[v]. Information on the cost for services for 118 of the 123 providers included in Oklahoma Broadband Mapping Project was collected through web searches and direct phone contacts resulting in the estimation of minimum monthly broadband service costs by census block. This information has been incorporated in the Oklahoma Broadband Service and Cost Mapping Application (http://sites.csa.ou.edu/broadband/). This application was developed by the OUCSA and is searchable by the public. The minimum monthly Internet service charge in Oklahoma ranged between $15 and $49.99, with the panhandle and southeastern quadrant of Oklahoma experiencing the highest monthly charges for service (see Figure 41). The lowest monthly charge for service was enjoyed by residents in the central part of the state. In addition, spatial inequality was observed in urban and rural areas in terms of the monthly charge for broadband services, with minimum charges in urban areas ranging between $15 and $30 per month as compared to $20 and $40 a month for rural areas.

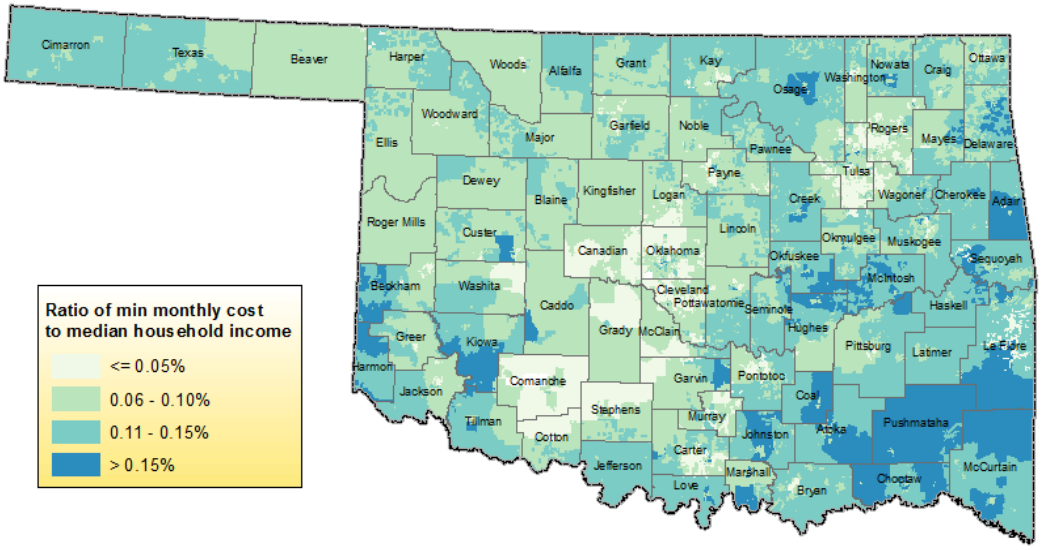


Figure 42. **Ratio of minimum monthly cost of broadband to median annual household income in Oklahoma, 2013**

The affordability of broadband services was examined by calculating the ratio of minimum monthly broadband service cost to median household income for census tracts (U.S. Census Bureau, 2008-2012). Estimates of median annual household income were missing in two census tracts near Oklahoma City (13 households) and Lawton (24 households) (see Figure 34, p. 47). Census tracts with high median household incomes were clustered in suburban areas near metropolitan regions. Low median household income tracts were clustered in eastern and southwestern Oklahoma. Poverty rates demonstrate a similar pattern across census tracts. Suburban areas near metropolitan regions had the lowest poverty rate, while more residents living in the eastern and southwestern part of Oklahoma experienced higher rates of poverty. When comparing minimum monthly broadband service cost with median household income, as shown in Figure 42, southeastern Oklahoma experienced the highest ratio of minimum monthly service cost to median household income. This suggests that costs associated with broadband services require a larger portion of the household income for persons residing in southeastern Oklahoma than for residents in other areas of the state. It should be noted that there are several pockets throughout the state where residents experienced elevated ratios of costs to household income when compared to the rest of the state. Most of the areas with a high ratio of costs to household income were not able to obtain broadband services through wireline technology. The cost per Mbps of bandwidth for broadband subscribers through fixed wireless and satellite technology are likely to be higher than other wireline technology. The lowest ratio of minimum monthly cost of broadband services to median household income was found in suburban areas within metropolitan regions. These suburban areas boasted a high income level and benefited from low broadband cost. Although broadband costs were relatively low in the central part of the state, small urban pockets within metropolitan regions of low income households were also required to spend a larger portion of their household incomes to purchase broadband services.

Broadband Awareness

According to 2010 data from the Census Bureau, awareness was the most significant challenge to broadband adoption in Oklahoma. Nearly 50% of Oklahoma respondents reported that broadband services were not needed (U.S. Census Bureau, 2011b). Findings from the community survey conducted between 2011 and 2014 by OBI suggest that more Oklahomans were aware of broadband. However, around 20% of Oklahomans had not experienced the benefits of broadband services. For instance, some of the elderly survey respondents reported that broadband services were new technology just for the new generation. This corresponds to findings from the Census Bureau that persons over 55 year of age reported the lowest percentage of broadband adoption (U.S. Census Bureau, 2011b). However, as more services move online, residents of all age groups must use the Internet in their interactions with employers, schools, or government. It is important for Oklahomans to understand that broadband services do not serve and benefit a particular group, but are necessary for everyone.

Mobile Wireless

With the pervasiveness of smartphones and their improving capabilities, Internet usage through mobile wireless has witnessed a rapid increase (National Telecommunications and Information Administration & Economics and Statistics Administration, June 2013). In Oklahoma, mobile wireless providers technically offered broadband services to 96.4% of land areas and 98% of households. Findings from the OBI community survey indicate that nearly 10% of broadband non-adopters in the home relied on mobile wireless for Internet services. However, service performance through mobile wireless is not equivalent to a wireline broadband connection. As with fixed wireless, transmission through mobile wireless is susceptible to environmental obstruction and changes of weather conditions. In-field speed tests suggest that smartphones with 3G and even 4G connections are not able to receive consistent and fast speeds as with wireline broadband connection. Services through mobile wireless are also constrained by capacity limits. Transmitting a large quantity of data through mobile wireless is more expensive and challenging than other transmission technologies. Although mobile wireless technology supports data communication at low speeds in the range of several hundred kbps, it serves as an affordable solution to Internet usage for residents living in areas identified as being unserved by wireline technology. It also encourages Internet usage, which helps demonstrate the relevance of broadband services. Internet service through mobile wireless provides a strong complement to broadband services through wireline, fixed wireless, and satellite technologies.

Highlights of Other Broadband Efforts in the State

Through the process of developing the framework, funding and partnerships for the OBI, other key enterprises targeting the improvement of Oklahoma's broadband capacity were identified. Some are more mature in their development while others are in their infancy. In this section, a brief description of the current work that is being done in this sector and future directions will be provided. This section does not represent an exhaustive list of all the work being done in the state, rather a brief introduction into the work of a few partners who shared their stories for use in this report.

Oklahoma Department of Libraries, OCAN and OK Connect

As with other social institutions, libraries have been significantly affected by the rapid adoption of Internet and computer related technologies by all sectors of society. More and more organizations, both public and private, are leveraging digital and web technology to realize gains in efficiency and productivity. However, a significant proportion of the U.S. population does not have the requisite computer hardware, Internet access or digital skills needed to utilize online services and resources. Public libraries have taken a lead role in filling this gap by providing open access to the Internet and computers along with knowledgeable support staff to assist patrons in obtaining services, training or information in relation to news, online education, employment, job training, business or self-employment activities, health and wellness, government or legal, community engagement, finances, and or social connections (Becker et al., 2010). In a 2010 national study of library use in the U.S., Becker and her colleagues found that "Internet access is now one of the most sought after public library services, and it is used by nearly half of all visitors" (pg. 1). This was especially true for households and individuals living below the federal poverty line with 44% of these households reporting use of library computers and Internet access and 61% of youth aged 14 to 24 from these households reliant on library computers and Internet for educational support. Of adults 65 and older residing in households with incomes below the federal poverty line, 54% reported using public library computers and Internet service to address their health and wellness needs (Becker et al., 2010, pg. 2). This is especially significant for rural libraries in that Oklahoma's poverty rate is at one of its highest levels with five year averages ranging from 7.5% to 17.8% in the four most urbanized areas (Oklahoma, Tulsa, Cleveland and Canadian counties) and 25% to 31% for the state's poorest rural counties (Adair, Okfuskee, McCurtain, Pushmataha and Harmon) (U.S. Census Bureau, 2014, July 08; Wheeler, Hackler, & Landgraf, 2014, February 12).

All Oklahoma libraries at the inception of the Broadband initiative were dependent on T1 connection technology which is equivalent to approximately 1.5 Mbps of bandwidth. T1 technology was developed in the 1960's providing some of the fastest speeds of its time. However, the variety of Internet uses and applications and the number of users has exploded exponentially since that time and continues to increase. The T1 technology used by Oklahoma libraries is no longer sufficient to meet the demands of library customers. Speeds proved to be

too slow to run new generation applications or for the sheer number of users. For instance some libraries had to post signs that internet services were unavailable in the afternoon due to after school student use and in other instances customers were unable to download materials due to low speeds.

The Oklahoma Department of Libraries (ODL) was a partner in the OCAN grant and staff were actively involved with the OCAN planning group throughout the project. The fiber deployed through the OCAN phase of the initiative provided identified CAIs which included public libraries the infrastructure needed to support higher broadband speeds. For instance, the Duncan Public Library was identified as a community anchor in the OCAN grant and was upgraded from a T1 connection to a fiber optic connection supporting 100Mbps. In addition the ODL obtained funds for OK Connect from the NTIA and the Bill and Melinda Gates Foundation to purchase equipment and the E-rate consulting services required to realize higher broadband speeds and ultimately provide advanced services in Oklahoma public libraries.

One of the greatest outcomes of the OK Connect grant was an increase in the contribution that libraries receive from the Oklahoma Universal Service Fund (OUSF) which supplements federal E-rate funds for monthly Internet charges. This was a direct result of the Launch funded by the Bill and Melinda Gates Foundation. Before the Launch, OUSF could fund up to the cost of a 56k line but at the Launch policy makers realized 56k lines were no longer sufficient and legislation was successfully passed to increase the OUSF funding cap to cover the cost of a T1 line. Although T1 technology is insufficient for the needs of today's libraries, the OUSF increase allowed technology upgrades that support higher than originally projected speeds with negligible monthly increases in Internet charges in all 42 OK Connect libraries. In most cases OUSF fully covered the percentage not funded through federal E-rate. Libraries couldn't have upgraded to the higher broadband achieved by OK Connect without this increase. Broadband speeds currently being achieved by the OK Connect libraries are included in Table 20:

Table 20. OK Connect Library Speeds Achieved

OK Connect Libraries (Number)	Speed Achieved (Mbps)
20	100
3	50
10	45
1	30
3	20
4	10
1	6

Reports from libraries that received connection upgrades are positive: more customers are accessing the wireless; city officials are visiting their local libraries and utilizing the libraries' increased speeds for downloads; and customers are using the upgraded speeds in lieu of slower speeds offered elsewhere. An unanticipated consequence of OK Connect was learning the vast differences for OUSF tariffs ranging from $514.00 to $2,400.00 monthly. This knowledge will allow ODL to be more successful in moving public libraries to the highest broadband speeds available in their areas.

The OK Connect project also received supplemental funds from the Library Services and Technology Act (LSTA) which allowed participating libraries to surpass originally projected results because of the ability to upgrade equipment to a greater future-proofed capacity. Higher grade video units, routers, switches, and firewalls were purchased as were an additional blade and content server, and desktop video units. A one year pilot project for 12 OK Connect communities was funded to test Brainfuse; Learning Express; and Tutor.com. With their input two years of Brainfuse was purchased for all 44 OK Connect Libraries. Supplemental funds from LSTA were used for video maintenance, development of marketing materials and the OK Connect website http://okconnect.org.

Thirty-seven OK Connect libraries received room based video-conferencing units, 26 through OK Connect and 11through LSTA. Thirteen libraries received desktop video conferencing equipment, nine through OK Connect and four through LSTA. Three computer labs were established and one existing lab was upgraded. Fiber lines were trenched and lain for six libraries. OK Connect and LSTA funds were used to purchase two servers and two blades to connect and record libraries' video conferencing.

Libraries received desktop and laptop computers, 273 through OK Connect and 59 through LSTA, Microsoft, Adobe Pro, and handicapped software, and a carrel that is handicapped accessible. This is an important addition for children who receive their formal education at home. Laptops are used heavily by homeschoolers for state testing. Prior to funding received through the OK Connect grant, students had to be taken to the nearest community college to complete the state test requirements. Now these can be completed at local public libraries. Employees of the Oklahoma Rural Water Association use library laptops for testing as well. Additionally, five libraries received network assessment and remediation and three received new cabling.

A successful partnership between OneNet, OK Connect and ODL has been forged with OneNet configuring, housing, and maintaining the blades and servers purchased with grant funds as well as providing direct access to OneNet staff who assist with video conferencing and connection issues. ODL has joined a user group sponsored by OneNet that represents other Oklahoma video conferencing entities.

Outreach and marketing for the project and resulting library enhancements has just recently been initiated. Materials have been developed including OK Connect brochures, posters, flyers, business cards and banners. Banners with the OK Connect logo were placed at two rodeo sites and 19 billboards displaying the designs for Connect and Soar; Connect and Succeed; Connect and Share; and Connect and Go have been leased (see scrolling header at http://okconnect.org for examples of billboard designs.

Although there has been limited customer training on videoconferencing or follow-up with identified community groups at this time, OK Connect has enjoyed some early success with programs using the new videoconferencing capabilities. For instance, one OK Connect library partnered with the Oklahoma Healthy Aging Initiative (OHAI) at the University of Oklahoma Health Sciences Center (OUHSC) to provide a 12 week “Eat Better Move More” evidence-based class. Seven library sites with video conferencing units are dialing into these classes. Each site has one to eight participants who received a journal and a pedometer. Without video conferencing capabilities the costs of this program would have been prohibitive for the individual libraries to provide to its patrons. One library spokesperson indicated that the programs they have provided through video conferencing were high quality and participants expressed an interest in attending future programs. Prior to having this capability participants would be required to travel out of town as the libraries budget did not support providing this type of programming independently. Further, it appeared that participants bonded with the group, shared information abouts local walking and biking trails as well as places to exercise.

Additional early uses of OK Connect libraries enhanced video conferencing capabilities include:

- Continuing education (CE) for nurses and physical therapists with Integris hospital,
- OK Virtual Library consortium conference on E-books, downloadable audios and music,
- Institute in Public Librarianship certification classes,
- Workforce Development Training, and
- Classes for Masters of School Administration (16 students).

Future programing includes:

- Children's presenters showcase for the summer reading program,
- Various Oklahoma authors representing the Oklahoma Center for the Book; and
- Participation with an Alaska library.

For more information on OK Connects successes with video conferencing see the projects website at http://okconnect.org/ .

All public libraries in Oklahoma have the opportunity to upgrade broadband bandwidth with the increased funds provided through the OUSF. Library consultants in the Office of Library Development have encouraged and assisted the public libraries in applying for funding and with the added funding should be able to upgrade to minimum speeds of 10Mbps. Although the federal government has set a goal of 1G broadband speed, this is not a realistic expectation for Oklahoma public libraries. Therefore, OK Connect has established a goal for every library to realize a 100Mbps broadband connection within the next five years. It is believed that this goal is more obtainable for very small libraries with limited infrastructure and cost effective options available. It is hoped that through the work of the larger broadband initiative, that seeds for competitive development and growth have been unalterably put into motion so that in the near future a goal of 1G is both achievable and affordable for all libraries and other organizations serving Oklahomans.

The ODL plans to utilize LSTA to continue Network Assessment and Remediation. This project aides in determining the bottlenecks of the library's aging network infrastructure and fixing network and Internet access problems through new routers, switches, wireless access points, and router configuration. Within the next year, seven libraries are targeted to undergo assessment and remediation and funding is currently available for additional libraries in the following year. Network Assessment and Remediation is necessary to ensure that speed increases are actually utilized given that higher broadband connections to a site does not guarantee that the higher speed is realized. The OK Connect website was developed in the last months of the grant period and libraries have not become accustomed to utilizing the calendar for their video conferencing programs or sending in their pictures and success stories. A staff member of the Office of Library Development has been assigned to maintain the website and all consultants in the Office of Library Development will work with OK Connect libraries on a one-to-one basis on promoting their video conferencing programs through the website.

Oklahoma Higher Education Research Networking

Science and engineering research is increasingly driven by large and exponentially growing datasets, in a data tsunami that requires moving large volumes of data across long distances extremely rapidly, in some cases in real time. This is true not only for traditionally data-intensive disciplines, such as high energy physics and weather forecasting, but increasingly for the social sciences as well, such as work with GPS offender monitoring and health informatics. Researchers at the Lawrence Berkeley National Laboratory and Brookhaven National Laboratory have identified several cross-cutting issues that are faced by most all sciences that rely on computer networks for data transfer, one of which is directly tied to the availability of a reliable broadband infrastructure that provides 100 Gbps over long distance fiber to users (Johnston, Dart, Ernst & Tierney, 2013). For Oklahoma researchers, the need for such high end broadband capability is becoming increasingly crucial. The following provides a précis of higher education research networking progress in Oklahoma. A more detailed description can be found in:

H. Neeman, D. Akin, J. Alexander, D. Brunson, S. P. Calhoun, J. Deaton, F. Fondjo Fotou, B. George, D. Gentis, Z. Gray, E. Huebsch, G. Louthan, M. Runion, J. Snow and B. Zimmerman, 2014: "The OneOklahoma Friction Free Network: Towards a Multi-Institutional Science DMZ in an EPSCoR State." *Proceedings of XSEDE'14*, Atlanta GA, July 13-18 2014.

Additional information about networking and other research cyberinfrastructure in Oklahoma can be found in:

H. Neeman, D. Brunson, J. Deaton, Z. Gray, E. Huebsch, D. Gentis and D. Horton, 2013: "The Oklahoma Cyberinfrastructure Initiative." *Proceedings of XSEDE'13*, San Diego CA, July 22-25 2013.

For information on how to obtain copies of these papers, please contact the lead author (hneeman@ou.edu).

Research Networking in Oklahoma

Research networking in Oklahoma is the product of several initiatives, including:

- "Oklahoma Optical Initiative" (OOI)
- Shared Services
- 100 Gbps Initiative
- "Oklahoma Community Anchor Network" (OCAN)
- "OneOklahoma Friction Free Network" (OFFN)
- OneOklahoma Cyberinfrastructure Initiative (OneOCII)

Oklahoma Optical Initiative (OOI): This was a $1.17M grant funded by the National Science Foundation (grant number EPS-1006919, $1,176,470, 9/1/2010 - 8/31/2013), led by Principal Investigator (PI) H. Neeman of the University of Oklahoma (OU) and Co-PIs D. Brunson of

Oklahoma State University (OSU) and J. Deaton of OneNet (Oklahoma's education, research and government network), that accomplished the following:

- upgraded the state ring (Tulsa, Stillwater, Norman and two sites in Oklahoma City) from routed-only to optical, which now facilitates the creation of new high-speed network circuits (10 Gbps and higher) within the state;
- put 10 Gbps or more research connectivity at each of OU, OSU and Langston University (Oklahoma's only Historically Black University);
- upgraded the University of Tulsa and the Samuel Roberts Noble Foundation to 1 Gbps for research networking;
- provided campus backbone networks of at least 100 Mbps at Pawnee Nation College (Tribal college) and Bacone College (Minority Serving Institution);
- provided a residence hall network at the College the of Muscogee Nation (Tribal college);
- provided a distance learning system at Comanche Nation College (Tribal college).

OOI also repurposed components to Tulsa and Ardmore, to improve capability for those communities.

OOI also facilitated two other projects:

- OU+OSU Shared Services initiative (non-research);
- OneNet 100 Gbps connection to the national Internet2 100 Gbps research backbone network, known originally as the Innovation Platform and later as Advanced Layer 2 Services (AL2S).

Shared Services: The OU+OSU Shared Services initiative is consolidating systems and services, both (a) across OU's campuses (Norman campus, Health Science Center campus in Oklahoma City and Schusterman campus in Tulsa) and (b) between OU and OSU. This initiative aims not only to reduce Information Technology (IT) costs substantially at Oklahoma's two public comprehensive PhD-granting academic institutions via aggregating capabilities (both of physical systems and of buying power) but also to improve reliability, robustness and performance by virtualization of key institutional capabilities.

100 Gbps Initiative: In 2013, Oklahoma became the first state in the US to connect to Internet2's 100 Gigabit per second (Gbps) national research backbone, now known as AL2S, through the efforts of OneNet, in collaboration with OU and OSU. In spring of 2014, OneNet activated 100 Gbps connections from their Tulsa facility, which houses Oklahoma's connection to AL2S, to each of OU's Norman campus and OSU's Stillwater campus. Because neither OU nor OSU currently has native 100 Gbps capability on campus (only 10 Gbps), OneNet also provided 100-to-10 Gbps breakout capability, so that each campus is already active on multiple 10 Gbps connections that then route into their 100 Gbps connection.

Oklahoma Community Anchor Network (OCAN): Funded in part by a $74 million award from the National Telecommunications and Information Administration under the Broadband Technology Opportunities Program, OCAN leverages over 1100 miles of new fiber optic paths

and equipment to serve community anchor institutions (CAI), providing greater broadband services and facilitating middle-mile initiatives for providers across the state to serve businesses and residences. Many of the community anchors served by OCAN are public and tribal higher education, with bandwidth in some cases being transformed from a DS3 (45 Mbps) to 10 Gbps. Infrastructure required for new opportunities in higher education research networking have now expanded to19 institution locations.

OneOklahoma Friction Free Network (OFFN): Under a National Science Foundation grant (grant number ACI-1341028, $499,961, 10/1/2013 - 9/30/2015), led by PI H. Neeman of OU and Co-PIs D. Brunson of OSU, J. Deaton of OneNet and S. Radhakrishnan of OU, Oklahoma is deploying a multi-institutional "Science DMZ" research network, alongside and complementary to extant campus and statewide backbone networks, to be shared among OU, OSU, Langston U, the Oklahoma Innovation Institute (OII), which is a non-profit in Tulsa, and (subject to NSF approval) the University of Central Oklahoma (UCO), all facilitated by OneNet. OFFN delivers increasing research network capabilities at each of the sites to increase capacity at each site by at least 10 Gbps, server capacity for virtualization of Software Defined Network (SDN) controllers and applications, as well as measurement and monitoring hardware supporting the PS Performance Toolkit. Additionally, OFFN provides a collaborative space across multiple Oklahoma institutions that brings together knowledge and expertise on emerging technologies such as SDN and Science DMZ as well as creating polices of use and implementation for such technologies. Via the OneOklahoma Cyberinfrastructure Initiative (OneOCII), below, OFFN's new capability will facilitate many research projects statewide.

OneOklahoma Cyberinfrastructure Initiative (OneOCII): This initiative provides institutional research cyberinfrastructure at OU, OSU, Langston U and OII to researchers statewide, including access to hardware, software and storage resources (so far provided to 26 Oklahoma institutions and organizations); dissemination via the annual Oklahoma Supercomputing Symposium (participants have included over 50 Oklahoma institutions and organizations); education via OU's "Supercomputing in Plain English" workshop series (23 Oklahoma institutions and organizations); faculty/staff development via summer workshops (18 Oklahoma institutions); informatics capability under the joint OneOklahoma Informatics Team that is shared between OU and OSU (2 Oklahoma institutions); outreach via a talk about the basics of cyberinfrastructure (24 Oklahoma institutions, including every public university in the state); proposal support via letters of commitment and collaborations; a new research data stewardship initiative that is bringing Oklahoma academic libraries together; helping institutions statewide acquire technology of their own; a workforce development initiative, the OneOklahoma Science, Technology, Engineering and Mathematics Mentorship Program, that brings STEM practitioners to courses and events statewide to discuss "A Day in the Life of a STEM Professional." To date, OneOCII and its predecessor initiatives have facilitated over $150M in external research funding, including over $40M on projects that, in the absence of OneOCII, likely wouldn't have been eligible for funding.

Future Directions: The OneOCII team perceives three areas influencing the future of broadband connectivity in Oklahoma higher education:

- outreach and training regarding SDN, provided to central IT organizations at institutions across Oklahoma, to clarify the value of SDN and to facilitate its adoption;
- migration of SDN technologies and techniques from research cyberinfrastructure to academic campus and statewide enterprise network backbones;
- adoption of 100 Gbps technologies into campus and statewide enterprise network backbones.

Via these mechanisms, academic institutions across the state will continue to leverage state of the art capabilities, fostering high quality education, research and workforce development.

Private Industry

The public and private carriers within the state of Oklahoma transport a large majority of the broadband traffic. For many years, the local telephone companies acted as the only method to connect broadband customers to Internet gateways or to the state's OneNet Network.There are 44 local telephone companies, which can be separated by larger and smaller carriers. The larger carriers service the metropolitan areas and roughly 50% of the geographic area. The average exchange size for the 39 smaller local telephone companies is 767 lines with 6,700 being the largest. A map of all the Oklahoma Exchange Boundaries is provided on the following page. (see Figure 42)

The first fiber was placed in service by Cross Telephone Company in the early 1980's between Porum and Warner, Oklahoma. Southwestern Bell followed a few months later with toll fiber in several other areas. By the early 1990's, fiber became the preferred transport medium between communities for all carriers. Over the years, the electronic portion of fiber facilities has been converted to IP to allow for broadband services. Initially, broadband services provided to end subscribers used DSL with speeds up to 8 Mbps at approximately two miles of loop length. Currently, copper technology has changed to increase broadband speeds to up to 50 Mbps down with loop length of 3,000 feet. The newest technology used today is Fiber-to-the-Home (FTTH). FTTH normally reaches 12.4 miles and has multiple times faster bandwidth for up to 30 to 40 years of service life. Few communities within the state currently have this technology in place, but FTTH is becoming the predominate replacement technology for copper DSL.

Other methods of providing broadband within Oklahoma are through fixed and mobile wireless and cable TV services. Fixed wireless technology is different from mobile in that a stationary facility (antenna) allows for the homing on a wireless carriers signal to improve the quality of service and speed.

Mobile wireless providers use frequencies that are different than the fixed providers. The main difference between mobile and fixed wireless systems is that the fixed systems have been designed to handle larger amounts of monthly data usage and do not require the sharing of bandwidth with voice users. Fixed users can also be reached at further distances than mobile users.

Cable TV systems throughout the state have become a major player in providing broadband within their communities. Cable TV systems, once designed for providing video channels in an outward direction only, have been redesigned with return channels that transmit data both down and up the systems. The use of fiber in the network, Hybrid Fiber Coax (HFC), has allowed the systems to transmit at speeds up to 1,000 Mbps. Cable TV systems are evolving to FTTH like their telephone counterparts.

The state's broadband service providers connect to businesses, residences, schools, libraries, hospitals, cell sites and government offices. The FCC collects data from each of the carriers and provides it to the public annually. The reports are made on a national basis for speeds, latency, sustained down load speeds, and migrations of customer to higher speeds by technology. The latest reports can be viewed at fcc.gov/reports/measuring-broadband-america-2014.

Moving forward, the networks throughout the state are connected together to provide a reliable, cost-efficient service to the residents, businesses and government entities. The largest areas, where broadband services have seen the most improvement, are through the connections made with wireless cell sites. The increase in broadband availability and speed in the rural areas derive from the new LTE technology, coupled with the increased capacity brought by fiber technology over the backhaul network.

Schools and libraries also receive the benefits of the faster speeds over fiber. When a service provider invests in new plant to upgrade the broadband speeds, everyone in the community has the opportunity to connect and have faster speeds.

In the future as private and public facilities work together faster connections will be made available throughout the communities. The benefits of the higher quality and faster speeds for broadband will improve and greatly change the economic and social connections of those in the areas affected.

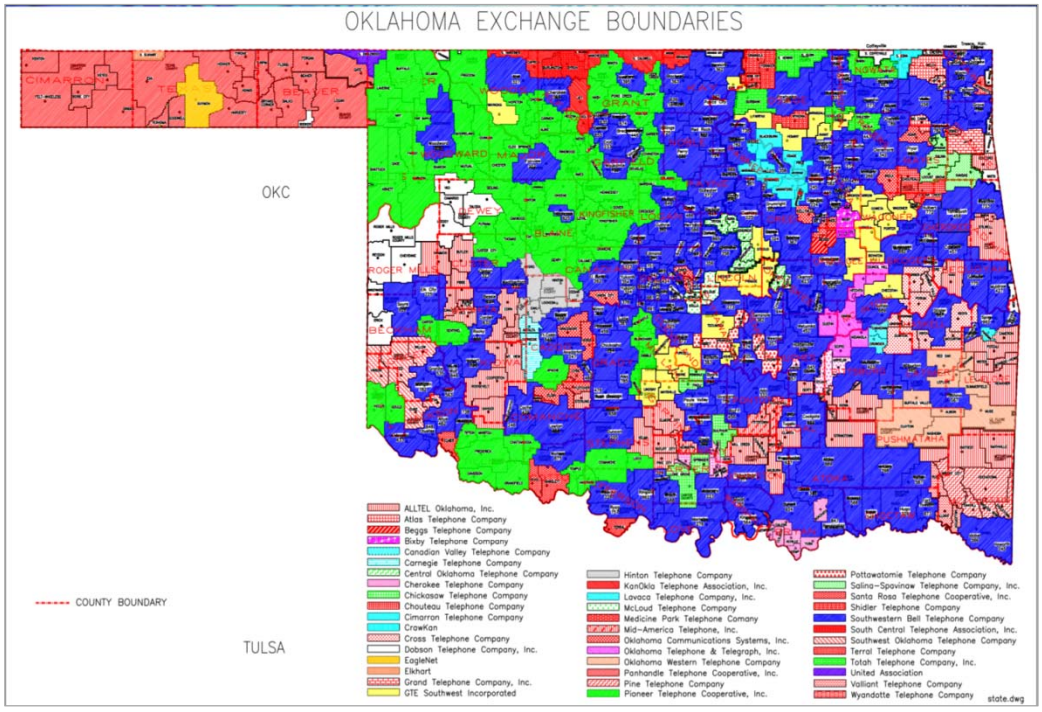


Figure 43. **Oklahoma exchange boundaries**

Broadband Needs of Small Rural Municipalities in Oklahoma

Broadband availability is crucial to the livelihood of small, rural communities in the state of Oklahoma. Small businesses located in communities with broadband availability have opportunities to further their reach into a larger customer base and compete in the global market. Furthermore, rural residents with broadband access are able to connect with general and specialized health care providers and harness educational opportunities that they otherwise would have to travel long distances to receive. Broadband also provides farmers with vital daily information concerning crops, prices and weather ("High-speed Internet and Rural Communities" n.d.) as well as allowing the elderly to age in place while continuing to have happy and healthy lives at home. Despite these opportunities and benefits both to rural residents and the state as a whole, 54% of Oklahoma's rural communities, many of them with populations of less than 5,000, are underserved or unserved by broadband services[vi].

According to the 2010 Census, there are 733 settled areas in the state of Oklahoma, covering 68,595 square miles and with a total population of 3,751,351. These settled areas are further classified into three categories; cities, towns and census designated places (CDP) resulting in 165 cities, 432 towns and 136 CDPs, for a total of 597 municipalities (see Figure 44).

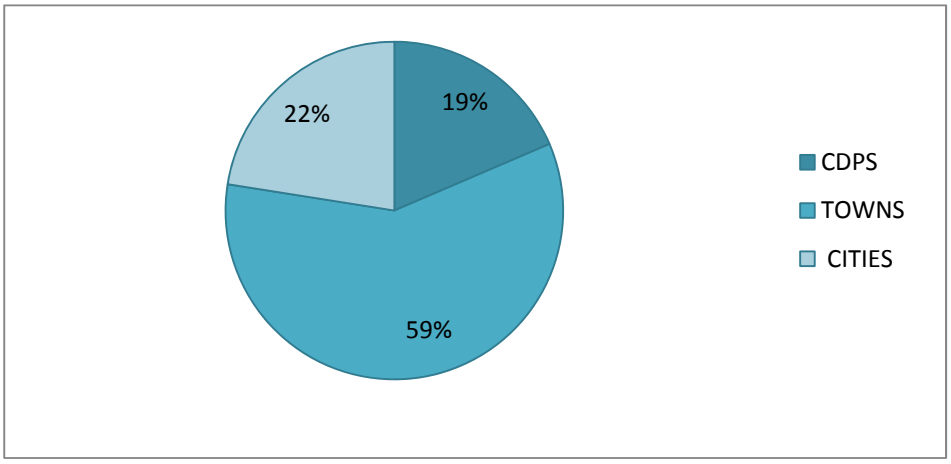


Figure 44. **Percent of cities, towns and census designated places in Oklahoma, 2010**

The majority of these towns and cities (87%, 522) have populations of 5,000 or fewer inhabitants (see Figure 45)[vii]. As for towns and cities with 5,000 or fewer inhabitants, 215 (41%) towns and cities were identified as being underserved and 60 (11%) towns and cities were unserved for wireline broadband services (University of Oklahoma Center for Spatial Analysis, 2014).

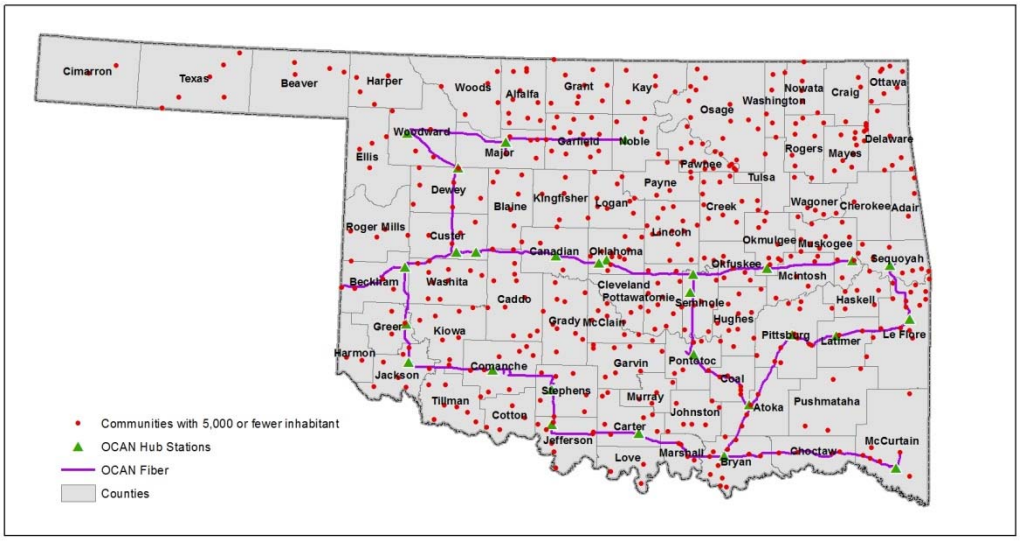


Figure 45. **Oklahoma communities with 5,000 or fewer inhabitants**

Although most of these communities need broadband services to bolster flagging economic and community growth, they face significant challenges to bringing adequate, reliable and affordable broadband services to their areas. For many small Oklahoma communities, service providers are unwilling to invest the amount of money required to build the last mile of wireline infrastructure because the small populations in these communities predicate limited returns on investment (ROI). Unfortunately this leads to an ongoing cycle of decline that small rural communities know all too well. Lack of economic growth or decline is associated with population loss which in turn supports further economic decline and so the cycle of degeneration continues.

Currently, residents of communities with limited or no broadband service utilize Community Anchor Institutions (CAIs), such as public libraries, to meet their needs. This often works for individuals when in town during work or business hours, but after hours, on weekends and for those that work from home this is not an optimal solution. Additionally, the sole reliance of a community, families, or individuals on the public library for Internet service in general is problematic for two reasons. First, while the use of libraries may serve to meet the needs of individual patrons, it does not serve community needs as a whole. Also, it may be the case that those who live in these small communities must make time consuming drives into town in order to gain access to broadband. For underserved and unserved areas, the proximity of residents to the library is extremely important for residents to benefit from vital services and resources provided through the web. Given that all libraries in Oklahoma have access to broadband service, closeness to the nearest library was measured by Euclidean distance[viii] . For households with no access to wireline broadband services, nearly 7% resided in areas greater than 15 miles from the nearest broadband enabled public library. Most of these unserved

households were located in southern Oklahoma as well as the state's panhandle while some unserved households were observed in Adair, Caddo, Garfield, Noble, Custer, Craig, Nowata and Garvin counties (see Analysis of Oklahoma Broadband Coverage & Broadband Adoption section).

All unserved towns and cities in Oklahoma had 5,000 or fewer residents. Through its efforts to map the broadband infrastructure, the OBI found that the average distance to the nearest broadband enabled community library for towns that were not able to obtain wireline broadband services was ten miles with 49 unserved communities (82%) located within 15 miles of the nearest broadband enabled community library. An additional 11 unserved communities (18%) were more than 15 miles away from a broadband enabled community library. Towns identified as being unserved and located more than 15 miles from a broadband enabled community library were located in Beaver, Kiowa, Garvin, Pittsburg, Love, Carter, Sequoyah, and McCurtain counties (see Figure 46).

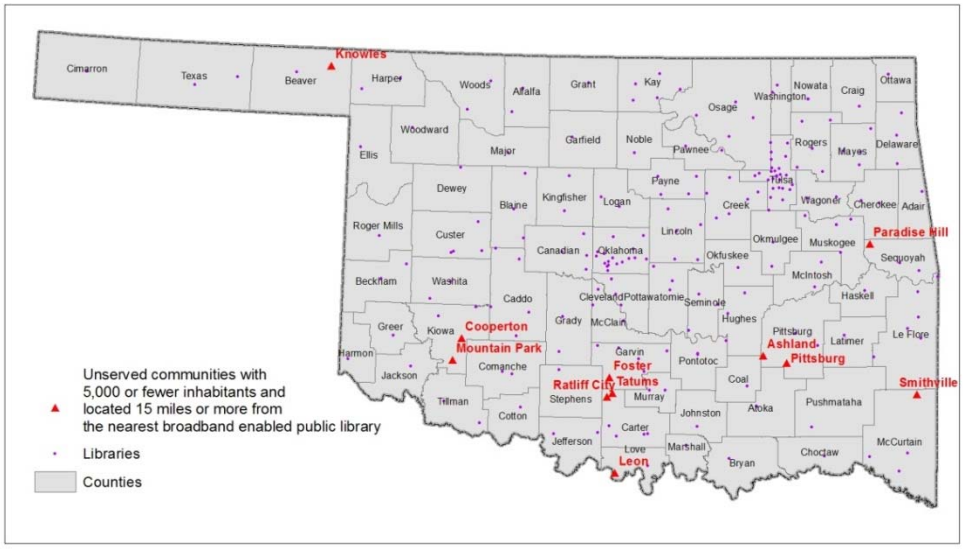


Figure 46. **Unserved communities with 5,000 or fewer inhabitants and located more than 15 miles from the nearest broadband enabled public library**

Another 215 towns with 5,000 or fewer inhabitants were identified as being underserved. Most underserved (190, 88%) towns were located within 15 miles of the nearest broadband enabled public library. An additional 25 underserved small towns (12%) were more than 15 miles to the nearest broadband enabled public library, which clustered in the northwestern and southeastern parts of the state, as well as Jackson, Beckham, Grant, Kay, Garfield counties (see Figure 47).

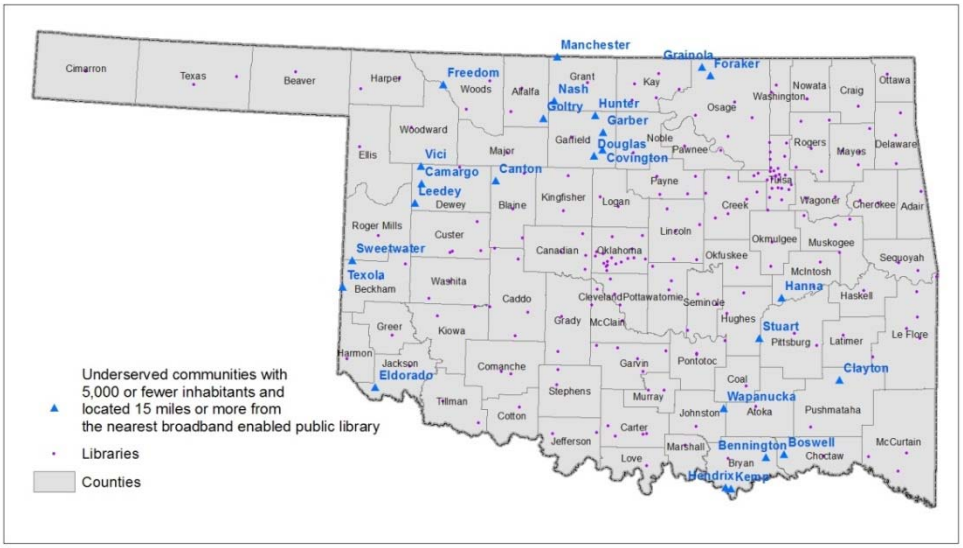


Figure *47.* Underserved communities with 5,000 or fewer residents and located more than 15 miles from the nearest broadband enabled public library

Findings from the OBI mapping and outreach initiative make clear that there is a great need for improved broadband services in the state and that most residents understand the need and desire a change. In an effort to address the needs of these communities, the state obtained funds to build 1,005 miles of middle-mile fiber infrastructure. This completed fiber route reaches 35 of Oklahoma's 77 counties and approximately 89% of the state's population. Although this phase of the OBI is in its infancy, the purpose of the OCAN is to leverage public/private partnerships to increase last mile broadband availability to rural Oklahoma. The enhancement of Oklahoma's middle mile fiber infrastructure is just the first step in a long-term strategy that will utilize the existing state fiber and new OCAN fiber to expand wireline broadband services to all residents of Oklahoma.

However, recent anecdotal information gathered by the Oklahoma Municipal League suggests that many of the leaders in these communities may not have a comprehensive understanding of the utility and potential broadband service provides. Based on information obtained from the Oklahoma Municipal League (OML)[ix] at least 30 Oklahoma municipalities

with populations less than 5,000 reported that broadband services are not available to their citizens. Three respondents to the OML's inquiry about broadband services reported that increasing broadband speed was a current project in their city or town; and only two of the three indicated that federal resources were being used to complete these projects.

Several barriers, such as budget constraints, lack of adequate education, training and skills, and limited access to online resources result in leaders of municipalities placing a lower priority on the purchase of new technology. Furthermore, a one-size-fits-all approach to the increasing demand for faster Internet will not be able to address the needs of the unserved and underserved communities in the state of Oklahoma. Efforts should be made to educate community leaders on the importance of broadband in their communities. Once community leaders understand the significance of broadband, they will be more willing and interested in increasing the broadband capabilities in their communities. Ultimately, increasing infrastructure will require money and time; however, not investing in a community's future technological capacity is likely to cost more in terms of lost economic development and population outmigration.

There are two very notable examples of communities being proactive in obtaining broadband services for their citizens. Ponca City, which now offers free Wi-Fi to its citizens because of excess bandwidth, installed its first few miles of fiber in 1997. By adding fiber in increments (generally a few miles at a time), they now have a network that exceeds 350 miles (Igonzalez, 2014). Additionally, after municipalities make the initial investment in infrastructure, they can use revenue from commercial Internet customers to pay for the network (Igonzalez, 2014). In instances where existing providers fail to offer broadband services, municipalities need to develop a long term technology plan to address their needs in a way that is uniquely tailored to their situation. The current gold standard for broadband services is fiber-to-the-home and was a dream made reality by leaders in Sallisaw, Oklahoma with DiamondNet (Christopher, 2014). Bringing broadband to small, rural communities will not be an easy task, but municipal leaders should research and weigh all of their options for making this a reality. Tapping into state funds, federal programs, and seeking partnerships with private and public sector entities, the municipalities can band together and bring broadband to their citizens. As the demand for faster Internet speeds increases, providing more access to new technologies will ultimately improve the opportunities and quality of life for those living in areas that do not have adequate broadband availability.

Smart Communities

A successful model used by communities across the nation to develop and implement long-term technology plans is the smart community model. A smart community seeks to improve the quality of life in its region by making a concerted effort to implement the use of information technology to be competitive in the global market ("The Smart community Concept", 2007)

> A 'smart community' is a community in which members of local government, business, education, health care institutions and the general public understand the potential of information technology, and form successful alliances to work together to use technology to transform their community in significant and positive ways (CALTRANS, 1997, Smart Communities Implementation Guide: What is a Smart Community).

In order to build to a smart community, it is necessary for the community, government, industry, and educational institutions to use broadband as an instrument to accomplish community objectives (Ward, 2012). Developing and initiating smart community plans will help encourage Oklahomans to familiarize themselves with new technology, and ultimately involve the entire state of Oklahoma in the global economy. There are many advantages to becoming a smart community, some of which are outlined below. Communities who successfully make this transformation ultimately increase the livelihood of their residents and increase the economic viability of their community. Those who are interested in implementing this change within their community should consult the "Smart Communities Implementation Guide" (CALTRANS, 1997). This guide can be obtained at http://www.smartcommunities.org/guide/index.html .

Benefits of Being a Smart Community

According to the U.S. Department of Education, Oklahoma continues to experience a critical shortage of math and science teachers. Additionally, in a study conducted by the Oklahoma State School Board Association, districts representing almost 75% of the public enrollment in the state reported more than 800 teaching vacancies (Office of Postsecondary Education, 2014). What is more, special education, elementary education, high school science, and high school math were among the top four "most difficult-to-fill teaching areas" (Watson, 2014). While these shortages impacted every district in the state of Oklahoma, rural districts seemed to be hit harder (Watson, 2014). In order to meet the needs of school districts, smart communities in the state of Oklahoma can use virtual instruction delivered through broadband technology (Ward, 2012). Schools can also connect parents, teachers, administrators, students, libraries, and even other schools across the globe. Currently, larger school systems in Oklahoma use tools to join parents, teachers and students to grades, schedules, class assignments, and more. Online applications can connect school systems beyond the classroom. They can even provide teachers and education beyond the four walls of the classroom to a virtual classroom. Oklahoma's virtual classroom, Oklahoma Virtual Charter Academy, allows students from kindergarten through twelfth grade to study in an online environment at their own pace ("How it Works" n.d.). Advances such as this can ensure that students throughout the state are receiving a complete education, which creates knowledgeable workers who are able to compete in a global economy (Ward, 2012). However, it is not enough that schools be broadband enabled, but students need ready access to this utility at home. Learning is not limited to the confines of the school or library building. More and more schools are finding that an effective partnership

between home and school is needed and high-speed Internet access is now a must for any learner.

Health care is another area in which a smart community can contribute to the overall quality of life of its residents. First-rate health care is dependent upon accurate information and connecting doctors and patients. Convenience and affordability are also deciding factors for health care. Smart communities can use broadband to meet the needs of their citizens by making heath care more accessible, especially in rural areas (Ward, 2012). "Broadband-enabled solutions, usually grouped under the term health information technology (HIT), can assist health care practitioners as they strive to serve patients more effectively and efficiently. HIT is an overarching term that includes electronic billing and scheduling systems, the use of electronic health records (EHRs) and automated processes for clinical care" (Ward, 2012, p. 9). HITs can be as simplistic as a patient accessing their test results from home, to complex telemedicine where a doctor can track an emergency patient from ambulance pick up to arrival at the emergency room doors. Online healthcare can be as convenient and inexpensive as receiving email invoices and making payments online, to saving the patient a long drive from a rural area to an urban doctor's office. The future of broadband technologies and Smart Communities can change the face of healthcare by bridging several gaps between doctors and patients (Ward, 2012). The notion of aging in place goes hand in hand with broadband enabled telehealth and telemedicine. The innovations made possible by high-speed Internet services, is allowing more people to remain at home in their golden years even when family members live too far to provide effective direct care. The eldercare technology field is a growing market; however, these innovations are limited to those who have the Internet capacity capable of supporting the technology.

Smart communities, particularly in rural areas, are able to access and control innovative wireless broadband networks for public safety. Additionally, these networks should be dependable and operate with other jurisdictions at the local, regional, and national level (Ward, 2012). Working to achieve this goal, Congress established the First Responder Network Board (FirstNet) in 2012. The goal of this initiative is to connect the broadband services of first responders such as police, firefighters, emergency medical professionals, and other public safety officials on a nationwide network ("The FirstNet Initiative," 2013). As part of the FirstNet national initiative, Oklahoma has implemented the Oklahoma Public Safety Broadband Network (OKPSBN), which will allow public safety organizations within the state to communicate effectively (Oklahoma Broadband Public Safety Network, 2014). OKPSBN and FirstNet are the first of many opportunities for a reliable and safe network dedicated to public safety.

In addition to public safety broadband networks, smart communities can also adopt a next-generation 911 (NG911) system. Using broadband capable devices and applications, the public can send information to public safety answering points. The NG911 system can also be

used to notify citizens about emergency situations via various electronic devices. The NG911 system allows for better response time in emergency situations, and improves public safety in general (Ward, 2012).

These examples are only a small glimpse into the possibilities of smart communities. Smart grid energy systems, up-to-the-minute weather information, security system applications and other IP connective systems have the potential to transform Oklahoma into a globally competitive state with educated and engaged citizens (Ward, 2012)

Conclusions

The purpose of this report is not to answer the question as to whether increased access to broadband in the state will improve Oklahoma's economy or create additional jobs. With the digitization of major sectors of society including commerce and trade, travel and transportation, security, social connectedness and support, health, education, arts and entertainment and spiritual communion, failure to keep up with innovations in broadband technology will ensure that states will fall behind economically as well as in the overall quality of life for its citizens. As discussed at the beginning of this report, Oklahoma's ranking on the State New Economy Index indicates that the state has already started falling behind in this regard (Atkinson & Steward, 2012). The additional 1,005 miles of new fiber represents a significant step forward. However, results from the mapping and preliminary outreach portions of the initiative indicate more is needed.

Service Availability

Currently wireline broadband technologies (i.e., fiber, cable and DSL) hold the distinction of providing higher speeds and reliable service with Fiber-to-the-Home being seen as the gold standard in broadband technology. However, only 32% of Oklahoma's land area has access to any form of wireline technology and 69% of rural households are limited to wireless technology as their only option. Over the past five years, only a slight change in coverage area was identified for cable, fiber and fixed wireless services; however, increases in speed for both wireless and wireline services were noted.

The availability of fixed wireless has increased over the past five years in northeastern areas of the state and is viewed as a cost effective alternative to wireline services. However there are still major limitations with this technology that reduce the viability of this service for many Oklahomans including required Line of Sight (LOS) between the ground station and the subscriber and a higher cost per Mbps of network bandwidth than other forms of service (Siddartha, 2012). Although more widely available to Oklahomans than wireline technologies, cellular wireless and satellite services were frequently characterized by study participants as being heavily affected by environmental conditions in the state and too expensive with

unrealistic data caps. In some areas of the state, the only option available to residents is satellite service.

With the addition of 1,005 miles of fiber to the states fiber optic infrastructure through the OCAN project, fiber is more evenly divided between urban and rural areas, but coverage is very limited in terms of both land area and households. One of the goals of future work should be to aid unserved and underserved communities in developing the resources needed to tap into the state's enhanced middle mile fiber infrastructure.

Disparity in Access

The criterion for estimating served, unserved and underserved geographic areas in the state was established by the State of Oklahoma and included only ***wireline*** service providers in the analysis. Based on NTIA's requirement to consider an area served if a single household receives services in a given block or street segment, the potential for over or underestimation is present. Served areas were geographic areas that had two or more providers serving the area **and** at least one offering download speeds greater than or equal to 3 Mbps. Underserved geographic areas served by one or more providers with download speeds between 768 kbps and 3 Mbps **or** only one provider providing download speeds greater than or equal to 3 Mbps. Unserved geographic areas were locations in which there were ***no*** providers or the existent providers offered download speeds less than 768 kbps. Overall, disparities in accessibility by geographic distribution were found in terms of urban/rural areas, concentrations of racial and ethnic populations and income.

Urban vs. Rural

The majority of urban households (91%) in the state had access to broadband services through two or more wireline providers with download speeds greater than or equal to 3 Mbps compared to 22% of rural households. The majority of rural Oklahoma households (78%) are located in unserved or underserved areas while only 9% or urban households experience this limitation. Using the states councils of governments (COGs) to identify under or unserved regions in the state, EOEDD, SODA and KEDD were identified as having the largest proportion of households located in areas that meet these criteria. Not surprising, the COGs serving the Oklahoma City and Tulsa metropolitan areas are well served with the percentage of households served for most of the other COGs much lower.

Race and Ethnicity

Asian Oklahomans enjoyed the greatest level of wireline service availability with 86% residing in areas identified as being served by at least two wireline providers with adequate download speeds. Due to the clustering of African American and Hispanic populations in and around urban areas, strong racial differences between African Americans, Whites and Hispanics in terms of access to service generally were not found. However, all of Oklahoma's historic All-Black towns (HBT) with active forms of local government are located in areas identified as being underserved or unserved by wireline technology with 46% of the residents in the HBTs

located in areas classified as underserved and 54% residing in areas unserved by wireline broadband technology.

Furthermore, the analysis revealed that a large percent of Oklahoma's American Indian households were located in areas classified as either underserved (30%) and unserved (18%) by wireline technology with only 51% of these households located in areas served by at least two wireline broadband providers. The tendency for American Indian residents in Oklahoma to live in areas identified as either under and unserved in comparison to their counterparts from other racial or ethnic groups persisted in both rural and urban areas.

Income

Overall a fairly consistent distribution was observed between urban and rural households across all three income tiers which suggest that the geographic distribution of wireline broadband services is associated with urban locations rather than income level. However, the relationship between income and broadband adoption is a much more nuanced relationship than this. Researchers were frequently reminded by participants that the perception of broadband as a luxury item and ultimately their ability to pay for such services is a function of household income.

Adoption

As stated earlier, fewer Oklahomans report having any form of Internet access in their homes when compared to U.S. residents in general (U.S. Census Bureau, 2014). Oklahoma ranked the 41st out of 50 states and the District of Columbia with 74.8% of Oklahomans reporting access to the Internet at home. Compared to Oklahoma's six neighboring states, the percentage of Oklahomans with home Internet access tied with Arkansas households and was higher than Texas and New Mexico. Following suit, Oklahoma subscription rates to services which provide speeds of at minimum of 3 Mbps download and 768 kbps upload is slightly better than Arkansas and significantly behind the .67 subscription ratio achieved in Colorado. With broadband being an engine of economic development and a necessary factor for businesses that make location decisions based on broadband availability, this information points to the need for Oklahoma to improve the uptake of broadband services.

Affordability

Overall results from the community survey and field contacts indicate that generally Oklahomans understand the need and have a desire to use high-speed Internet services. Discussions with rural Oklahomans indicate that they have a basic understanding of the difference in technologies and believe that fiber services could enrich their lives. However, along with access, affordability is a significant challenge to broadband adoption in the state. According to results from the cost survey conducted, state residents could be charged a minimum monthly Internet service charge of between $15 and $49.99, with the panhandle and southeastern quadrant of Oklahoma experiencing the highest potential monthly chargesx. Disparity in pricing was observed between urban and rural areas of the state in terms of the

monthly broadband service charges. The minimum charges for urban areas ranged from $15 to $30 as compared to $20 to $40 a month for rural areas with the cost per Mbps of bandwidth for broadband subscribers higher through fixed wireless and satellite technology than other wireline technology. When considering median household income it was found that southeastern Oklahoma residents experienced the highest ratio of minimum monthly service cost to median household income. The lowest ratio of minimum monthly cost of broadband services to median household income was found in suburban areas within metropolitan regions. These suburban areas boasted a high income level and benefited from low broadband cost. Although broadband costs were relatively low in the central part of the state, small urban pockets within metropolitan regions of low income households were also required to spend a larger portion of their household incomes to purchase broadband services.

Awareness

For non-users in urban areas of the state, there appears to be a misperception regarding broadband service availability, which is likely to be affecting adoption levels. As services are improved in rural areas, a lack of awareness of services availability could keep adoption levels down in these areas as well. These findings indicate that a general education and awareness campaign needs to be included in future projects so that the state can realize the maximum benefits for its efforts. Education and awareness campaigns also need to include discussions on the depth and breadth of services available through the Internet, how to utilize and leverage these services as well as stay safe online. With almost 25% of Oklahomans indicating they don't need Internet service, it is clear that education on the benefits beyond social connections is sorely needed. As more services move online, it is important for Oklahomans to understand that broadband Internet service is an essential tool for every individual and household.

Along with Oklahomans in general, targeted education and awareness campaigns are needed for community leaders as well. Results from the Oklahoma Municipal League's inquiry regarding plans for improving broadband capabilities in small communities throughout Oklahoma suggests that leaders may not have a clear understanding of the benefits adequate broadband services could bring to their areas. The smart communities' model for technology planning and development provides a collaborative framework that can be used to leverage existing resources and work with other stakeholders in improving community infrastructure and services.

Mobile Wireless

In Oklahoma, a large section of non-adopters rely on mobile wireless for Internet services. However, service performance through this technology is not equivalent to a wireline broadband connection, is more susceptible to environmental obstruction and weather conditions, data caps and in some cases higher costs. Preliminary, in-field speed tests suggest that smartphones did not consistently achieve advertised or minimum speeds defined by this project as broadband. However it is a good complement to wireline services and encourages Internet

usage, which helps demonstrate the relevance of broadband. It is important to note at this juncture, that significant improvements continue to be made in wireless services and these services may eventually become more comparable with wireline services in the near future.

Highlights of Other Broadband Efforts in the State

While the highlights of other broadband efforts in the state of Oklahoma outlined in this report are not comprehensive, they should still be mentioned as key enterprises that have taken strides to improve broadband capacity in the state of Oklahoma. Identified as CAIs, libraries have been able to connect to the OCAN network and provide higher speed broadband to communities. Several initiatives have produced the Oklahoma Higher Education Research Network. Private industry is now providing broadband services via Fiber-to-the-Home (FTTH) technology. In the future though, small rural municipalities should make efforts to become "Smart Communities." In developing and implementing a plan to become a Smart Community, small municipalizes can become active in the global market and thrive into the future.

Central Information Repository

As the completion of the project draws near, a few questions remain -- "What's next?" and "Who will continue the work?" The amount of effort targeted at the improvement of the states broadband infrastructure is quite impressive, but seem to be occurring independently of each other in some cases. These forerunners have been and continue to be very effective. Interfering with the innovative work being done is not suggested. Rather, a central repository of knowledge about work being done and existing resources could assist others in leveraging existing resources and connecting with others knowledgeable in the area. Key supporting activities for a centralized repository of this nature would be to:

- Update online and mapping projects developed through this initiative,
- Monitor the technological infrastructure needs of the state,
- Work with subject matter experts to identify related promising new technologies,
- Work with communities to develop and implement community based technology plans and identify resources and funding for last mile build outs,
- Assist other broadband related initiatives in leveraging resources and funding,
- Develop and implement education and awareness campaigns designed to prepare Oklahomans for participation in current and future technological environments, and
- Work with policy makers to address affordability issues for all Oklahomans.

[i] The minimum speed established refers to actual speeds obtained by the end user. Due to limitations in reported data, the FCC adopted 3Mbps as a proxy for the 4Mbps download speed (http://www.fcc.gov/document/bringing-broadband-rural-america)

[ii] Source: U.S. Census Bureau, Current Population Survey, November 2007, October 2009 & 2010.

[iii] Source: U.S. Census Bureau, Current Population Survey, Table 7, 2011.

iv NTIA grant funds were made available as part of the American Recovery and Reinvestment Act (ARRA) under the State Broadband Initiative (SBI, previously called State Broadband Data and Development or SBDD).

v Prices collected for analysis in the study excluded special offer pricing and reflects advertised standard service charges.

vi Underserved/unserved communities refer to communities with over 80% of land areas identified as being underserved/unserved.

vii The municipal boundaries for towns were provided by the University of Oklahoma Center for Spatial Analysis (2014).

viii Euclidean distance is the straight-line distance between two points in the mapping coordinate system.

ix It should be noted that only 32 of the 522 communities with populations less than 5,000 responded to this survey. Therefore, the data from this survey is not representative.

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Appendices

Appendix 1

Events Attended & Survey Locations

Year	Events/Festivals	City
2012	GIS Day	OKC
	Woody Guthrie Folk Festival	Okemah
	37th Annual Cookson Jubilee	Cookson
	Tulsa House Beautiful show	Tulsa
	Fall A Days Festival	Woodward
	Pumpkin Palooza	Hobart
	Cowboy Days Festival	Poteau
	Living Dead Center Festival	Pauls Valley
	RES Conference	Tulsa
	Oklahoma Association of Conservation Districts (OACD) Meeting	OKC?
	Annual Information Systems Leadership of Oklahoma (ISLOK) conference	OKC?
	Elgin Chamber of Commerce	Elgin
	Information Systems Leadership of Oklahoma Symposium	
2013	Oklahoma Association of Conservation Districts (OACD) Meeting	Midwest City
	GIS Day	OKC
	Annual Conference of Oklahoma Library Association (OLA)	Ardmore
	Oklahoma School Administration (CCOSA) Summer Pre-Conference	Norman
	American Heritage Music Festival (AHMF)	Grove
	Cajun Festival	Grove
	SDE Vision 2020	OKC
	Poteau Hot-Air Balloon Festival	Poteau
	Choctaw Labor Day Festival	Tuskahoma
	Joint Rural Health Conference	OKC
	Cherokee Strip Celebration	Enid
	Oklahoma Technology Association Encyclo-Media Conference	OKC
	Watonga Cheese Festival	Watonga
2014	Oklahoma Sheriffs Association Conference	OKC
	Oklahoma Sheriffs & Peace Officers Association Centennial Conference	
	Oklahoma PTA Convention	Tulsa
	Oklahoma Association of Chiefs of Police Training Conference	Norman

Table 21. Survey Locations

2011

McAlister	Seminole	Wewoka	Holdenville	Calvin
Indianola	Stuart	Arpelar	Braggs	Gore
Buffalo	Alva	Gate	Guymon	Felt

2012

Snyder	Heavener City	Hammon	Asher	Temple
Mangum	Howe	Canute	Byng	Randlett
Hollis	Panama	Foss	Francis	Frederick
Gould	Poteau	Dill City	Indiahoma	Davidson
Granite	Soper	Rocky	Headrick	Grandfield
Duke	Sawyer	Bessie	Friendship	Devol
Fort Cobb	Hugo	Mulhall	Blair	Noble
Hobart	Fort Towson	Springer	Martha	Slaughterville
Erick	Valliant	Gene Autry	Olustee	Wanette
Cheyenne	Millerton	Liberty	Eldorado	Duncan
Mountain View	Idabel	Warner	Elmer	Cache
Sentinel	Garvin	Wainwright	Weatherford	Terral
Burns Flat	Broken Bow	Loverland	Thomas	Waurika
Foss	Hitchcock	Walters City	Custer city	Ryan
Watonga	Okeene	Geronimo	Butler	Hastings
Buffalo	Forgan	Eva	Freedom	Fairview
Marlow	Beaver	Guymon	Felt	Cleo Springs
Comanche	Knowles	Hooker	Boist City	Carmen
Rush Springs	Gate	Turpin	Keyes	Alva
Lookeba	Mill Creek	Hitchita	Meno	Crescent
Hinton	Swink	Council Hill	Ringwood	Dover
Eakly	Grant	Rentiesville	Isabella	Loyal
Bridgeport	Eagletown	Eufaula	Ames	Kingfisher
Binger	Pocasset	Stidham	Drummond	Okarche
Hydro	Norge	Checotah	Henryetta	Hunter
Corn	Ninnekah	Hickory	Schulter	Kremlin
Colony	Bradley	Dougherty	Dewar	Hillsdale
Minco	Amber	Davis City	Grayson	Carrier
Union City	Alex	Wynnewood	Hoffman	Lahoma
Wayne	Weleetka	Okarche	Covington	Orlando
Pink	Dustin	Piedmont	Garber	Perry
Lima	Wetumka	Cromwell	Breckenridge	Lucien
Bowlegs	Goldsby	Bearden	Fairmont	
Maud	Cole	Castle	Douglas	
St Louis	Dibble	Boley	Waukomis	
Macomb	Lindsay	Paden	Bison	
Tribbey	Erin Springs	Prague	Hennessey	

Cashion	Maysville	Meeker	Dover
Cimarron City	Paoli	Clearview	Kingfisher

2013

Velma	Choctaw	Helena	Roff	Kaw City
Bray	McLoud	Aline	Fitzhugh	Braman
Katie	Dale	Waynoka	Rosedale	Blackwell
Foster	Johnson	Dacoma	Byars	McCord
Elmore City	Earlsboro	Ringling	Stratford	Tonkawa
Tatums	Brooksville	Cornish	Hanna	Madill
May	Lambert	Thackerville	Dustin	Kingston
Laverne	Helena	Marietta	Red Rock	Boswell
Shattuck	Deer Creek	Leon	Marland	Mead
Gage	Tonkawa	Wilson	Duchess Landing	Bokchito
Fargo	Nardin	Healdton	Texanna	Bennington
Longdale	Medford	Konawa	Shady Grove	Armstrong
Canton	Renfrow	Goltry	Weatherford	Kemp
Camargo	Leedey	Wellston	Coweta	Hendrix
Oakwood	Arnett	Warwick	Porter	Durant
Lamont	Kendrick	Ponca City	Depew	Colbert
Pond Creek	Fallis	Newkirk	Bristow	Calera
Jefferson	Davenport	Kildare	Stroud	Achille
Nash	Carney	Cushing	Yale	Cartwright
Jet	Harrah	Kellyville	Ripley	Drumright
Perkins	Oilton	Langston	Coyle	Tryon
Agra	Konowa	Stonewall	Roff	Fitzhugh
Rosedale	Byars	Stratford	Mannford	Osage
Terlton	Skedee	Pawnee	Avant	Hominy
Jennings	Hallett	Cleveland	Skiatook	Pawhuska
Wynona	Barnsdall	Dickson	Mannsville	Ravia
Tishomingo	Milburn	Washington	Wagoner	Okay
Tullahassee	Porter	Gregory	Chouteau	Locust Grove
Verdigris	Chelsea	Foyil	North Miami	Commerce
Quapaw	Welch	Bluejacket	Vinita	Lenopah
Delaware	Wilson	Tatums	Springer	Ratliff City
Healdton	Gene Autry	Tullahassee	Salina	Spavinaw
Ologah-Talala	Justice	Pryor	Pryor Creek	Adair
Gregory	Wilburton	Red Oak	Fanshawe	LeFlore
Stringtown	Rattan	Antlers	Wapanucka	Lane
Vian	Paradise Hill	Carlisle	Notchietown	Sasakwa
Francis	Spaulding	Atwood	Shady Point	Bokoshe
Stigler	McCurtain	Keota	Kansas	Roland
Colcord	Jay	Grove	Gregory	Justice
Tiawah Hills	Bernice	Copeland	Afton	Fairland
Gideon	Briggs	Hulburt	Peggs	Stilwell

Lyons Switch	Watts	Christie	Peavine	Westville
Grandview	Park Hill	Woodall	Longtown	Whitefield
Kinta	Quinton	Crowder	Canadian	Indianola
Mulburry	Maryetta	Elm Grove	Fairfield	Cherry Tree
Zion	Titanic	Short	Belfonte	Long
Spiro	Fort Coffee	Arkoma	Pocola	Rock Island

2014

Brent	Gans	Long	Belfonte	Short

Appendix 2

Table 22. Definition of Providers and Participation Adopted by Sanborn

Total Universe of Possible Providers	This is the list of all possible broadband providers compiled from various sources such as Federal Communications Commission (FCC) list of companies that file Form 477, lists of members of cable associations, wireless service providers, web research and local knowledge.
Providers Not Participating	Providers who were contacted by Sanborn to participate in the NTIA SBI program for Oklahoma, who are valid broadband providers but told Sanborn that they were not interested in participating or did not submit data.
Shell	A subsidiary/joint venture or provider that has merged with or acquired by another provider. Data from the shell is usually included in the data received from another company.
Non-providers	Providers who were identified in the above universe of providers but are not actually provisioning service based on the NTIA requirements of speeds and time of deployment of service. (see definition below of Actual Providers)
Resellers	A company which purchases a block of cellular numbers or a block of long distance minutes from a wireless or a wireline carrier respectively blocks to its customers
Difficulty Contacting	Potential broadband providers who have been contacted multiple times by Sanborn using various medium such as email and phone message, but have not called back or showed any interest in participating in this program. These providers have not refused to participate but have been unresponsive to any contacts.
Actual Providers	These are Internet Service Providers (ISPs) who provision broadband using NTIA's definition of broadband – *"broadband service" is "available" at a location if the provider does, or could, within a typical service interval (7 to 10 business days) without an extraordinary commitment of resources, provision two-way data transmission with advertised speeds of at least 768 kilobits per second (kbps) downstream and greater than 200 kbps upstream to end-users at that location."* *Internet Service Providers (ISPs) are not "end users" for this purpose. An entity is a "facilities-based" provider of broadband service connections to end user locations if any of the following conditions are met: (1) it owns the portion of the physical facility that terminates at the end user location; (2) it obtains unbundled network elements (UNEs), special access lines, or other leased facilities that terminate at the end user location and provisions/equips them as broadband; or (3) it provisions/equips a broadband wireless channel to the end user location over licensed or unlicensed spectrum.*
Actual Providers Participating	Providers of broadband that meet the above definition of broadband and who have provided data and are participating in the NTIA SBI program for

	State of Oklahoma. This also counts all the shells described above.
% of Participation	Percentage of actual providers who are participating in the NTIA SBI program for State of Oklahoma and include shells.

Appendix 3

Provider Participation Status

Sanborn contacted a total of 217 providers in OK for Submission 9 (S9).

Sanborn identified 115 potential providers (155, if shells are included), of which 94 are participating in this map as of S9 which includes shell providers and 21 have refused to participate. In addition, 7 providers have not responded to Sanborn's efforts to contact them and it is not clear whether any of these providers are actual providers or not. A list of the participating providers, shell providers, non-responders, resellers and non-providers is provided below.

Participating Providers

1 Advanced Automation LLC (NEOKNET)
2 AirLink Internet Services
3 Airosurf Communications
4 Allegiance Communications, LLC
5 Arbuckle Communications
6 AT&T Communications of Texas Inc / AT&T Inc
7 AT&T Mobility LLC
8 Atlas Broadband
9 Atlink Services
10 BCI/ James Cable, LLC/MediaStream
11 Beggs Telephone Company, Inc.
12 Bixby Telephone Co.
13 Broken Bow Cable
14 Cable One, Inc.
15 Canadian Valley Telephone Company
16 Carnegie Telephone Company
17 Cellco Partnership / Verizon Wireless
18 Cellular Network Partnership / CNP
19 Central Cellular LLC / dba COTC Connections
20 Central Oklahoma Telephone Co., LLC
21 Century Link
22 Cherokee Telephone Company
23 Chickasaw Telephone Company
24 Chouteau Telephone Company / FairPoint Comm
25 Cimarron Telephone Company / MBO Corp
26 Cogent Communications, Inc.
27 Community Cablevision Company
28 Cowboy.Net
29 Cox Oklahoma Telecom, LLC
30 Craw-Kan Telephone Cooperative, Inc.

31 Cricket Wireless/ Leap Wireless International Inc
32 Cross Cable LLC / Cross Telephone Co
33 Cross Telephone Company
34 Cross Valliant Cellular dba Sprocket Wireless
35 Cross Wireless / Sprocket Wireless
36 DCM – Del Nero Communications Management – WIMAX
37 Diamond Net/ City of Sallisaw
38 Dobson Telephone Company
39 Elkhart Telephone Co., Inc.
40 Fidelity Cablevision Inc / Fidelity Comm Co
41 Get Real II LLC / Get LLC
42 Grand Telephone Company
43 Hinton CATV (THE) / Hinton Holding Co
44 Hinton Telephone Company / Hinton Holding Co
45 HNS Licensed Sub LLC / Hughes Comm Inc
46 HTS Wireless/Hudson Technologies
47 Jab Broadband
48 KanOkla Communications Inc / KanOkla Tele Assn
49 KanOkla Telephone Association, Inc
50 Lavaca Telephone CO / Pinnacle Communications
51 Level 3 Communications, LLC
52 Martineer.net
53 Medicine Park Telephone Company
54 Oklahoma Western Telephone Company
55 Oklatel Communications, Inc
56 Omega 1 Wireless
57 Ozark Telephone Company / Seneca Telephone Co
58 Panhandle Telecommunication Systems Inc
59 Panhandle Telephone Cooperative Inc
60 Pine Telephone Company
61 Pioneer Telephone Cooperative, Inc.
62 Plainsnet, LLC
63 Pottawatomie Telephone Company Inc / MBO Corp
64 Precision Wireless Internet/PWI
65 Provalue.net
66 Resonance Broadband
67 RuraliNet LLC
68 Salina Spavinaw Telephone Company Inc.
69 Santa Rosa Telephone Coop, Inc.
70 Seneca Telephone Company
71 Shidler Telephone Company
72 Skycasters

73 South Central Telephone Assn.
74 Southwest Oklahoma Telecommunications, Inc.
75 Southwest Oklahoma Telephone Company
76 Sprint Nextel Corporation
77 StarBand Communications Inc.
78 Suddenlink Communications / Cequel Communications
79 Taloga Cable
80 TDS Telecommunications Corp.
81 The Junction
82 T-Mobile USA Inc / Deutshe Telekom AG
83 Totah Communications, Inc.
84 TW Telecom of Oklahoma LLC
85 United States Cellular Corporation / Tel & Data Sy
86 United Telephone Assn Inc
87 Valliant Telephone Company
88 Valnet
89 Vaxeo Technologies, LLC
90 ViaSat/WildBlue Communications, Inc.
91 Wavelinx / Terral Telephone Co
92 Wichita Online Inc.
93 Windstream Corporation
94 XO Communications Services, Inc.

Shell Providers

1 ALLIANCE COMM NETWORK
2 AT&T Corp / AT&T Inc
3 AT&T Services Inc / AT&T Inc
4 BartNET
5 Brinks Networks
6 Broadwing Communications LLC / Level 3 Comm
7 BTC Broadband / Bixby Telphone
8 CableLynx
9 Cebridge Acquasitions LP / Suddenlink Comm
10 Classic Cable of Oklahoma Inc / Suddenlink Comm
11 Clearwire
12 Cox Com Inc.
13 Datz
14 DIRECT WAY
15 Duracom
16 Grandlinx / Terral Telephone Co
17 Intelleq Comm Corp / DWL Holding Co
18 MBO Video

19 Mid-America Telephone Inc / TDS Telecom
20 New Cingular Wireless Services / AT&T Corp
21 NuVox, Inc. / Windstream Corp
22 Oklahoma 5 Licensee Co., LLC
23 Oklahoma Comm Systems Inc / TDS Telecom
24 Oklahoma Windstream / Windstream Corp
25 Partnership Broadband
26 Rhino Communications
27 RSI Communications
28 Southern Plains Cable
29 Terral Telephone Company
30 TW Telecom Holding
31 Valor Telecom of Texas / Windstream Corp
32 Vroom Wireless, LLC
33 WestOK Internet
34 Whitespace LLC / Terral Telephone Co
35 Wilnet Communications LLC
36 WilTel Communications LLC / Level 3 Comm
37 Windstream Oklahoma / Winstream Corp
38 Wireless Broadband of Oklahoma
39 Wyandotte Telephone Company / TDS Telecom
40 Xanadoo Holdings, Inc.

Non-providers

1 4D Networks Corp.
2 ACRS 2000, Inc.
3 Blossom Telephone Company, Inc.
4 Cable West
5 Charter Communications
6 COMCAST CABLE COMMUNICATIONS, INC.
7 Cyber Rover
8 Fulltel
9 INETmax
10 IO-2 Services
11 KoehlerPro Wireless
12 LightEdge Solutions Inc.
13 Magic Wireless Internet Service Providers LLC
14 McLeodUSA Telecom Services Inc. / PaeTec Corp
15 MEDIACOM LLC
16 OKC Broadband (Ideal Advertising Inc.)
17 OneLink Wireless

18 OneNet
19 Pavlov Media
20 PCS Internet Services
21 PRIDE Network, Inc.
22 Qwest Communications Company, LLC
23 ruralOK
24 Stouffer Communications / Granby Telephone
25 Stratos Offshore Services Company
26 Telovations, Inc.
27 Texhoma Wireless
28 The Internet Shop
29 Tulsa MetroNet
30 United Wireless Communications, Inc.
31 UnplugUSA
32 UTPhone Inc.
33 VectorLink
34 Verizon Business Global LLC dba Verizon Business
35 Vidia Communications, Inc.
36 Zayo Enterprise Networks, LLC

Resellers

1 Broadview Networks Holding Inc.
2 BullsEye Telecom, Inc.
3 Earthlink
4 Enventis Telecom Inc. / Hickory Tech Corp
5 eVolve Business Solutions LLC/Cincinnati Bell Inc.
6 Global Crossing Telecommunications Inc.
7 Greenfly Networks, Inc.
8 Intelletrace, Inc.
9 LocalNet Corp
10 Logix Communications, LP
11 Metropolitan Telecommunications of Oklahoma, Inc.
12 Network Innovations, Inc.
13 New Edge Network, Inc.
14 NewRoads Telecom
15 Optimum
16 Reallinx, Inc.
17 Telefonica USA, Inc.
18 TulsaConnect
19 Westel, Inc.

Non-Responders/Difficulty Contacting

1. eConnect
2. HDR Internet Services/ OnALot.com
3. KPowerNet, LLC/KAMO
4. Lakeview Cable
5. ms bit
6. Onlineok.com
7. Utopian Wireless Corporation

Not-Participating

1. Atlas Telephone Company
2. Buford Media Group, LLC
3. Coalgate Internet
4. CSWEB.NET
5. DataFlys
6. EasyTEL Communications
7. Flash-Link Internet Service
8. horizon net
9. LRC Group
10. Meetpoint Networks
11. Meriplex Communications, Ltd.
12. Picks Communication
13. PriceNET Wireless
14. Reach Broadband
15. RecTec
16. Sooner Wireless
17. Summit Digital, Inc.
18. Tahlequah Cable/WEHCO Video, Inc.
19. University Corporation for Advanced Internet
20. upperspace.net
21. WPS, Inc.

Appendix 4

Geographic Distribution of Served, Unserved and Underserved Areas by Oklahoma Councils of Government Regions

Table 23 shows estimates of the number of households served, underserved and unserved in Oklahoma by Council of Governments (COGs) regions. The numbers reported are based on broadband data collected by Sanborn as of June 30, 2013 and demographic data from 2010 U.S. Census. As the households data by census block was not available at the beginning of the project, geographic distribution of served, underserved, and unserved households was first analyzed at a county level. With the release of the 2010 household data at the census block level, a second set of estimates were developed. Estimate ranges provided in Table 23 were obtained by using two different estimation methods. The tight interval between estimates for most COG regions indicate fairly strong agreement between the methods used. Specifically, the method used by Sanborn was based on count level census data along with the use of linear miles for processing street segments. The method used by OUCSA relied on census block level data and applied buffers to process street segments. Estimates developed using county level census data and linear miles tend to result in a higher percent of served households and a lower percentage of unserved households than the method using census block data with buffers. Estimates at a county level tend to result in a higher percentage of served households and lower percentage of unserved households (see Table 25) than estimates using block level household data (see Table 24).It is reiterated that the information presented here are interval estimates and do not imply any level of statistical precision. In considering the estimates provided in the tables below and in the appendices, it is important to understand the method used to estimate the number of households (blocks and road segments) as well as the method used to generate the estimates at the various levels of census geographies.

The estimates provided in Table 23 indicate that the largest unserved populations with over 20% of the households unserved by broadband are located in the Eastern Oklahoma Economic Development District (EOEDD), the Southern Oklahoma Development Association (SODA) and the Kiamichi Economic Development District (KEDD). These three regional COGs also have the largest percentage of underserved households and consequently the lowest percentage of served households in Oklahoma. Not surprisingly, the area around Oklahoma City is the best performing area, with 87-88% of the households served. The Indian Nations Council of Governments (which includes the City of Tulsa) ranks a close second in the percentage of households served, also with about 87% of the households served. These findings indicate that the COGs serving the two major metropolitan areas are well served but thereafter, there is a sharp drop in the percentage of households served. The percentage of households served is in the 50% range for most of the other COGs. Maps showing served, underserved and unserved for each COG were created each year and the latest maps from Submission 8 (data current as of June 30, 2013) are provided in this Appendix

Figures 48 through 57. These maps show thepattern of served, underserved and unserved across the COG and show pockets of served in urban areas in all COGs.

Table 23. Estimates of Served, Underserved and Unserved Households by Regional Councils of Governments (COGs)

Council of Governments (COGs)	% Households Served	% Households Underserved	% Households Unserved	Total Households
Association of Central Oklahoma (ACO)	87-88%	10%	2-3%	443,628
Association of South Central Oklahoma (ASCO)	50-55%	32-35%	13-15%	114,870
Central Oklahoma Economic Development District (COEDD)	49-51%	32-33%	17-19%	94,971
Eastern Oklahoma Economic Development District (EOEDD)	41-42%	29-31%	27-30%	119,952
Grand Gateway Economic Development District (GGEDD)	44-46%	37-38%	17-19%	108,281
Indian Nations Council of Governments (INCOG)	87%	9%	3-4%	286,481
Kiamichi Economic Development District (KEDD)	32-35%	41-42%	23-26%	70,179
Northern Oklahoma Development Association (NODA)	57-59%	33-35%	8%	64,097
Oklahoma Development Association (ODA)	52-60%	32-38%	8-10%	26,891
South Western Development Association (SWDA)	59%	28-29%	13%	42,448
Southern Oklahoma Development Association (SODA)	50-51%	24-25%	23-26%	88,650
Oklahoma (Totals)	67-69%	21%	10-12%	1,460,450

Note: Although there is not a large difference in estimates, ranges are provided for served, underserved, and unserved households as estimates were obtained using two differing sets of assumptions. See page 106 of this report for a discussion of the methodologies used to estimate the number of affected households. The range of estimates comes from calculation at county and block levels (see Appendix , Table 24 and Table 25.

Table 24. Estimates of Households Served, Underserved and Unserved by Regional Councils of Governments (COGs) Using Census Block Level Data and Buffers to Process Street Segments

	Total Households	Households Served	% Households Served	Households Underserved	% Households Underserved	Households Unserved	% Households Unserved
Association of Central Oklahoma (ACO)	443,628	391,918	88%	42,167	10%	9,543	2%
Association of South Central Oklahoma (ASCO)	114,870	63,010	55%	36,673	32%	15,187	13%
Central Oklahoma Economic Development District (COEDD)	94,971	48,696	51%	30,214	32%	16,061	17%
Eastern Oklahoma Economic Development District (EOEDD)	119,952	50,853	42%	37,020	31%	32,079	27%
Grand Gateway Economic Development District (GGEDD)	108,281	49,493	46%	40,809	38%	17,979	17%
Indian Nations Council of Governments (INCOG)	286,481	250,470	87%	27,045	9%	8,966	3%
Kiamichi Economic Development District (KEDD)	70,179	24,728	35%	29,087	41%	16,364	23%
Northern Oklahoma Development Association (NODA)	64,097	37,589	59%	21,326	33%	5,182	8%
Oklahoma Development Association (ODA)	26,891	16,057	60%	8,702	32%	2,132	8%
South Western Development Association (SWDA)	42,448	25,203	59%	11,938	28%	5,307	13%
Southern Oklahoma Development Association (SODA)	88,650	45,578	51%	22,331	25%	20,741	23%
Oklahoma (Totals)	1,460,450	1,003,597	69%	307,312	21%	149,541	10%

Note: The estimates are based on the assumption that households are evenly distributed within a census block.

Table 25. Estimates of Households Served, Underserved and Unserved by Regional Councils of Governments (COGs) Using Census Block Level Data and Linear Miles to Process Street Segments

	Total Households	Households Served	% Households Served	Households Underserved	% Households Underserved	Households Unserved	% Households Unserved
Association of Central Oklahoma (ACO)	443,628	387,925	87%	44,216	10%	11,409	3%
Association of South Central Oklahoma (ASCO)	114,870	57,689	50%	39,862	35%	17,364	15%
Central Oklahoma Economic Development District (COEDD)	94,971	46,303	49%	30,916	33%	17,813	19%
Eastern Oklahoma Economic Development District (EOEDD)	119,954	49,724	41%	34,938	29%	35,419	30%
Grand Gateway Economic Development District (GGEDD)	108,281	47,827	44%	40,003	37%	20,445	19%
Indian Nations Council of Governments (INCOG)	286,481	248,412	87%	26,367	9%	11,622	4%
Kiamichi Economic Development District (KEDD)	70,179	22,192	32%	29,588	42%	18,389	26%
Northern Oklahoma Development Association (NODA)	64,097	36,379	57%	22,456	35%	5,415	8%
Oklahoma Development Association (ODA)	26,891	14,075	52%	10,228	38%	2,615	10%
South Western Development Association (SWDA)	42,448	24,946	59%	12,148	29%	5,338	13%
Southern Oklahoma Development Association (SODA)	88,650	44,353	50%	20,999	24%	23,334	26%
Oklahoma (Totals)	1,460,450	979,826	67%	311,721	21%	169,163	12%

Note: The estimates are based on the assumption that households are evenly distributed within a county.

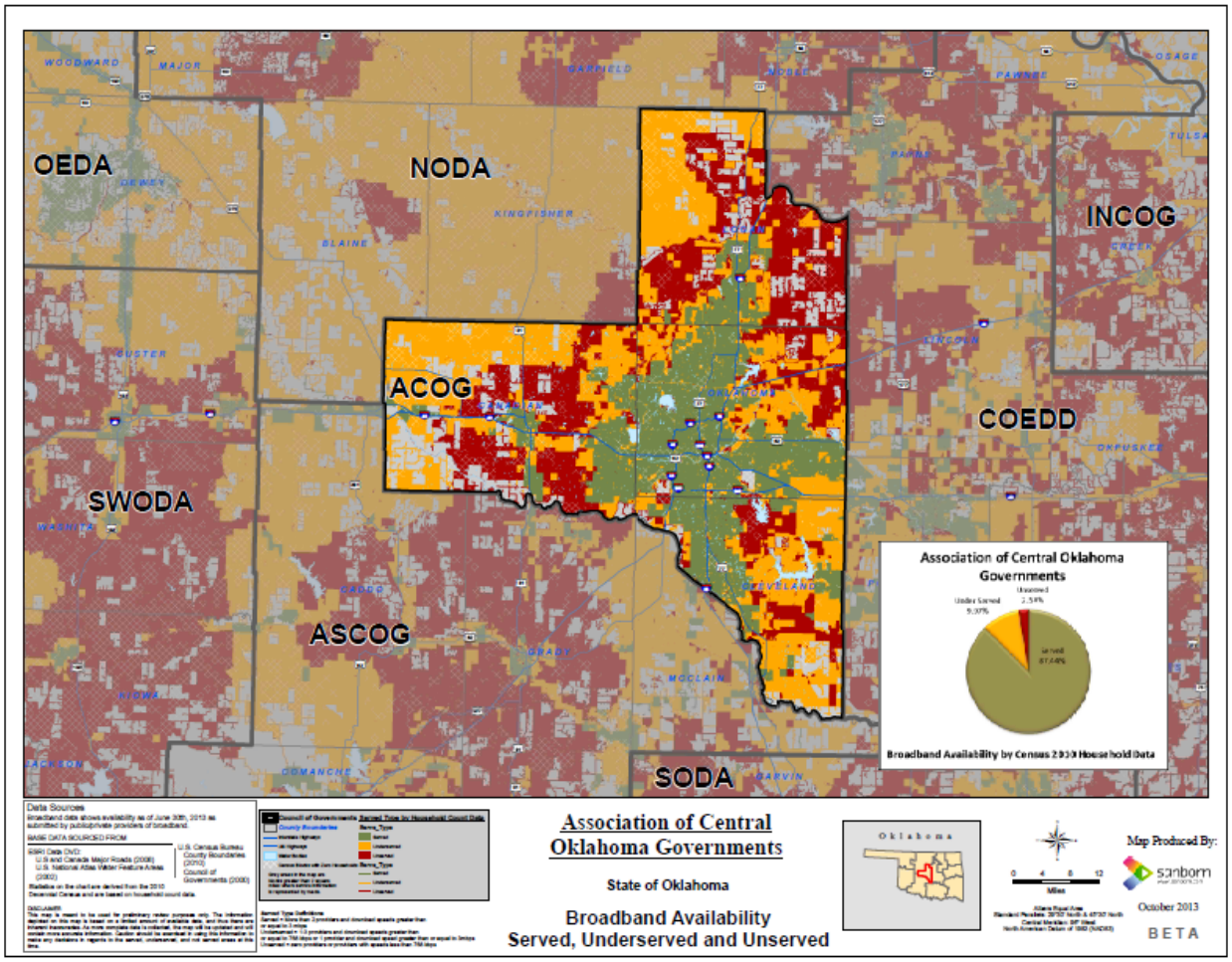

Figure 48. Areas Served, Underserved and Unserved by Broadband for ACOG, 2013

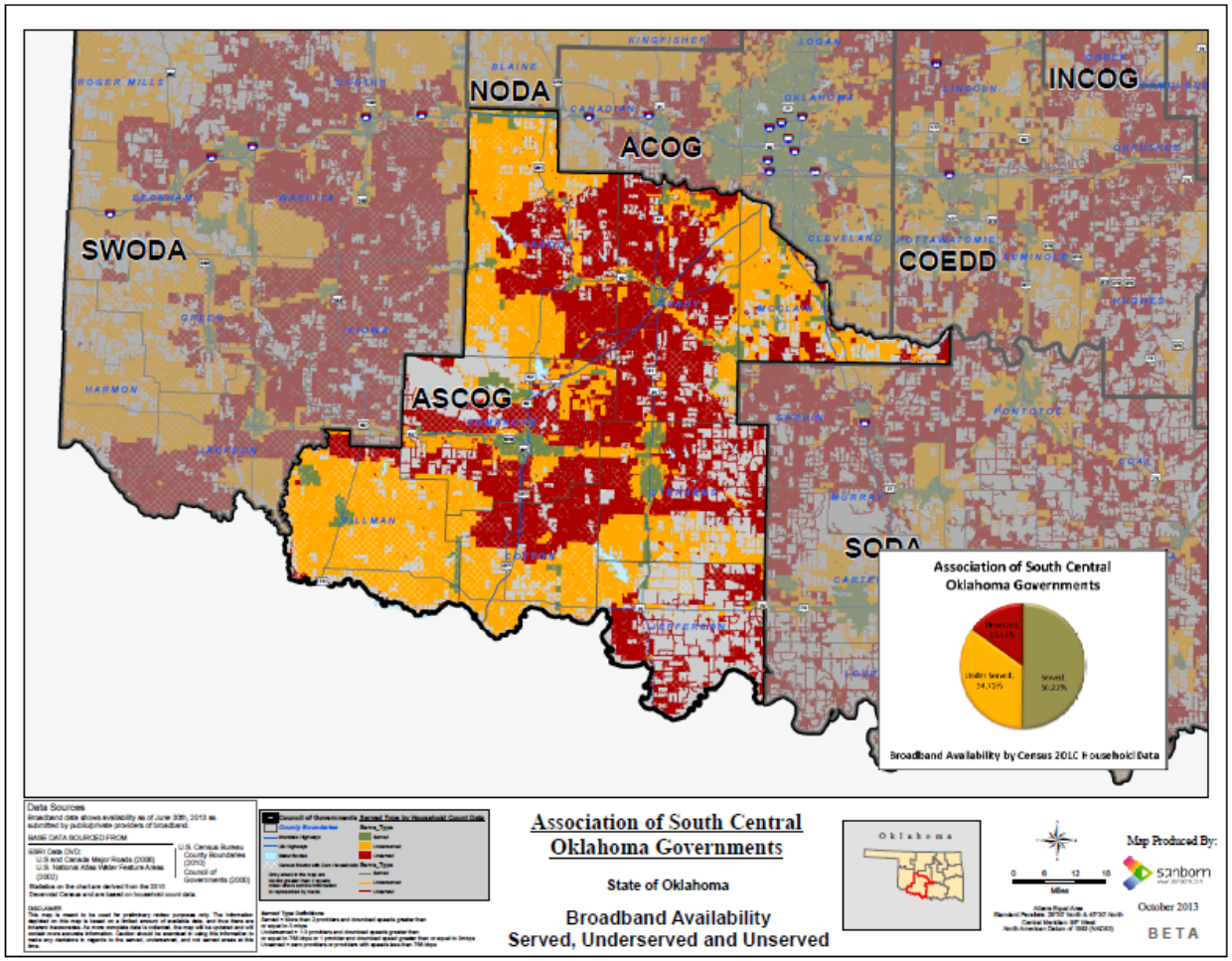

Figure 49. **Areas Served, Underserved and Unserved by Broadband for ASCOG, 2013**

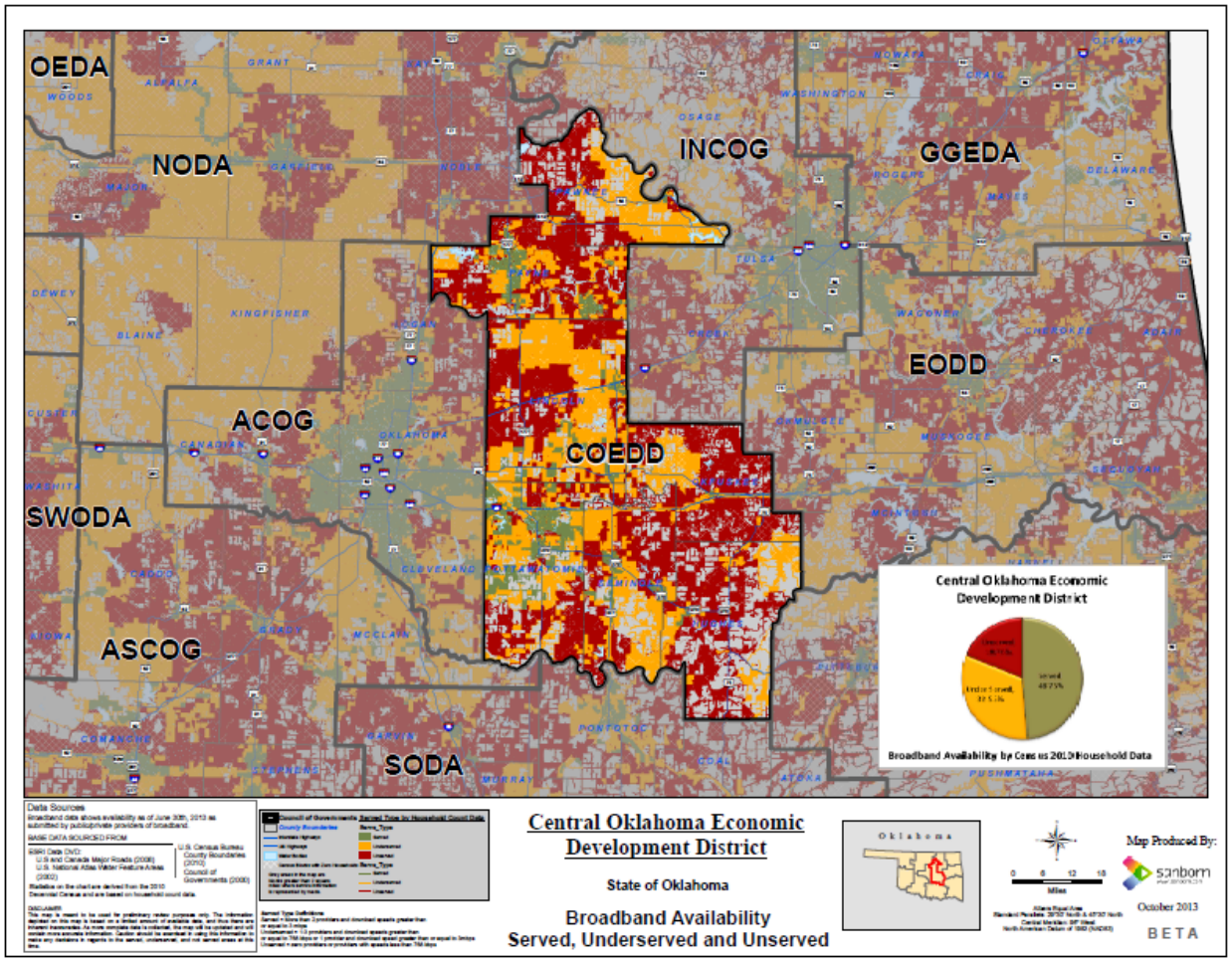

Figure 50. **Areas Served, Underserved and Unserved by Broadband for COEDD, 2013.**

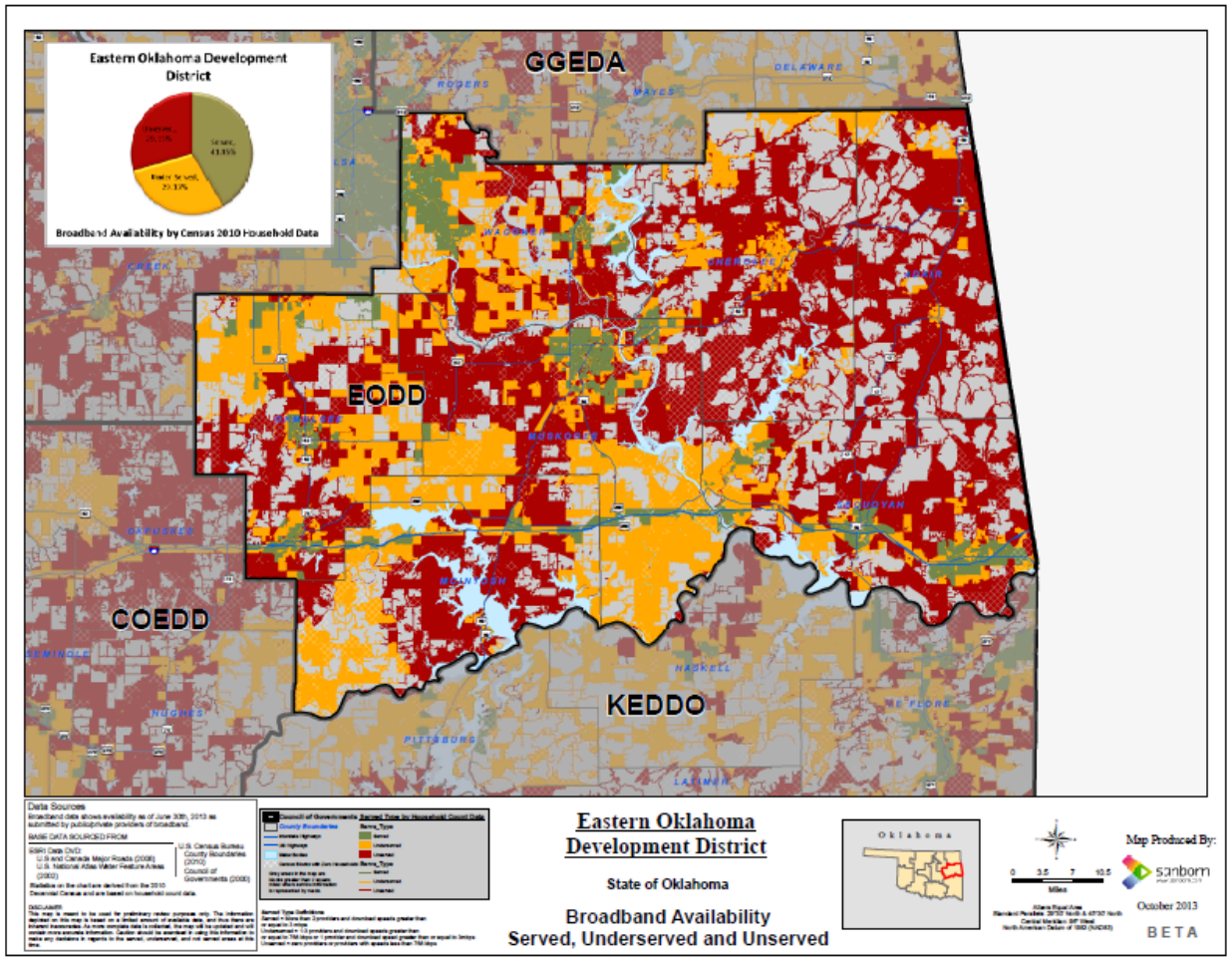

Figure 51. **Areas Served, Underserved and Unserved by Broadband for EODD, 2013**

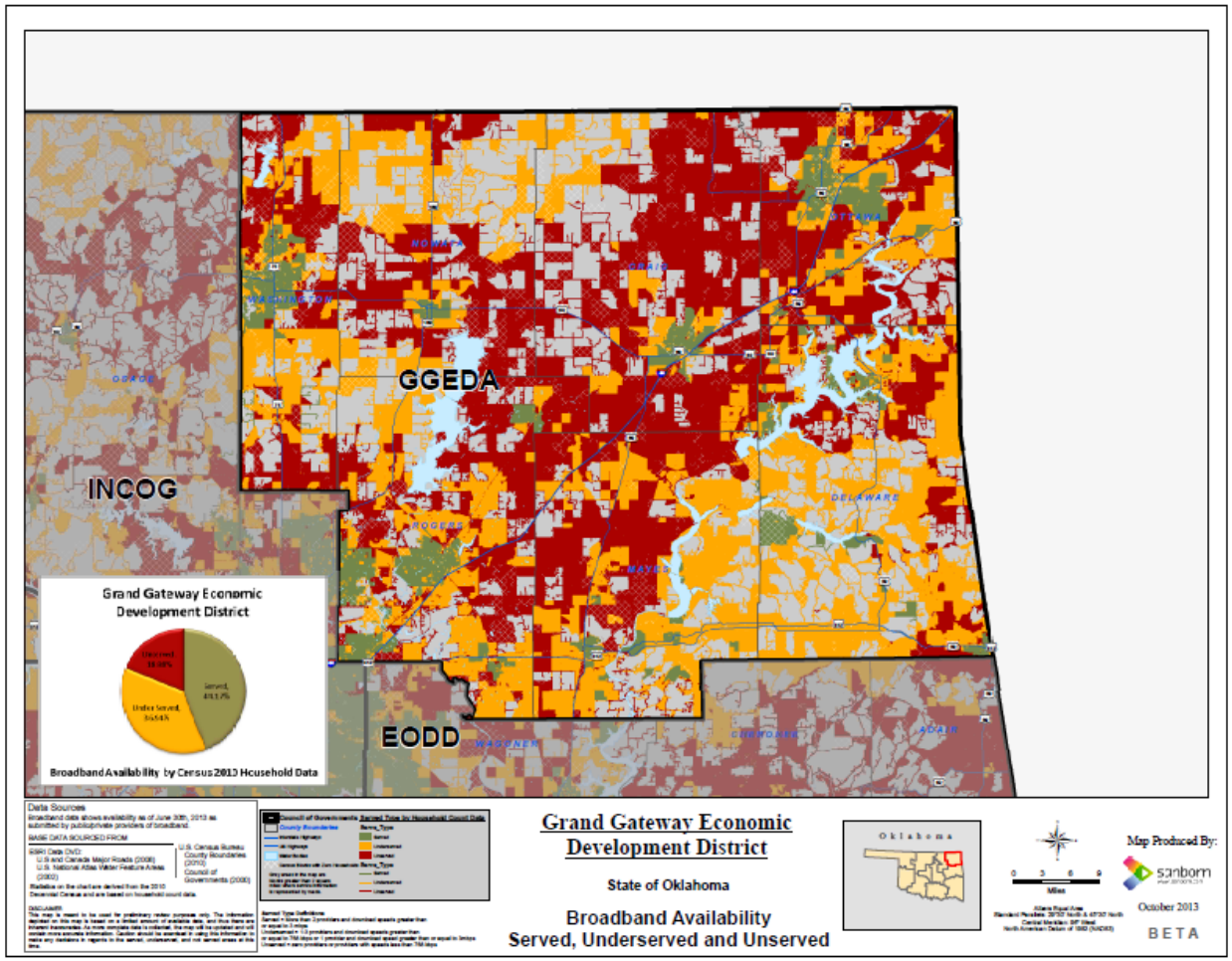

Figure 52. **Areas Served, Underserved and Unserved by Broadband for GGEDA, 2013**

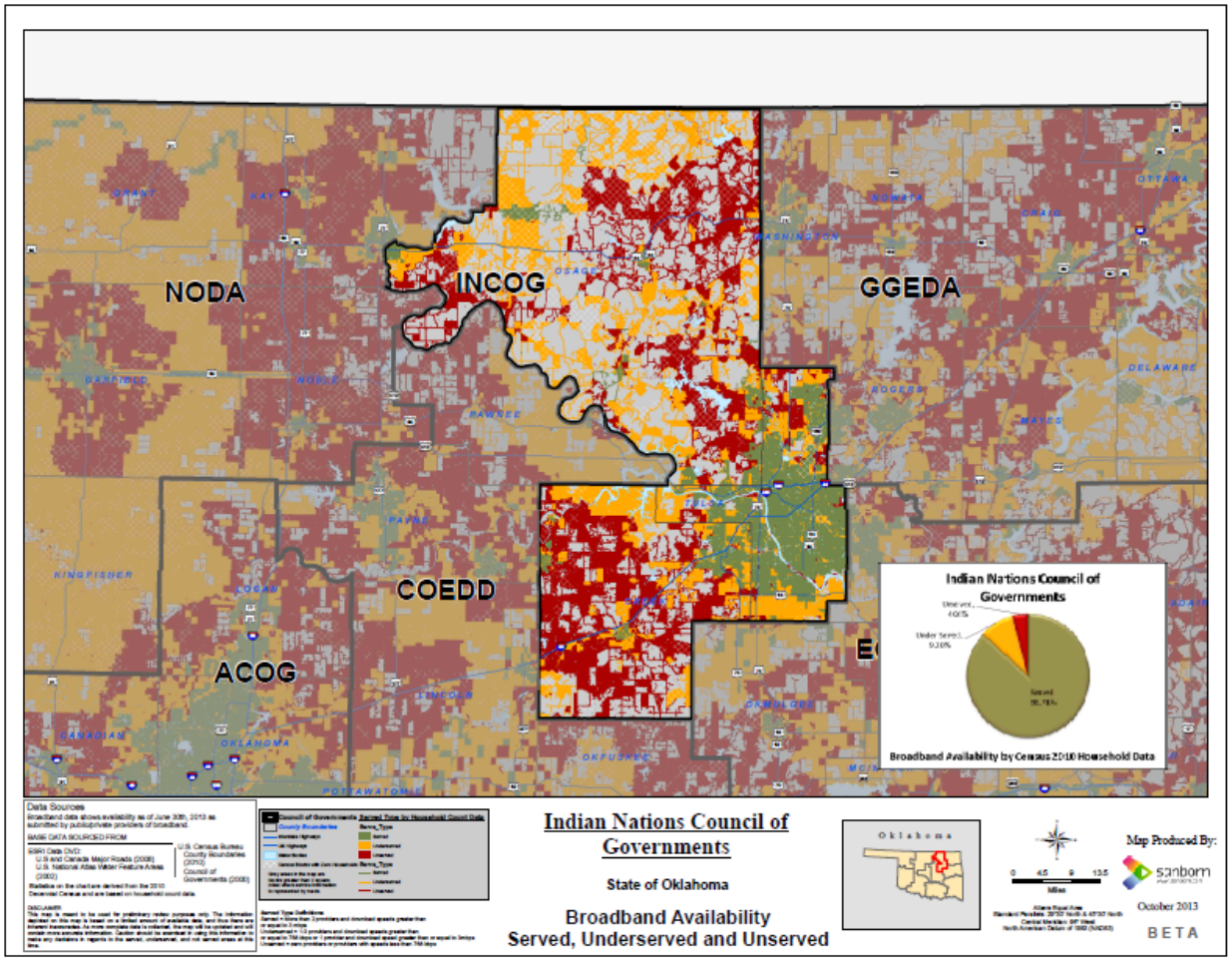

Figure 53. **Areas Served, Underserved and Unserved by Broadband for INCOG, 2013**

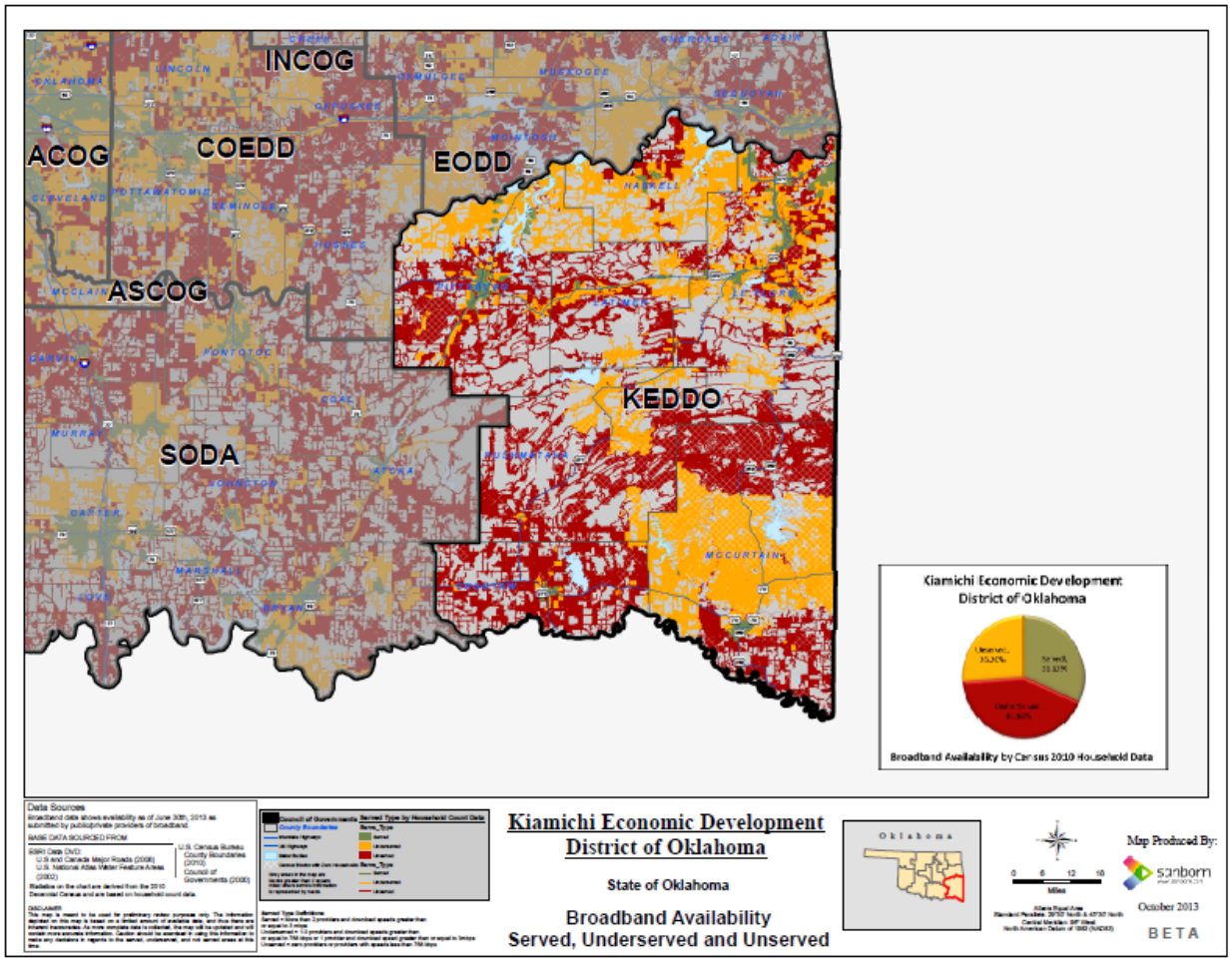

Figure 54. **Areas Served, Underserved and Unserved by Broadband for KEDDO, 2013**

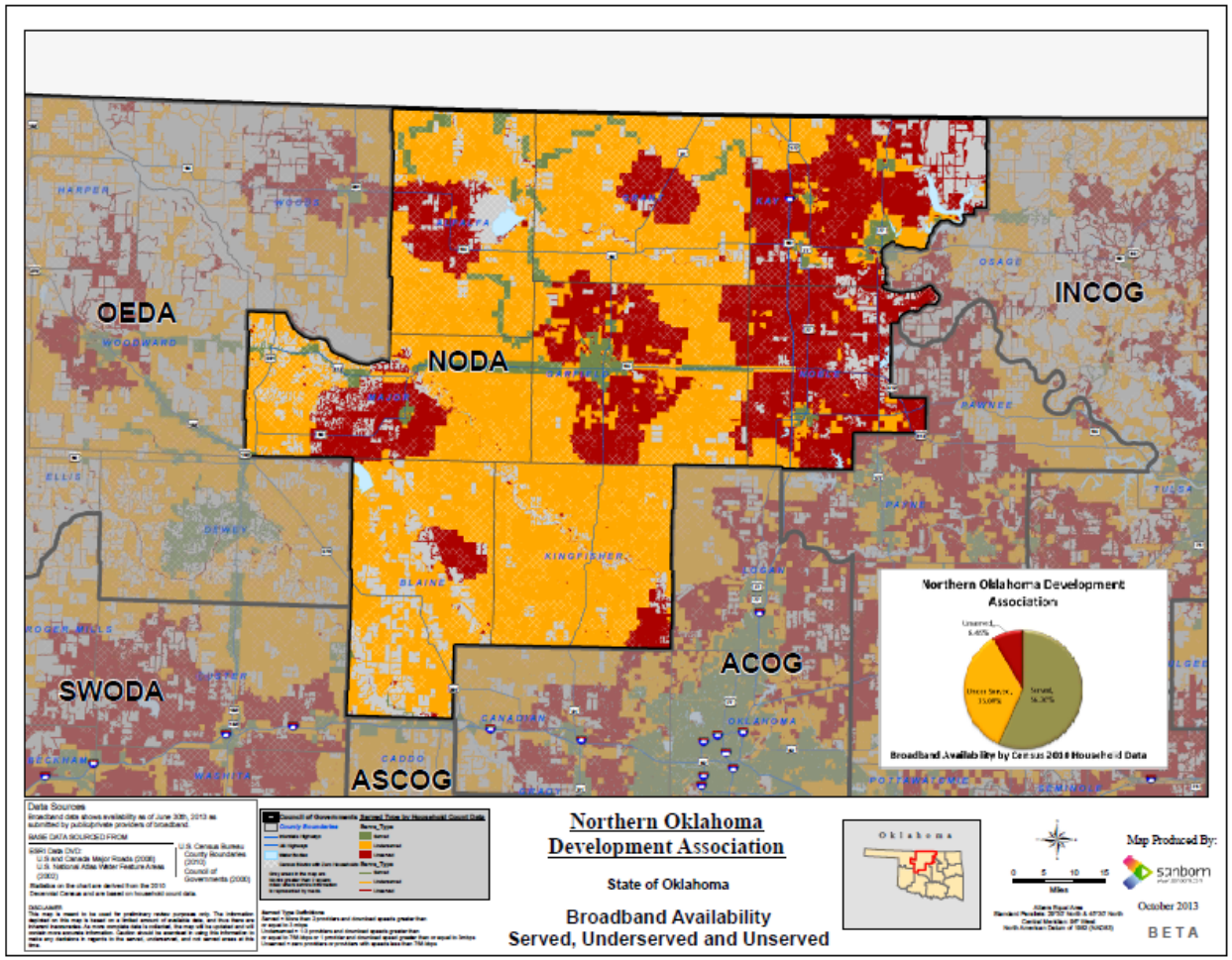

Figure 55. **Areas Served, Underserved and Unserved by Broadband for NODA, 2013**

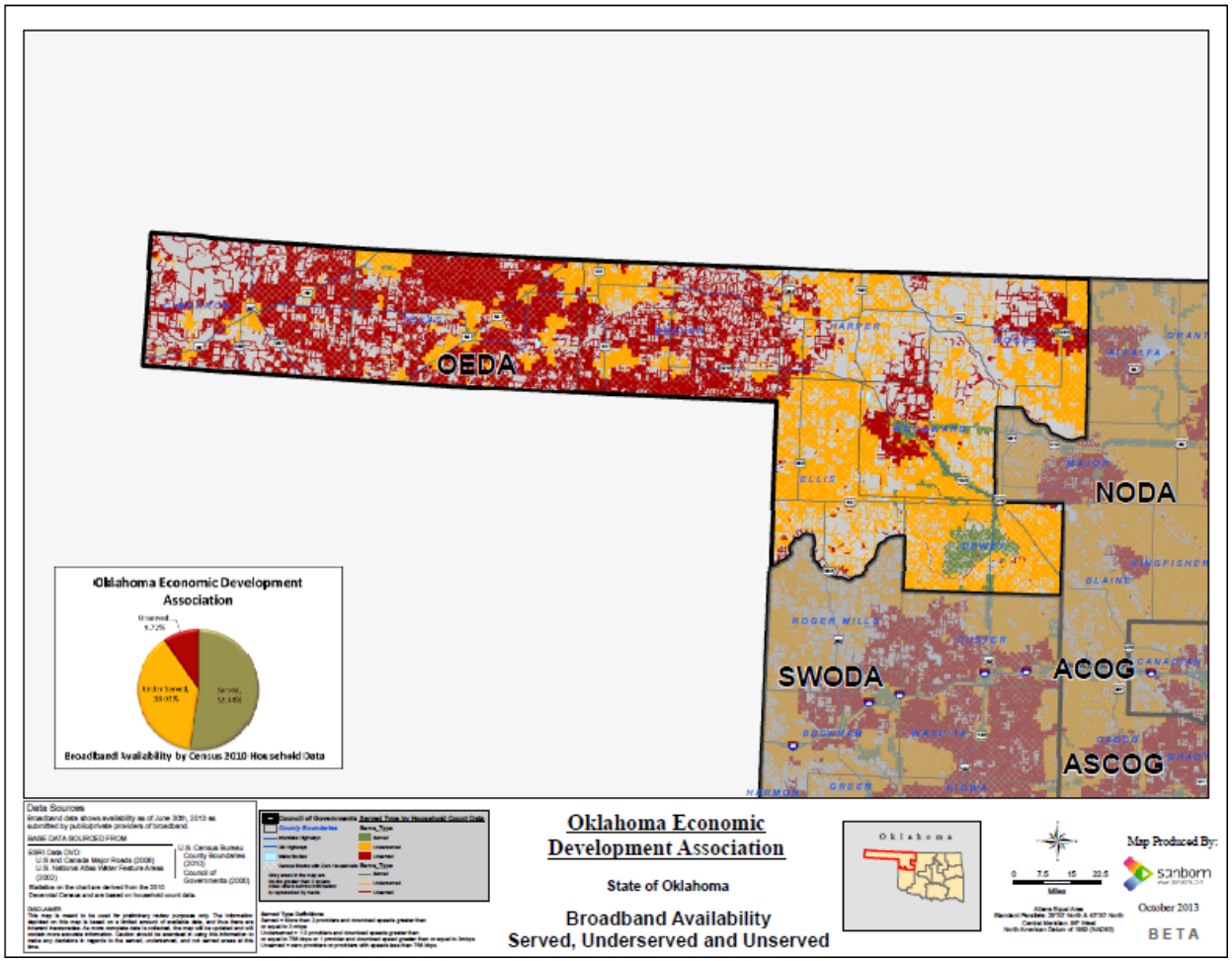

Figure 56. **Areas Served, Underserved and Unserved by Broadband for OEDA, 2013**

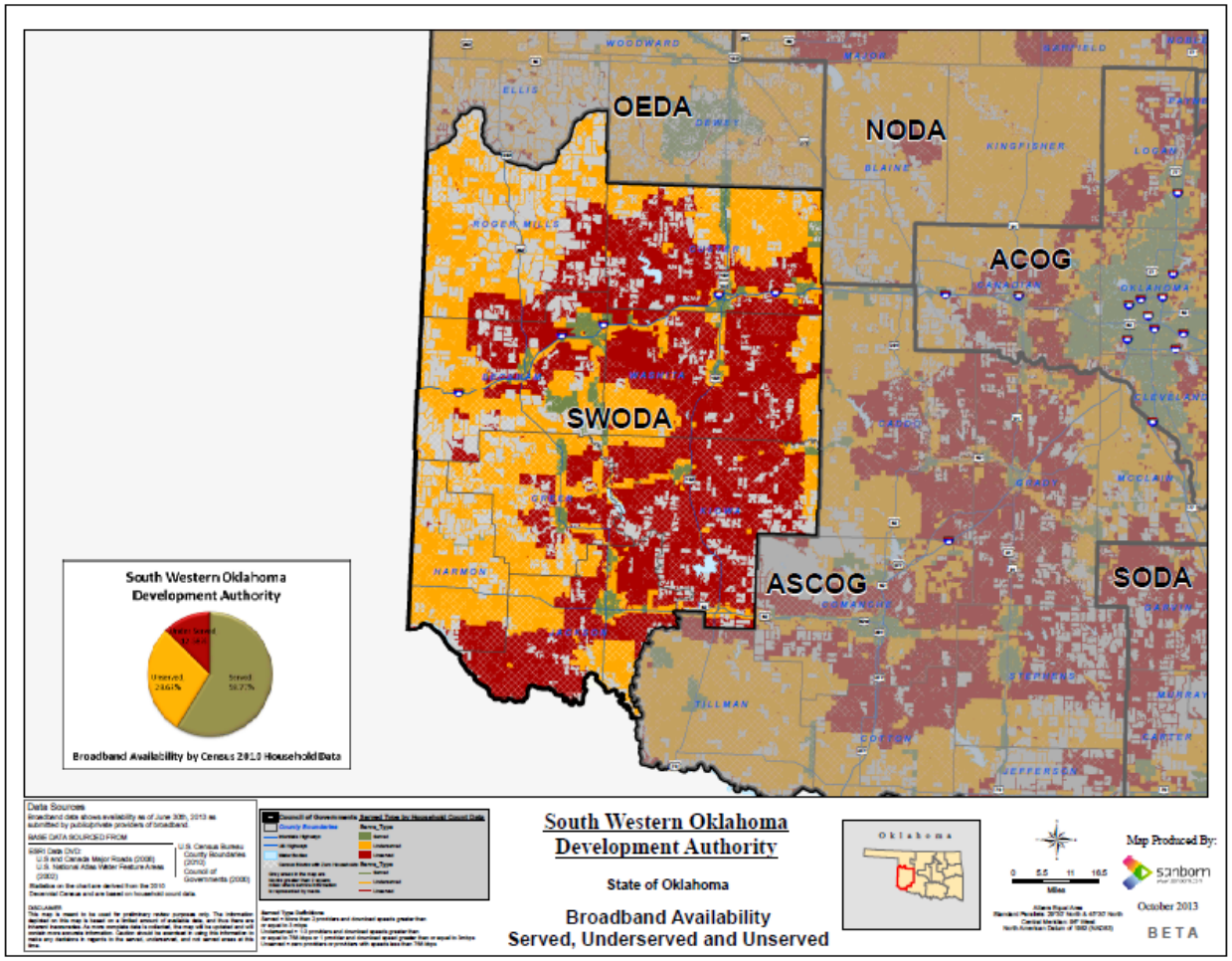

Figure 57. **Areas Served, Underserved and Unserved by Broadband for SWODA, 2013**

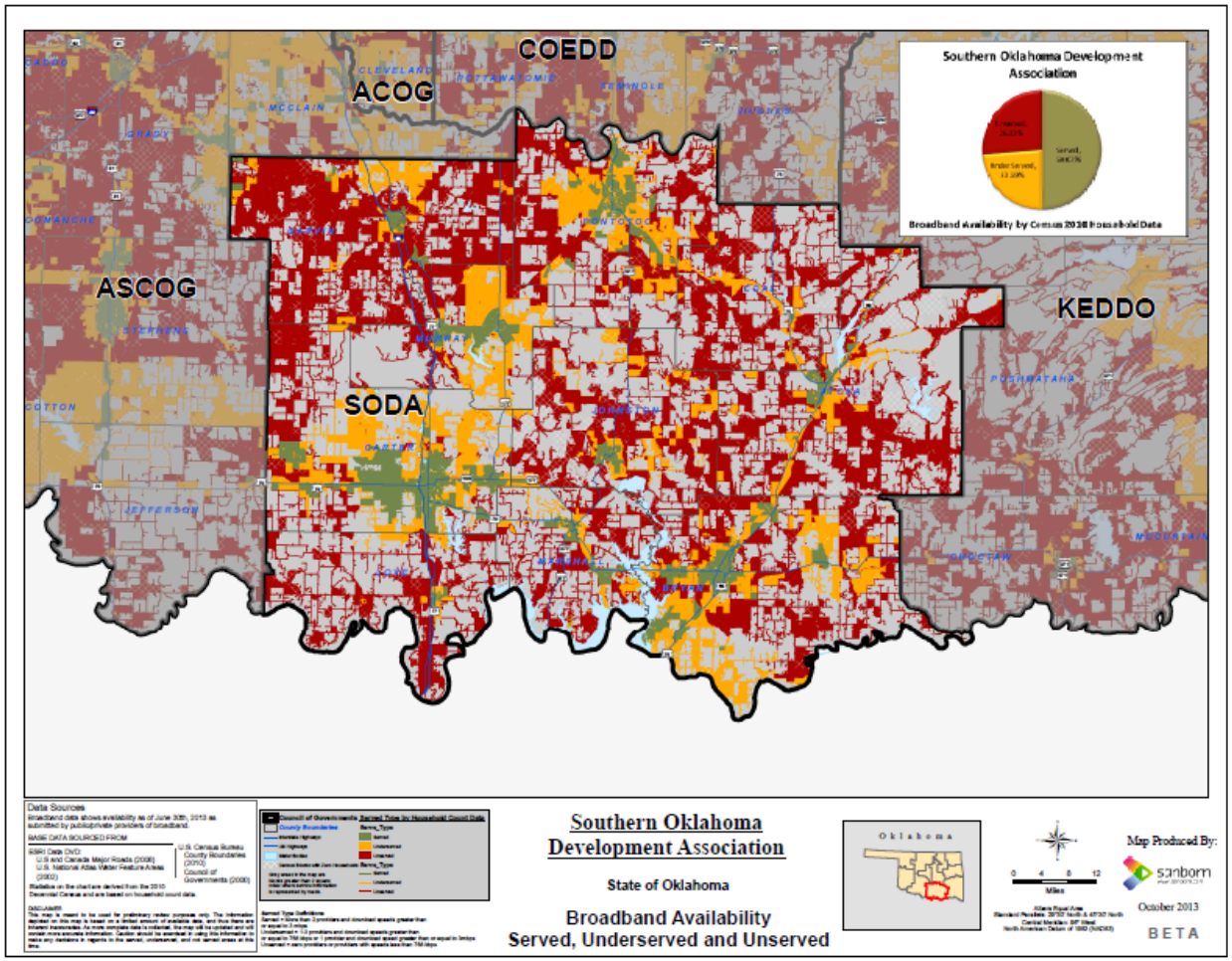

Figure 58. **Areas Served, Underserved and Unserved by Broadband for SODA, 2013**

Appendix 5

Broadband Terminology

2G

The first digital mobile standard; it introduced encrypted calls, made more efficient use of spectrum, and allowed for limited (non-broadband) data transmission. This started is set to be decommissioned completely in the US by 2016.

3G

An acronym commonly used to designate the third generation of mobile telecommunication technology which supports services that transfer information at a minimum rate of 200kpbs.

4G

The successor to 3G standards, 4G is an acronym used to designate the fourth generation of mobile telecommunication technology and provides supports services that provide mobile ultra-broadband Internet access such as laptops with USB wireless modems and smartphones.

ASDL

When used in relationship to Internet services, ASDL is an acronym for asymmetric digital subscriber line which is a type of technology that allows for the transfer of more data across existing copper telephone lines than traditional modem lines and generally requires users to be located within a radius of 2 to 2.5 miles of the provider. Transfer speeds supported by this technology range from 1.5 to 9 Mpbs downstream (receiving) and 16 to 640 Kbps upstream (sending).

Backhaul

The broadband infrastructure used to transport traffic from a geographically distant point, such as a wireless base station, to a significant aggregation point in the network, such as a mobile telephone switching office or Internet peering point.

BIP (Broadband Initiatives Program)

This federal program is responsible for dispersing American Recovery and Reinvestment Act (ARRA) funds from the U.S. Department of Agriculture Rural Utilities Services to support the expansion of access to quality broadband services in rural areas of the U.S. As a part of ARRA, the project is expected to have a broader impact of job creation and economic revitalization as well.

BTOP (Broadband Technology Opportunities Program)

The goal of this federal grant program is to promote the development and adoption of broadband services throughout the U.S. with a focus on improving services and utilization in unserved and underserved areas in the U.S. As a part of ARRA, the project is expected to have a broader impact of job creation and economic revitalization as well.

Cable Modem

Primary used to provide cable Internet access through the same coaxial cables used to deliver pictures and sounds to television sets across the U.S.

Coaxial Cable

A common type of cable used for transmitting data over long distances. It can carry either analog or digital signals. While coaxial cables have many applications, they are most commonly used to transmit cable TV and Internet signals.

Bandwidth/Data Capping

The practice of limiting the transfer of a specified amount of data over a specific period of time. Internet service providers generally apply a cap to control usage and thus reduce congestion on their networks. Implementation of a bandwidth cap is sometimes termed a *Fair Access Policy*, *Fair Usage Policy* or *Usage-based billing.*

Dark Fiber

A fiber optic cable that is laid and ready for use, but for which the service provider has not provided modulating electronics and thus the fiber is unused.

Digitization

The mass adoption of connected digital services by consumers, enterprises and governments (World Economic Forum, 2013).

Digital Economy

An economy based in digital technologies.

DOCSIS

Data Over Cable Service Interface Specification, the standard for data transmission over cable networks.

Download Speed

The speed at which an Internet connection can receive data to a computer, generally measured in kbps and Mbps (aka upstream). This includes anything that comes across the Internet to a computer such as the receipt of emails, streaming television or videos or computer programs.

DSL

When used in relation to Internet services, DSL (digital subscriber line or loop) refers to a family of telecommunication technologies that provide Internet access through the transmission of digital data over traditional telephone wires. DSL supports typical download transfer rates of 256 kbps to 40Mbps (receiving).

Ethernet

The most common type of connection computers use in a local area network (LAN). An Ethernet port looks much like a regular phone jack, but it is slightly wider.

FCC

The Federal Communications Commission is responsible for regulating interstate and international communications in all 50 states, the District of Columbia and U.S. territories. Communication technologies regulated include radio, television, wire, satellite and cable (www.fcc.gov).

Fiber

Fiber-optics or fiber refers to a telecommunications technology used to transfer information through transparent glass fibers with pulses of light. Fiber is capable of transmitting data at far greater speeds than current DSL and cable modem technology.

Fixed-line

A term used to describe cable or ADSL Internet connections that come to directly to the home via cables or telephone lines. This term is generally used to distinguish technology that relies on a wired connection from wireless mobile technology.

FTTH

Fiber-to-the-home is a term used to describe the provision of broadband Internet services through optical fiber that reaches directly to the physical boundary of the home such as a box on an outside wall of the dwelling. This acronym may be seen in similar form to refer to other locations such as neighborhood (FTTN), curb (FTTC), business/building/basement (FTTB), premises (FTTP), etc.

Gb

This acronym may be written as Gb for Gigabit or Gbps for Gigabits per second. This is a unit of measurement used for determining data transfer speed (i.e., how fast packets of digital information can be transferred across a computer or telecommunication networks). One gigabit is equivalent to 1024 megabits.

IP address

A set of numbers that acts as a unique identifier for each computer connected to the Internet.

ISP

Internet Service Provider.

kbps

Kilobits per second is a unit of measure used for determining data transfer speed (i.e., how fast packets of digital information can be transferred across a computer or telecommunication networks).

Last mile

The final leg or segment of a communications network that reaches to the customers home or office.

LTE (Long Term Evolution)

Mbps

Megabits per second is a unit of measurement used for determining data transfer speed (i.e., how fast packets of digital information can be transferred across a computer or telecommunication networks). One megabit is equivalent to 1024 kilobits.

Middle mile

Middle mile is a term referring to the segment of a communications network that connects local area networks to a larger metropolitan network or a major carrier.

Modem

Short for Modulator/Demodulator, a modem is a communications device that allows one computer to connect another computer and transfer data. The original dial-up modems are all but obsolete and are being replaced by the much faster cable and DSL modems.

NTIA

National Telecommunications & Information Administration. This administration is an Executive Branch agency in the U.S. Department of Commerce responsible for providing guidance to the President on telecommunications and information policy (www.ntia.doc.gov).

OCAN

The Oklahoma Community Anchor Network is a federal grant awarded to the state for the purposes of building 1,005 miles of middle-mile infrastructure connecting 32 anchor institutions in underserved or unserved areas in Oklahoma.

Open source

A development model which promotes universal access via free license to a product's design or blueprint, and universal redistribution of that design or blueprint, including subsequent improvements to it by anyone.

Penetration

A measure of broadband access represented as a percentage of homes passed by and connected to a given network.

Router

A device that joins multiple networks together wither wired or wirelessly; the most familiar implementation being the in-home Wi-Fi router.

Satellite

Internet access provided through communications satellites.

SDSL

When used in relation to Internet services, SDSL (symmetric digital subscriber line) refers to DSL services that support an equal rate of data transfer both downstream and up stream.

Smart Grid

An end to end (from generation to usage) modernization of the electrical grid integrating it with sensors, software, and two-way communications technologies to improve reliability, security, and efficiency.

Smart Meter

A part of the smart grid implementation, this device measures electrical usage but has a two way communication system connected to the utility company to send usage data and receive information about rates and usage statistics.

Spectrum

In wireless, this refers to the radio portion of the electromagnetic spectrum. The radio spectrum spans a certain, limited frequency range.

Throttling

The intentional, reactive slowing of Internet service by an Internet service provider in the interest of regulating network traffic and minimizing bandwidth congestion on its network.

Upload Speed

The speed at which an Internet connection can transmit data from your computer to another location, generally measured in kbps and Mbps (aka upstream).

VOIP

Voice over Internet Protocol, a technology allowing telephone calls to be made over computer networks, like the Internet, by converting analog voice signals into digital data packets. It supports real-time, two-way transmission of conversations.

Wi-Fi

A local area wireless technology that allows an electronic device, such as a computer or a cell phone, to exchange data or connect to the Internet using radio waves.

Wireless

Wireless communication refers to the transfer of data to different locations through the use of some form of energy such as radio waves and without an electrically wired connection between the locations. Devices that use wireless forms of communication include but are not limited to two-way radios, cell phones, wireless networking, GPS, satellite television, broadcast television and cordless telephones.

WLAN

Wireless local area network, links two or more devices using some wireless distribution method , typically Wi-Fi, to provide a connection to one another and access to the wider Internet.