Native American Broadband Mapping Analysis and Report

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Submitted to:
National Telecommunications and Information Administration

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On behalf of:
Center for Innovative Technology

In collaboration with:
Native American Capital, LLC and Virginia Geographic Information Network

Purpose Statement/Abstract:

As a response to the growing digital divide within federally recognized tribal boundaries in the United States and the need to identify the availability of broadband in Indian country, Virginia's Center for Innovative Technology (CIT) assembled a team for this initiative that includes Native American Capital, LLC (NAC), the Virginia Geographic Information Network (VGIN), and Virginia Tech's Center for Geospatial Information Technology (CGIT), with funding provided by the National Telecommunications and Information Administration (NTIA) through the American Recovery & Reinvestment Act, State Broadband Initiative. The team directly worked with American Indian tribes, produced outreach and educational materials such as map books showing the National Broadband Map information for each tribe, and developed Data Hawk, an Android application for georeferenced broadband quality of service (QoS) reporting. Such tools as Data Hawk are necessary to aid in the production of more comprehensive broadband maps in order to improve National Broadband Map (NBM) data accuracy and completeness within federally recognized tribal boundaries (i.e., "Indian Country"). This report analyzes existing data sets to provide a unique view of the current state of broadband in Indian Country. This report will also address important background information on the challenges of increasing broadband access within the borders of federally recognized tribal boundaries. In doing so, we hope that future projects can be more attentive to the potential challenges for such a project and in turn are more successful in their endeavors.

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Introduction: Producing a comprehensive broadband map to improve National Broadband Map data accuracy and completeness in "Indian Country"

The Center for Geospatial Information and Technology (CGIT) at Virginia Tech received funding from the National Telecommunications and Information Administration (NTIA) through Virginia's Center for Innovative Technology (CIT) to develop the Data Hawk tool to help produce a more comprehensive broadband map to improve National Broadband Map (NBM) data accuracy and completeness within the boundaries of federally recognized tribes (i.e., "Indian Country"). The need to develop these tools originated from NTIA's "Indian Country Final Report,[1]" and the Native American Capital's (NAC) Feasibility Study,[2] which highlighted the need to increase broadband access within Indian Country and address data deficits in these regions respectively.

Why Map Coverage in Indian Country?

Broadband is a fundamental building block for contemporary tribal economies, self-determination, and self-governance. As such, there is a need to visualize and analyze data where broadband exists, who provides it, and what speeds are available. The current NBM is one way to visualize this data but it has some limitations. "Coverage" on the NBM can include areas that lack broadband and/or where services may not be available currently but can be made available by the provider "within 7-10 business days.[3]" Additionally, a majority of NBM data is collected and reported by commercial providers, which results in reporting bias. Many other smaller

[1] See http://www.wired.virginia.gov/wp-content/uploads/Broadband/Initiatives/Indian-Country/Indian-Country-Final-Report.docx

[2] See http://nativeamericancapital.com/broadband-mapping-initiative/completed-feasibility-study

[3]See http://www.ntia.doc.gov/files/ntia/publications/usbb_avail_report_05102013.pdf

providers serving Indian Country may not have the information needed and/or are willing to furnish middle mile and last mile performance data needed to create an accurate NBM. Another aspect is that telecom innovation and deployment move very quickly and as such there are temporal limitations of the NBM due to the fact that data is only updated biannually.

Recognizing limitations in current data, NTIA sponsored a grant to identify and collect Indian Country broadband data as a pathway to upload data to the NBM. This project leveraged a team with complementary expertise (CIT, NAC, CGIT, and Virginia Geographic Information Network) to address the current data limitations. As a part of this effort, CGIT developed the Data Hawk tool, map book tool, and Indian Country mapping portal to generate broadband dead-zone and speed-test data in Indian Country using a 3-step implementation process.

3-step Process Utilized by All Parties to Implement the Data Hawk Tool:

1. Begin with tribal lands with available data
2. Develop mapping and self-reporting tools available for tribes and/or tribal providers
3. Upload self-reported data to government broadband maps for publication

To address NTIA's concerns, NAC's feasibility study suggests replicating strategies uniquely effective in Indian Country such as access to opinion leaders by long-standing trusted parties and to avoid practices known to backfire, but those nonetheless often repeated by inexperienced practitioners attempting to access tribal communities[3]. This report will analyze existing data sets to give a unique view of the current broadband state of Indian Country as well as background information on the challenges of increasing broadband access within the borders of federally

[3] Such issues are explained in parts I and II of this report.

recognized tribes.

Part I) Broadband in Indian Country: Breaking the Digital Divide and "Empowering Technologies"

"Any Project regarding the US federal government and American Indians must take into account the historical, cultural, and social context in which the project is occurring."

-Walter Hillabrant, NAC

As the quote addresses above, in order to begin a conversation as to why breaking the digital divide in Indian Country is important today, we must place such a need within the temporal context in which it is being addressed. As such, a conversation about access to advanced telecommunications in Indian Country such as broadband cannot begin without understanding the historical background of the social and economic inequalities pervasive in Indian Country today, which is arguably why the digital divide itself exists. Contemporary issues in Indian Country such as poverty, unemployment, lack of and access to basic infrastructures such as drinkable water and proper health care, and, as this project addresses, broadband services, reflect the colonization of North America. Although this project will not address the specifics as to what has occurred throughout the past 520 years of colonial expansion in North America, it is important that we draw attention to the fact that the introduction of Western culture and the subsequent and forcible removal of American Indians to different geographical regions across North America (e.g., reservations) have created the burdens that plague Indian Country to this day. As such, starting initiatives to introduce broadband in Indian Country requires a team that is mindful of this historical legacy and respects the voices of tribal communities.

Today it is widely recognized that broadband access in particular can help to alleviate the social and economic inequalities in Indian Country and both American Indians and non-Natives alike.

In addition, the growing digital divide in Indian Country only magnifies these inequalities.[4] While the history of the application of Western technologies in Indian Country as well as the relationship between American Indians and the US federal government have not always been positive, this section of the report will highlight the positive aspects of broadband access for American Indian communities. Telecommunication technologies can benefit a broad range of life in Indian Country. Understanding *why* broadband access can produce these benefits is necessary before discussing *how* such access can even be provided.

The colonial period saw the devastation on a scale difficult to comprehend including massive mortality/population loss associated with disease, war, and forced removal of American Indians from their homelands onto reservations. These relocation policies lasted until the 1970s, the latter, known as the Indian Termination Policies, saw the largest population of rural-to-urban migration in American Indian communities. In turn, these tragedies resulted in the loss of vibrant economies and fundamental, cultural, and spiritual practices. Next came Indian Termination policies with the distribution of tribal lands to individual Indians/families and, after that Indian relocation programs and policies which moved American Indians and Alaska natives from the reservations to urban communities. As a result of the postcolonial devastation and the lack of employment opportunities in Indian Country, today the majority of American Indians reside away from the reservations, in urban centers. Fortunately, the introduction of advanced communication technologies, traditional knowledge such as language and other cultural values can now be shared through, for example, digital recordings disseminated via such things as cloud based audio/video sharing. As the National Congress of American Indians (NCAI) stated in

[4] See for instance: Bisell, Therese. 2004. "The Digital Divide Dilemma: Preserving Native American Culture While Increasing Access to Information Technology on Reservations." *Journal of Law, Technology, and Policy*. No. 1.

2011, communication services such as Broadband can aid in and strengthen the efforts of tribal communities to preserve their cultural traditions.[5]

Commerce, Development, and Employment

Social and economic inequalities are pervasive in Indian Country today. The lack of basic infrastructure such as plumbing and drinkable water on some reservations is a reality and as such addressing these issues requires a stronger sovereign economy in Indian Country. Begay Jr. et al. define development in Indian Country in particular as "the process by which a community or nation improves its economic ability to sustain and achieve its sociocultural goals, and support its sovereignty and governing process.[6]" Economic development in Indian Country is necessary in order to begin to address other more important issues related to the health and well-being of tribal members. This is why breaking the digital divide in Indian Country is so important, as it is considered almost necessary for the establishment of businesses and households today. With regards to employment in particular, unemployment for tribal communities is often significantly higher than the national average and as many as fifteen tribal communities have unemployment rates of over 80%.[7] Development and job opportunities are desperately needed in Indian Country and broadband, if made tribal-centric as will be addressed in Part III, can provide the necessary employment opportunities in Indian Country. This in turn can aid in the process of developing other infrastructures, such as commerce, which in turn brings job opportunities to

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[5] See NCAI. 2011. "In Support of Improving Communications Services for Tribal Communities." *Resolution #MKE-11-004.*

[6] See Begay Jr., Manley A., S. Cornell, M. Jorgensen, and J. P. Kalt. 2007. "Development, Governance, Culture: What Are They and What Do They Have to Do with Rebuilding Native Nations?" in *Rebuilding Native Nations: Strategies for Governance and Development*, ed. M. Jorgensen. Tucson, AZ: University of Arizona Press, 36.

[7] Schilling, Vincent. 2013. "Getting Jobbed: 15 Tribes with Unemployment Rates Over 80 Percent." *Indian Country Today Media Network*, August.

Indian Country through the establishment of specialty retail and recreational opportunities (CIT 2012).

Healthcare, Education, and other Community Anchor Institutions

Contemporary healthcare and educational institutions are highly dependent upon broadband access and advanced telecommunications. Not only do they provide access to telecommunications for tribal members, but also, as mentioned above, they provide an opportunity to share traditional knowledge and culture, which is beneficial for both the health and education of tribal communities. According to Traci L. Morris of Homahota Consulting: "Broadband is the basis and future of economic development, health, public safety, housing, energy and educational models for the future in Indian Country.[8]" With regards to health care in particular, many tribal communities lack basic access to medical services. E-Health services can help ensure that basic health needs are addressed in Indian Country and can also provide opportunities for tribal members to access information regarding health care service opportunities. Regarding educational institutions, tribal youth in particular benefit greatly from access to broadband as this provides them with the opportunity to communicate inter-tribally, learn about traditional indigenous knowledge from other communities, access educational information from outside resources and other educational institutions, etc.[9] In the Information Era, other non-profit community anchor institutions such as community and cultural centers, clinics, public libraries, etc., are often only beneficial for the development of local communities and economies via job training and employment, with access to broadband. As Tom Wheeler,

[8] Morris, Traci L. 2011. "A Short Overview of Native American Telecommunications Issues." *National Alliance for Media, Arts, and Culture*, 21-23.
[9] See *supra* note 5.

Chairman of the FCC, stated in a 2014 address, without breaking the digital divide in Indian Country, even the adoption of new technologies such as broadband is impossible.[10] As such, understanding why and how the digital divide exists so prolifically in Indian Country today can help to ensure that tribal communities can access funding opportunities to begin building the proper telecommunication infrastructures. We turn now to see how programs such as CIT and Virginia's broadband mapping team can help bring broadband to Indian Country.

[10] See NCAI. 2014. "Prepared Remarks of Tom Wheeler, Chairman FCC." http://www.fcc.gov/document/chairman-wheeler-remarks-national-congress-american-indians

Part II: Why Programs such as CIT and Virginia's Broadband Mapping Team Can Help Bring Broadband to Tribal Nations

This research study examines broadband coverages in Indian Country. The focus of our study is to analyze broadband access, capacity and utilization as it relates at the national and tribal level.

National Level Statistics for Federally Recognized Tribes

A federally recognized tribe is defined by the US Department of Interior Indian Affairs as "An American Indian or Alaska Native tribal entity that is recognized as having a government-to-government relationship with the United States, with the responsibilities, powers, limitations, and obligations attached to that designation, and is eligible for funding and services from the Bureau of Indian Affairs.[11]" We analyzed the 2010 federally recognized tribes in the lower 48 states, which totaled to 358 tribes. These tribes are located across the United States, but are not evenly distributed. 60.7% of the tribes are located in the West region, while 35.5% are in the Pacific division.[12]

The geography of land area is a key element in the growth, distribution, and success of economics, as well as the development of broadband services for tribal nations.[13] The average elevation information is derived from the National Elevation Dataset (1 arc-second) and highlights geographic limitations for tribes. About 40% of tribes are located in low elevation

[11] See http://www.bia.gov/FAQs/index.htm.

[12] According to the U.S. Census the United States is split into four major regions and further subdivided into nine divisions. Each of these divisions are characterized by geographic variables, such as climate and elevation that effects broadband coverage. Tribes were divided and categorized into these groups.
See https://www.census.gov/geo/maps-data/maps/pdfs/reference/us_regdiv.pdf.

[13] National Telecommunications and Information Administration. 2006. *Bringing Advanced Telecommunications to Native American Communities*. Washington D.C.: National Telecommunications and Information Administration. http://www.ntia.doc.gov/legacy/otiahome/top/publicationmedia/onepagers/TOPnative.pdf.

areas (lower than 1,000 ft). While about 15% of tribes are located in high elevation areas, which includes about ⅓ of total tribal land (higher than 5,000 ft). This area holds 35% of the total tribal population. Climate variables such as temperature and precipitation range over the tribal areas. Annual average temperature range is 3.7 - 24.4 degrees Celsius while the annual average precipitation range is 1.4 - 85.1 inches. 19% of tribes have a mean annual precipitation value of less than 10 inches, while 34% of tribes have mean annual temperature values less than 10 degrees Celsius.[14] The location, elevation, and climate endured by these tribes can affect the distribution of native people, resources available, and physical limitations that characterize each tribal area.

Populations in Federally Recognized Tribes

The population estimation derives from the 2010 Census data. Total population of a tribal nation is based on the combined population for all the reservations and trust lands in the United States delineated in the TIGER dataset for the 48 contiguous states. Prior to analysis we strengthened the 2010 Census tribal list available. We expanded the list with an additional 34 federally recognized tribes that were excluded from the 2010 Census dataset. These tribes account for 71.2% of all tribal population totaling to 2,421,030 people left out of the 2010 tribal census, mostly in the state of Oklahoma.[15] Therefore, enhancement of this data was accomplished via LandScan population distribution database (Oak Ridge National Laboratory, 2010) (Figure 1). After we included the additional federally recognized tribe, the names and boundaries were

[14] See *infra* Appendix A.

[15] The additional 34 tribes include Caddo-Wichita-Delaware, Cherokee, Cheyenne-Arapaho, Chickasaw, Choctaw, Citizen Potawatomi Nation-Absentee Shawnee, Creek, Eastern Shawnee, Iowa, Kaw, Kickapoo, Kiowa-Comanche-Apache-Fort Sill Apache, Miami, Modoc, Otoe-Missouria, Ottawa, Pawnee, Peoria, Ponca, Quapaw, Sac and Fox, Seminole, Seneca-Cayuga, Tonkawa, Wyandotte, Creek/Seminole, Kaw/Ponca, Kiowa-Comanche-Apache-Ft Sill, Apache/Caddo-Wichita-Delaware, Miami/Peoria, Cayuga Nation, Ione Band of Miwok, Mechoopda, Samish, and Shinnecock tribes.

examined and found that most were abbreviations or incomplete names of each tribe. Therefore, comparison with the "2010 Indian Entities Recognized and Eligible To Receive Services" list from the United States Bureau of Indian Affairs[16] resulted in coupling these abbreviations with the formal names and designated geographic boundaries. Thus a complete list of all of the federally recognized tribes in 2010 was used in further broadband analysis.

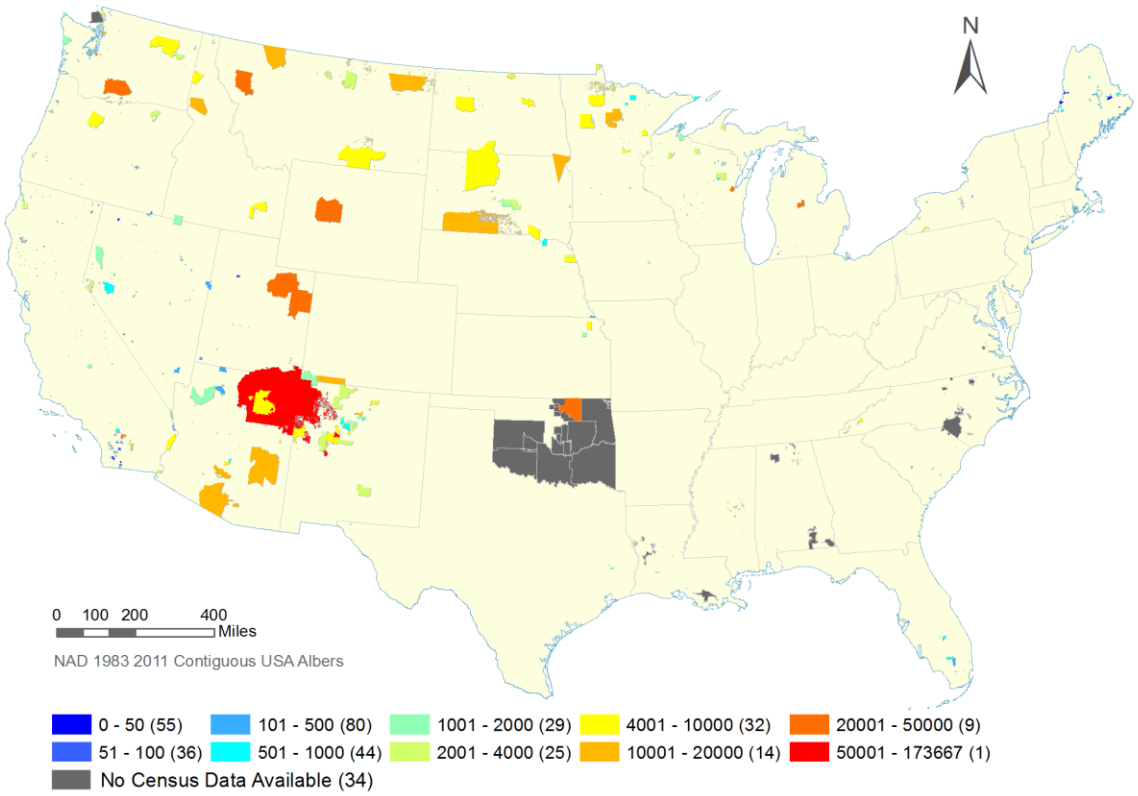

Figure 1. 2010 Federally Recognized Tribal Locations and Associated Populations (2010 Census)

[16] Bureau of Indian Affairs: U.S. Department of the Interior. 2010. "Indian Entities Recognized and Eligible to Receive Services from the United States Bureau of Indian Affair." *Federal Register*. See http://www.fws.gov/nativeamerican/pdf/indian-entities-list-october-2010.pdf.

According to the 2010 Census, 5.0 million people identified as Native American Indian and Alaska Native, either alone or in combination with one or more other races in the United States. Inclusive in this number were 2.8 million people recorded as Native American Indian and Alaska Native alone.[17] Only 570,865 people who identified as American Indian and Alaska Native alone or in combination with one or more other races lived on federally recognized tribal lands. Inclusive in this number were 541,957 people who were Native American Indian and Alaska Native alone and lived on federally recognized tribal land. These statistics do not include the 34 tribes described earlier. Therefore, the population of federally recognized tribes with available 2010 Census data (324 out of the total 358 count) was calculated to be 994,129.

The top 10 most populated Native American Indian tribal nations in regards to available 2010 Census data were the Navajo Nation, Osage, Puyallup, Yakama Nation, Flathead, Wind River, Isabella, Agua Caliente, Uintah and Ouray, and Oneida (WI) tribes. The Navajo Nation which covers reservation areas of 24,156 square miles, has the largest population of 173, 667. The census data was then divided into 6 age classes to display the distribution of age throughout the tribal lands. Age classes are divided into categories that correlate with potential educational level and/or working status.

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[17] "Alone" refers to respondents who selected American Indian/Alaska Native and not any other race category. "In combination with one or more other races" refers to respondents who selected American Indian/Alaska Native and one or more other race categories. Both "alone" and "in combination" include persons of Hispanic ethnicity. Tribal groupings compiled by the Census Bureau do not necessarily correspond with federally recognized tribes. Self-identified membership does not necessarily correspond with official membership in a federally recognized tribe. Tribal populations do not sum to totals because totals include American Indian/Alaska Native populations from many additional tribes. In addition, the numbers by American Indian and Alaska Native tribal groupings do not sum to the total population because tribal groupings are tallies of the number of American Indian and Alaska Native responses rather than the number of American Indian and Alaska Native respondents. Respondents reporting several American Indian and Alaska Native tribes are counted several times. For example, a respondent reporting "Apache and Blackfeet" would be included in the Apache as well as Blackfeet numbers.
See: Norris, Tina, Paula L. Vines, and Elizabeth M. Hoeffel. *Census 2010 Briefs: the American Indian and Alaska Native Population 2010*. U.S. Department of Commerce, Census Bureau, 2012.

Table 1. Population Statistics by Age and Race for Federally Recognized Tribes (2010 Census)

Population Statistics		**Total**	**Range (Individual Tribal population)**
Total Population		994,129	0 - 173,667
Native American Population	American Indian and Alaska Native alone or in combo with one or more other races	570,865	0 - 169,321
	American Indian and Alaska Native Alone	541,957	0 - 166,824
Age Class (years)	15 to 19	83,682	0-18,030
	20 to 29	129,077	0-13,316
	30 to 39	112,356	0-9,996
	40 to 54	194,743	0-11,811
	55 to 64	109,891	0-8,668
	65 and over	116,924	0-5,318

The average population density for these tribes is 20.6 people per square mile, of the 358 tribes. Total population from LandScan data was divided by the square mileage of associated tribal land boundaries. The highest population density was the Yerington Tribe with 4,808 people per square mile (Table 2).

Table 2. Total Population, Total Land Area, and Average Population Density for Federally Recognized Tribes (LandScan 2010)

	Population	Data Range
Total Population	3,442,067	0-765,848
Total Land Area (Square Miles)	165,407	0.002 - 24,156
Average Population Density (Individuals per Square Miles)	20.6	0-11,235

Urban and Rural Areas

Urban and rural classes are based on residential population density and non-residential development. Rural areas are shrinking in America due to individuals migrating to cities and suburban areas, resulting in increased urbanization. The distinction between urban and rural is defined by the U.S. Census Bureau, which states that urbanized areas consist of densely settled territories that contain 50,000 or more people. Furthermore an urban cluster contains at least 2,500 people but fewer than 50,000. All areas outside of these two categories are considered rural.[18]

The LandScan population dataset was used in delineation of urbanized areas and urban clusters at the census tract level and census block level. Tribal land is dominated by rural areas. 99.3% tribal land is rural, accounting for 51.1% total tribal population. While, 0.7% tribal land is urban, accounting for 48.9% total tribal population (Table 3). This substantial difference in land distribution directly affects broadband coverage. As of June 30, 2011 nineteen million Americans, accounting for 6% of the American population, lacked access to fixed broadband

[18] U.S. Census Bureau. 2012. "Qualifying Urban Areas for the 2010 Census." *Federal Register* 77 (59): 18651–69. See http://www.gpo.gov/fdsys/pkg/FR-2012-03-27/pdf/2012-6903.pdf.

meeting the speed benchmark. Furthermore, 76% of these Americans resided in rural areas. [19]

Table 3. 2010 Federally Recognized Urban and Rural Tribal Area (Landscan 2010, Census Block 2010)

	Tribal Urban Area	Tribal Rural Area
Area proportion	0.7%	99.3%
Population proportion	51.1%	48.9%

Socioeconomics

Community anchor institutions are nonprofit institutions that have a major impact on local economies.[20] In many regions these institutions have surpassed traditional manufacturing corporations in their role as employers. In the United States, the most numerous nonprofit anchors are universities and non-profit hospitals in America. Thus, the linkage between anchor institutions and economic development is concrete.

In 2011, National Telecommunications and Information Administration (NTIA) launched the National Broadband Map initiative. The data from this unveiled that community was largely underserved in broadband services. Anchor institution data from NTIA was used in our study. All institutions were counted within the 2010 TIGER tribal boundaries. Schools K-12 were most numerous, followed by public safety institutions. Nongovernmental support and postsecondary education which include universities and colleges were least numerous.[21]

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[19] See Federal Communications Commission. *Eighth Broadband Progress Report*. Washington, D.C., August 21, 2012. https://apps.fcc.gov/edocs_public/attachmatch/FCC-12-90A1.pdf.

[20] See http://community-wealth.org/strategies/panel/anchors/index.html.

[21] U.S. Department of Commerce, National Telecommunication and Information Administration, State Broadband Initiative. 2013. "US National Broadband Map Datasets."
See http://www2.ntia.doc.gov/broadband-data.

Tribal Gaming is regulated by the Indian Gaming Regulatory Act (IGRA). IGRA's goals include, promoting tribal economic development, self-sufficiency and strong tribal governments, maintaining the integrity of the gaming industry, and ensuring that tribes are the primary beneficiaries of the gaming activities.

Gaming data from the 2014 National Indian Gaming Commission was analyzed as the same methodology as anchor institutions. Total there were 475 tribal gaming facilities. The tribal land with the largest number of facilities is the White Earth tribe in Minnesota with 22, followed by the Chickasaw and Choctaw tribes in Oklahoma.[22]

Table 4. Federally Recognized Tribal Anchor Institution (2013) and Gaming Facility (2014) Counts

Factors	Counts
Schools K-12	2090
Libraries	341
Healthcare	539
Public Safety	1968
Postsecondary Education	103
Government Support	694
Non-government Support	103

[22] National Indian Gaming Commission. 2014. *List and Location of Tribal Gaming Operations*. See http://www.nigc.gov/Portals/0/NIGC%20Uploads/readingroom/listandlocationoftribalgamingops/abc2.pdf. See *infra* table 5.

Gaming Facilities	475

Areas and Populations with Access to Broadband Services

The broadband availability data was obtained from the NTIA's latest State Broadband Initiative dataset (December, 2013).[23] The area and population with access to six broadband services were measured for all 358 federally recognized tribes included in this study. [24] Tribal areas with access to each broadband service were calculated based on tribal boundaries obtained from the US Census Bureau 2010 TIGER/Line files. For these areas, the population information was extracted from the 2010 LandScan population dataset (at 1 km resolution) to examine tribal population covered by each broadband service (Figure 2).

Percentages of land area accessible to broadband services in Indian Country are lower than the national averages. The percentages of population who have access to broadband services in Indian Country fall far below the national averages as well, except for fixed wireless (Figure 2).

[23] See U.S. Department of Commerce, National Telecommunication and Information Administration, State Broadband Initiative. 2013. "*US National Broadband Map Datasets*." http://www2.ntia.doc.gov/broadband-data.
[24] The six broadband services (with corresponding technology codes) included in this study are: DSL wireline (10, 20; i.e., Asymmetric and Symmetric), copper wireline (30), cable wireline (40, 41; i.e., DOCSIS 3.0 Down and other), fiber wireline (50), terrestrial fixed wireless (70, 71; i.e., unlicensed and licensed), and mobile wireless (80). The satellite wireless (60) is excluded due to 100% tribal land coverage.

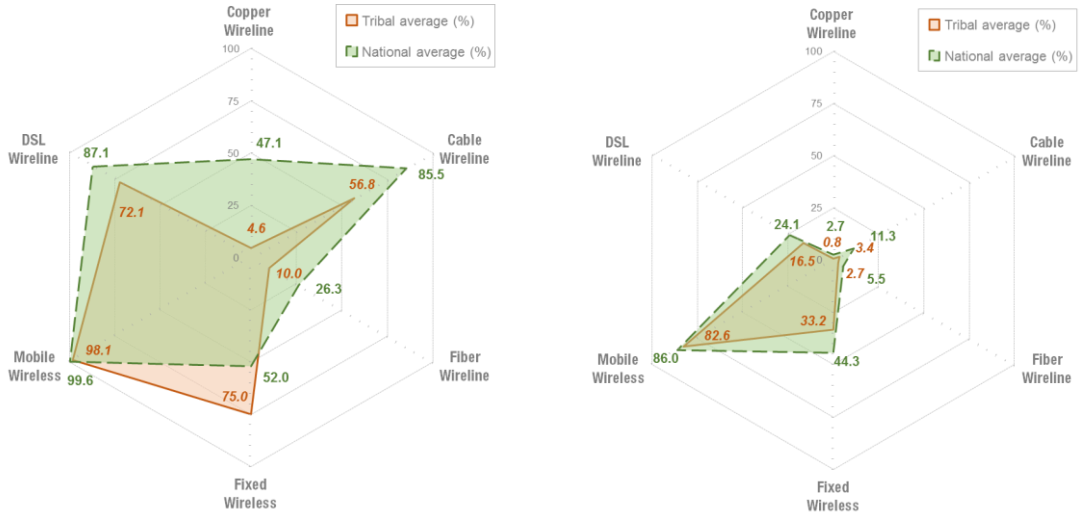


Figure 2. Percentages of Population (left) and Area (right) with Access to Broadband Services for 2010 Federally Recognized Tribes and the U.S

The wireless technologies have higher average coverage than wireline technologies across all tribes. Mobile service is available for 82.6% of Indian Country area, allowing 98.1% of Indian Country population to access this service. The wireline technologies have relative low coverage in tribal lands, with total coverage being DSL (16.5%), Cable (3.4%), Fiber (2.7%), and Copper wireline (0.8%). In terms of tribal population with access to broadband services, the percentages and population coverages of DSL, Copper, Cable, Fiber, Fixed, and Mobile wireless are 72.1%, 4.6%, 56.8%, 10.0%, 52.0%, and 98.1%, respectively (Table 5).

Table 5. Percentages of Area and population with access to Broadband Services for Federally Recognized tribes and U.S

	Area Coverage		Population Coverage	
Broadband Services	Federally recognized tribes	U.S	Federally recognized tribes	U.S
DSL wireline	16.5%	24.1%	72.1%	87.1%

Copper wireline	0.8%	2.7%	4.6%	47.1%
Cable wireline	3.4%	11.3%	56.8%	85.5%
Fiber wireline	2.7%	5.5%	10.0%	26.3%
Fixed wireless	33.2%	44.3%	75.0%	52.0%
Mobile wireless	82.6%	86.0%	98.1%	99.6%

Accessibility Limitations: Terrain Ruggedness and Road Density

Terrain ruggedness (or roughness of land) can characterize the accessibility, efficiency, and feasibility of broadband services and their providers. Riley's Terrain Ruggedness Index (TRI)[25] was used to categorize tribal land into three TRI classes (Figure 3). Broadband coverage for each service differentiates among TRI classes (level or slightly, moderately, and highly rugged area). Most broadband services were found in level or slightly rugged areas, with highly rugged areas barely having any coverage. In addition, wireless coverages were higher than wireline coverages for all TRI classes (Figure 4).

[25] See Riley, Shawn J., Stephen D. DeGloria, and Robert Elliot. "A Terrain Ruggedness Index That Quantifies Topographic Heterogeneity." *Intermountain Journal of Sciences* 5, no. 1–4 (1999): 23–27

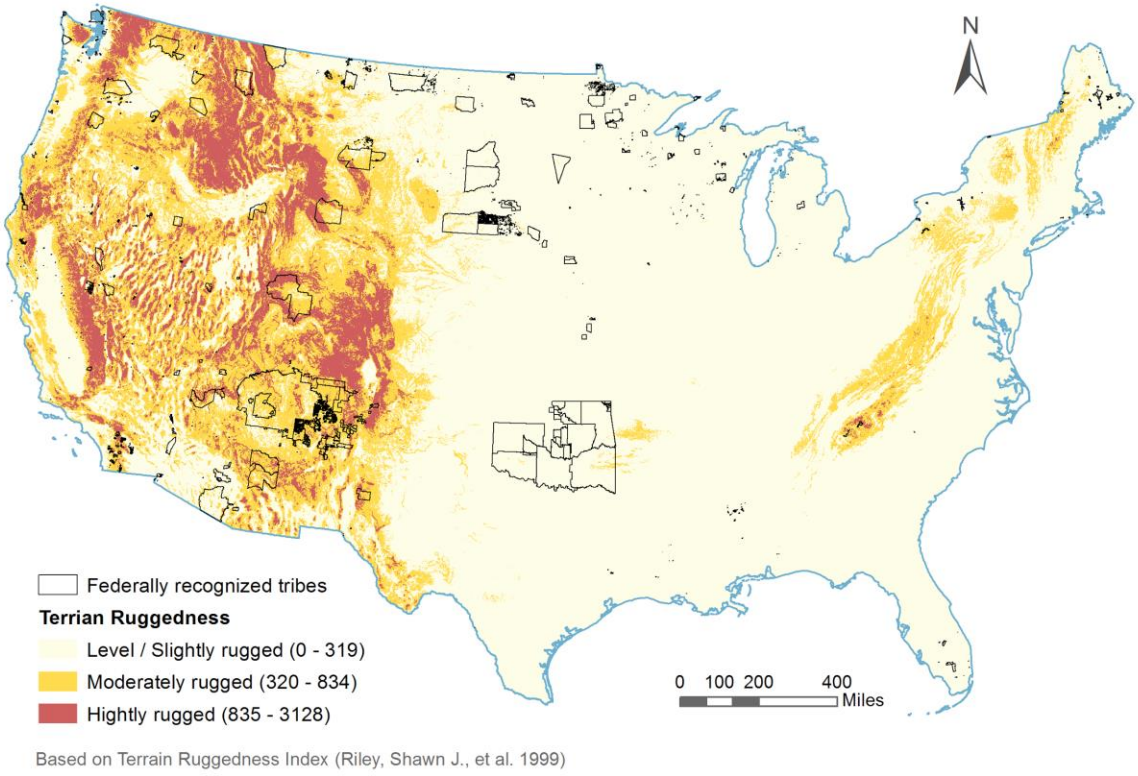


Figure 3. U.S Terrain ruggedness

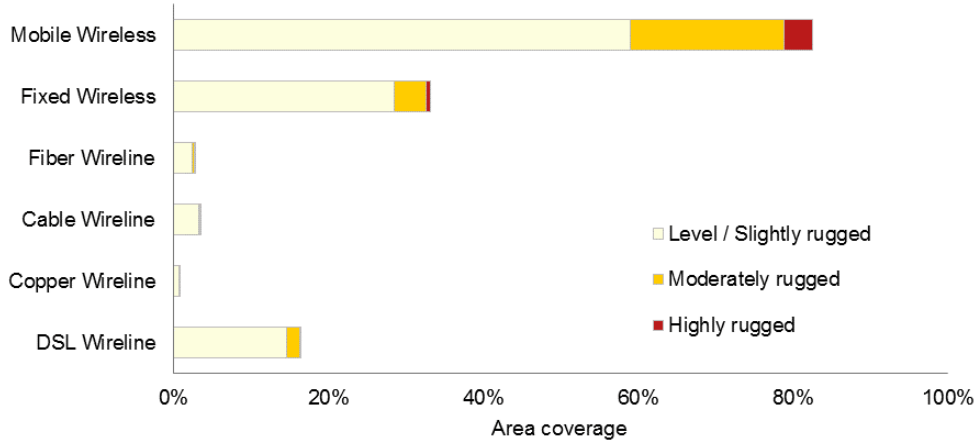


Figure 4. Percentages of Area with Access of Each Broadband Service in Different Terrain Classes

Road networks are primarily designed to connect local resources and people to distant

markets and population centers.[26] They are considered the "backbone of the economy," and secure the rest of the transport network together. The accessibility of tribes via roads was measured by the density of primary and secondary roads. [27] There are 21,288 miles of road in federally recognized tribal land, while road density is 12.9 mi/100 square mi. Total U.S routes (4.5 mi/100 square mi) and state roads (6.9 mi/100 square mi) account for the majority of road types in tribal nations (Table 6). In relation to the national level, tribal road density is far lower. The states that include tribes within them, have a closer road density to the national level.

Table 6. Federally Recognized Tribes and U.S. Road Densities

Area	Road Length (mi)	Density (mi / 100 square mi)
Tribal	21,288	12.9
Tribal States	603,224	22.8
U.S.	893,160	29.6

Case Study: A comparison between tribes and surrounding counties

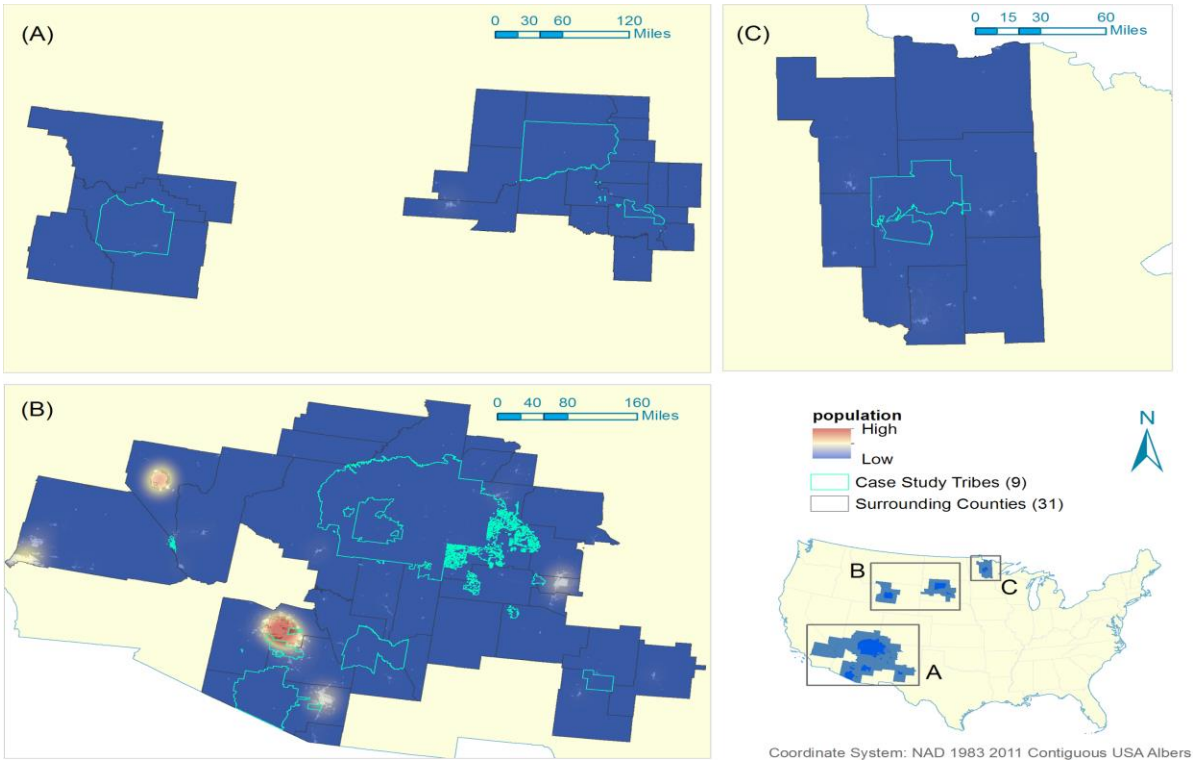
Due to close association with specific tribes, we chose to use 13 as case study. We compared the broadband coverages between tribal land and their surrounding counties. Highlighting high

[26] Forman, Richard T. T., ed. *Road Ecology: Science and Solutions*. Washington, DC: Island Press, 2003.

[27] Only primary and secondary roads were considered in measuring road density, including US route (U), interstate (I), state recognized road (S), county road (C), and other urban and rural roads (O) from 2010 U.S. Census Bureau TIGER line dataset. According to Hawbaker, Todd J., and Volker C. Radeloff, due to the addition of minor roads, road density measurements can be significantly different from each other using different sources (*e.g.*, U.S. Census Bureau TIGER line files, U.S. Geological Survey digital line graphs, and U.S. Geological Survey digital raster graphics). See "*Roads and Landscape Pattern in Northern Wisconsin Based on a Comparison of Four Road Data Sources*." Conservation Biology 18, no. 5 (2004): 1233–44.

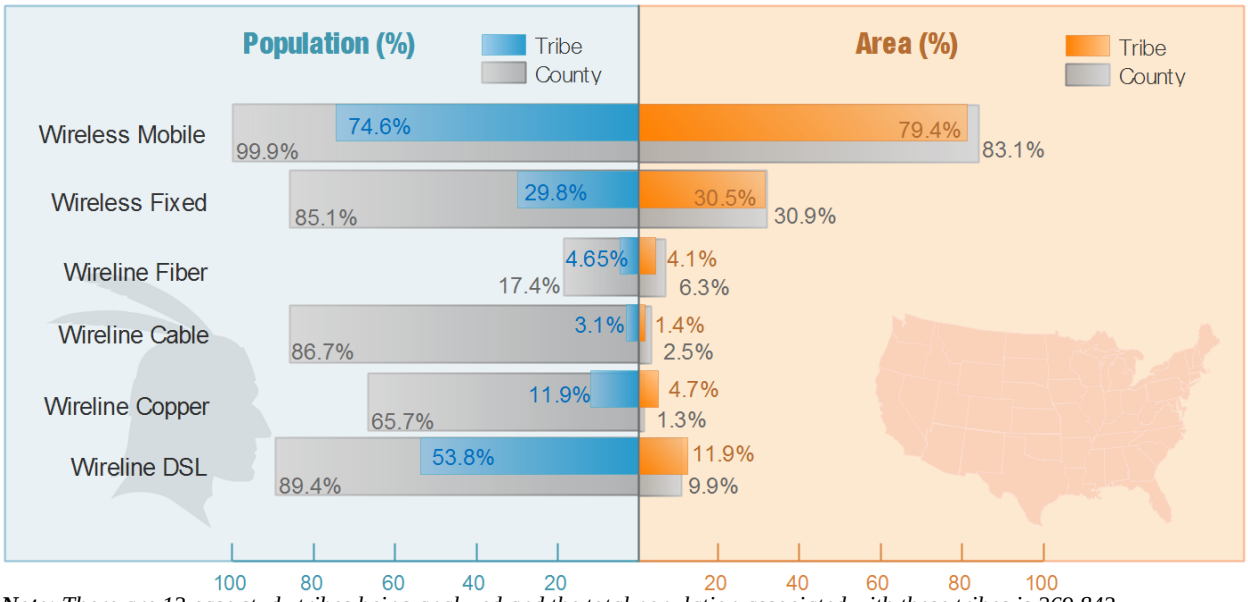
populated areas, most were located outside of the case study tribal boundaries (Figure 5). Although in geographic similar settings, tribal surrounding counties displayed higher broadband coverages for population and area with the exception of wireline copper and wireline DSL area coverage (Figure 6).

For our case study tribes, road density, area and road length was considerably low compared to surrounding counties. Road length for the case study tribal area was 1/10th of road length for the surrounding counties, with lengths of 2,553 mi and 20,250 mi respectively. Thus, road density in our tribal case study area equaled 5.6 mi/100 square mi, while the road density of surrounding counties was nearly doubled calculated to be 9.0 mi/100 square mi.



Note: Case Study Tribes include: Cheyenne River Sioux, Fort Mojave, Gila River, Hopi Nation, Leech Lake Band of Ojibwe, Lower Brule Sioux, Maricopa Indian Community, Mescalero Apache, Navajo Nation, Northern Arapahoe, San Carlos Apache, Salt River Pima, and Tohono O'odham Nation.

Figure 5. 2010 Population Density of Case Study Tribes (13) and Their Surrounding Counties (LandScan 2010)



***Note**: There are 13 case study tribes being analyzed and the total population associated with these tribes is 269,843. Surrounding these case study tribes are 63 counties and the total population associated with these counties is 11,571,362.*

Figure 6. 2010 Population and Area with Access of Broadband Services for Case Study Tribes and Surrounding Counties

Percent of area and population with broadband access for Indian Country are noticeably low compared to national averages. We have provided a representative method to view this topic in which background information and supporting statistics displayed this difference of coverage in our case study areas. However, to further analyze in more detail, various tools or methods used by CIT and Virginia's Broadband Mapping Team can aid in this process. These tools can provide accurate broadband information in Indian Country, such as speed rate and streamline data collection methods while complementing data already in place by NTIA.

Part III: Potential Issues and Future Observations for Federally Sponsored Broadband Projects in Indian Country

Government-to-Government Communication

Historically, establishing positive and beneficial dialogue between tribal governments and the US federal government has faced many challenges. As discussed in part I, the history of these relations often led to negative outcomes for the well-being of American Indians. Today, issues regarding dialogue between governing bodies are well known and are being addressed by US institutions such as the FCC. When addressing issues regarding the digital divide in Indian Country in particular, funding is available for tribal and other rural communities. As stated by the Chairman of the FCC, a promise was made by the US federal government to consult with tribal communities before policy and action takes place particularly regarding establishing broadband infrastructures and subsequently markets in Indian Country.[28] This opportunity however is only available so long as dialogue between governing bodies engages and acts in accordance with ensuring the best available options. However, as was experienced first-hand in this broadband project, dialogue is often not present or difficult to achieve and opportunities for funding for broadband is often and/or may often end up being handed over to major telecommunication companies.[29] This can greatly diminish the positive benefits of having access to broadband in Indian Country centralized within the hands of the tribes themselves as will be described below. Furthermore, the limited access to resources in Indian Country including broadband, as well as the lack of "technically trained tribal peoples" in understanding telecommunications, has led to a lack of proactive engagement with the US federal government

[28] See *supra* note 5.

[29] See Kemper, Kevin R. 2013. "Tribal Sovereignty Means Competition, Broadband Access, and Economic Development for Indian Country: A Law and Economic Analysis of the Efficiency of the FCC's Standing Rock Sioux Case." *Journal of Information Policy*. Vol. 3: 442-463.

regarding accessing funding for establishing broadband infrastructures in Indian Country.[30] Although these issues are not directly addressed in this project, the data herein can provide information for governing bodies to understand where, whom, and why particular spaces and peoples are affected by the digital divide, so that dialogue is encouraged and prioritized in areas with the greatest needs.

Sovereignty and Self-Governance: "Tribal-Centric Markets"

Aside from assuring that tribes have access to broadband, it is also recommended that tribes have the first say in whether they want to establish tribal-centric markets for broadband in their communities. Tribal-centric markets not only bring more affordable options for access, but also provide high-tech job opportunities for tribal members, which in turn can help to create stronger local economies. To uphold promises and ensure that not only the digital divide, but also the many other social inequalities in Indian Country are eliminated, protecting the sovereignty of tribes and tribal markets, specifically regarding advanced telecommunications, also requires that dialogue is valued as the first step in the process of engaging in broadband projects in Indian Country. As stated, if tribal communities have control in the decision-making process and more importantly have control over broadband markets, this ensures that the sovereignty of the tribe is recognized. To honor the sovereignty of tribal Nations, in the past, the FCC for instance has granted Eligibility Telecommunication Status to tribal telecommunication companies, which has provided a more "efficient" model for establishing broadband markets in Indian Country.[31] Efficiency here meaning not just establishing a competitive and successful market, but one that

[30] See *supra* note 7.
[31] See *supra* note 12.

also honors the sovereignty and needs of the tribal community where the market is established.[32] US institutions working on broadband projects in Indian Country need to recognize the sovereignty of tribes by ensuring that funding and infrastructure for broadband is tribal-centric and/or that the option for tribal-centric markets are addressed before outside telecom companies enter into Indian Country.

Funding for Infrastructure

As mentioned above, funding is one of the first obstacles for establishing broadband projects in Indian Country, but lack of access to knowledge about these opportunities can lead to the creation of many more obstacles regarding the sovereignty of tribal communities as well as affordable access to broadband services. Knowing about these opportunities is important to ensure that tribes have a say in the implementation of advanced telecommunications infrastructures and markets in Indian Country. There are several funding opportunities that exist to support broadband projects in Indian Country today in the form of grants, innovative funding models, and loan opportunities, which are listed below. Other opportunities available nationwide are listed in CIT's "Broadband Funding Options" document.[33]

Grants available to Indian Country are the USDA Rural Utilities Service (RUS), which includes Community Connect Grants and Distance Learning and Telemedicine Program Grants.[34] The USDA has also recently announced that it will be offering 12 more grants to tribal communities as a part of the 2501 program that assists disadvantaged rural communities.[35]

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[32] Ibid.

[33] See www.wired.virginia.gov/wp-content/uploads/Broadband/Virginia-Resources/Broadband-Funding-Options.pdf

[34] See http://www.rurdev.usda.gov/RD_Grants.html.

[35] See http://www.outreach.usda.gov/grants/FY14%20OASDVFR%20FOA.pdf

There is also federal funding available such as e-Rate Funding for Schools[36] and Federal Economic Development Administration broadband services, which partners with local providers to move all local government/school services to one provider to ensure the establishment of a more sustainable market for the provider, which in turn encourages providers to expand services. Such a funding opportunity, regarding tribal-centric markets, would greatly benefit the local economies and help to alleviate many of the economic and social inequalities experienced in Indian Country. The Federal Economic Development Administration,[37] Federal and State Agencies for Telemedicine, and the Rural Health Care Program[38] are also grants available for developing Indian Country broadband infrastructures. In addition to grants there are several federal loan opportunities that have provided innovative funding models in other parts of the country to increase broadband access to rural areas, which often experience similar problems with broadband access such as geographical constraints.[39] RUS also provides loan services for broadband development.[40] The new Farm Bill has loan opportunities for broadband. [41] These loan opportunities and funding models should be examined and leveraged to increase broadband access to Indian Country.

[36] See http://www.fcc.gov/encyclopedia/e-rate-schools-libraries-usf-program
[37] See http://www.grants.gov/web/grants/view-opportunity.html?oppId=248297
[38] See http://www.fcc.gov/encyclopedia/rural-health-care
[39] Examples of innovative funding models implemented in Vermont, Utah, and Steuben County Indiana can be found at http://www.cjspeaks.com/msp/snapshot-5-21.pdf.
[40] See http://www.rurdev.usda.gov/RD_Loans.html
[41] See https://agriculture.house.gov/bill/agricultural-act-2014).

Conclusions / Recommendations

Based on this report and the data analysis herein, it is apparent that broadband access in Indian Country falls far below the national average based on the percent of population covered. This may be attributed to a combination of complex and intertwining factors from tribal/government relations to the remoteness in location of many tribal lands. Although current challenges exist in establishing increased broadband access in Indian Country, there are funding opportunities, tools, and organizations willing to address this problem.

Funding avenues should allow tribal-centric telecommunication companies to have the first opportunity in order to establish stronger high-tech job opportunities within Indian Country. Tools, such as Data Hawk, developed to assist in the process of bringing broadband to Indian Country needs to have the backing and participation of tribal leaders and communities. Additionally any tools that are deployed need to have tech savvy trained local tribal members available to assist others in running the tools. In order for these things to occur, current Native American affiliated organizations, such as NAC and others, should continue their outreach efforts in Indian Country and continue to emphasize the importance of and positive impacts that broadband can have on their communities. In order to provide tribes with the information and data needed to determine where broadband is needed most, the tools developed by CGIT should be provided to tribal organizations that can champion the continued development of broadband in Indian Country.

Appendix A

Table 1. 2010 Census Population, Population Density, Area

Table 2. 2010 Census Age and Race Population Statistics

Table 3. 2013 Anchor Institutions

Table 4. 2010 Federally Recognized Tribes Categorized by Region, Division, and State

Table 5. 2014 Gaming Facilities

Table 6. 2010 Federally Recognized Road Density

Table 7. 2010 LandScan Broadband Area Coverage

Table 8. 2010 LandScan Broadband Population Coverage

Table 9. 2010 Federally Recognized Tribal Urban and Rural Land

Table 10. 2010 Federally Recognized Tribal Case Study Area Broadband Coverage

Table 11. 2010 Case Study Surrounding County Area Broadband Coverage

Table 12. 2010 Case Study Surrounding County Population Coverage

Table 13. Elevation

Table 14. Climate