



# Rural Broadband Strategies: Bringing Wireless Opportunities to Rural America

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## White Paper

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PCIA – The Wireless Infrastructure Association is the principal organization representing the companies that build, design, own and manage telecommunications facilities throughout the world. Its over 200 members include carriers, infrastructure providers, and professional services firms.

**Disclaimer:** The opinions expressed in this market study are those of *iGR* and do not reflect the opinions of the companies or organizations referenced in this paper. All research was conducted exclusively and independently by *iGR* on behalf of PCIA's Rural Broadband Working Group, which consists of PCIA members dedicated to expanding wireless broadband deployment to rural America. More information about the Working Group's membership is available throughout the paper in highlighted sidebar boxes.

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## Executive Summary

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Mobile network coverage has always been a challenge in rural areas due to the relatively high number of cell sites needed to cover an area with low population density. Historically, network investment has been concentrated in metropolitan markets mainly because these markets have higher population density, which leads to a higher potential return on investment in new networks and subsequent technology upgrades. In a rural market, the same investment in the same number of cells would cover far fewer customers and have higher fixed costs per customer, generating significantly less operating revenue. And to compound the problem, the population of rural areas is in decline as more people move to urban centers.

While the economic calculations used in metro markets may not add up in rural areas, rural consumers have shown a demand for broadband and the services and applications that broadband enables. A different economic equation is therefore needed to justify the costs of bringing broadband to rural America.

People in rural communities are increasingly dependent on smartphones, tablets and other wireless devices at similar rates as their counterparts in metro areas. Farmers in rural America, for example, are taking advantage of broadband connectivity to vastly increase their productivity and yields.

The entire rural economy and a host of vital human services benefit from increased wireless broadband availability, including:

- Public safety and security;
- Education;
- Community development, civic participation;
- Healthcare;
- Energy independence and efficiency; and
- Worker training.

One major issue caused by the population shift back to cities is that, as towns shrink, there is less demand for everyday services that create jobs. For example, a school with small class sizes might have to lay off teachers or a business could abandon plans to open up a new plant, further siphoning off jobs and depriving the area of additional tax dollars. As more people leave, community investment decreases, and citizens are left with diminished services, triggering even greater flight to metropolitan areas with better services.

The challenge is to maintain the services and quality of life offered in rural areas—even if the population drops. This is where broadband connectivity can benefit the community and perhaps help break the cycle. Broadband data networks can be thought

of as roads and highways – without connectivity, rural areas will shrink. But with reliable broadband connectivity, just as with access to highways, rural areas are able to thrive and attract more people.

While there are fewer people per square mile living in rural areas, rural America remains economically vital to the country. According to the United States Department of Agriculture (USDA), in 2012 farming was responsible for \$167 billion of the America's \$17 trillion annual gross domestic product (GDP) and agriculture as a whole was responsible for 4.8 percent of the country's GDP.

The farms responsible for this economic impact are not your grandfather's farms. Today's farms use a large amount of technologically-advanced, high-cost machinery as well as numerous automated systems for irrigation, crop management and livestock feeding. All of these systems can be monitored and controlled by machine-to-machine (M2M) wireless technology that allows farm machinery to communicate amongst each other and collect valuable data, just as factory machinery currently can. M2M farm applications and solutions would strengthen productivity by promoting better inventory control, reducing inefficient routes, facilitating machine maintenance and repair, and expedite the ordering of parts and services—all of which enhance the global competitiveness of U.S. farmer. This, in turn, boosts the economies of rural communities.

Rationalizing investment in rural areas requires an economic justification—and for that, rural investment analysis needs to use different metrics than are used in the metropolitan markets. For example, while a metro mobile broadband network can be justified based on population, as well as the average-revenue-per-user (ARPU) plus the amount of data consumed by the subscribers, a model using those same assumptions will not work in rural areas.

Rather than simply looking at population densities, the economic model for rural broadband deployment needs to consider the following:

- Examining broadband holistically, not just mobile broadband, in assessing the rural region to be covered.
- Assessing the rural market network design so that it does not simply mimic the design used in metro areas, but instead pursues a more extensive use of repeaters, taller towers, and lower spectrum bands.
- Acknowledging that the economic model for mobile broadband in rural areas should be based on the number of *devices* and *connections*, not simply the number of people to be covered. This would, therefore, include tablets, security devices, home monitoring, healthcare, and a host of M2M devices and applications.
- Gauging the special role of private-sector investors, especially those corporations that have a vested interest in the rural region. For example, if a hospital chain wishes to build a clinic in a rural town and needs fiber for broadband access, it could potentially be used as a backhaul hub for connecting local cell sites. The hospital, moreover, might be willing to share the fiber

access in exchange for lower monthly rates. These types of models are not often used in metro markets (but are being discussed for large buildings); in rural areas, however, lateral and out-of-the-box thinking is needed.

- Appraising plans for enhanced public safety broadband services (such as FirstNet) and the opportunities these services create for shared infrastructure between private and public users in rural markets. Federal and state investment in public safety networks and subsequent buildout of backhaul and antenna structures will be key drivers in extending mobile broadband coverage to rural areas.
- Fully appreciating the nexus between improved broadband networks, job creation and economic growth. Once a broadband network is deployed, subsequent economic activity will likely lead to a reduction in population loss, further justifying the investment.
- Finally, publicizing wireless broadband successes in rural America. If one rural market develops an economic and investment model that works for broadband deployment, that community should share its results with others to ensure that benefits are appreciated nationwide. Imitation is the sincerest form of flattery: if there is a model that has been successful, other markets would benefit from information sharing and may adopt it for themselves.

## Economic Variations: Rural vs. Urban America

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It is no surprise that there are significant differences between the economies in metropolitan markets and rural areas. These differences have historically resulted in more limited availability of wireless networks in rural markets and, in recent years, mobile broadband networks in rural markets.

Wireless networks require significant capital to deploy and are expensive to operate. Not surprisingly, today's wireless networks are built to provide coverage where the majority of Americans live and work.

For mobile carriers, the higher the population density, the higher the potential return on investment in new networks and subsequent technology upgrades. This greater economy of scale also benefits the consumer in the form of lower pricing.

This creates a broadband availability problem for rural markets with low population densities. The FCC defines a rural county as one with a population density of fewer than 100 people per square mile. Investors have difficulty justifying the expense of wireless networks in rural markets because the return-on-investment (ROI) will be far lower than in a metropolitan market. While taller cell sites can be built in rural markets to potentially cover a larger area, the laws of physics still apply: no matter how large the cell site, wireless signals will only travel so far. Hence, many cell sites are still required to cover a given area even though there may be very few people living in that area.

Wireless networks do cover most rural markets, but newer, faster technologies (such as Long-Term Evolution (LTE)) generally are not offered in rural areas for several years after their launch in metro markets. As a result, wireless users in rural areas sometimes face poorer voice quality and slower data speeds when compared to their counterparts in metro areas.

Numerous *iGR* surveys and studies have shown that the demand for mobile broadband is growing in rural markets, just as it is in cities. People in rural communities use smartphones, tablets, and assorted other devices just as people in metro areas do. In fact, rural residents are sometimes more dependent on connectivity because they have fewer commercial, cultural, educational, health care and other services available directly. In essence, the availability of broadband networks shrinks the differences between the cities and rural areas, and therefore supports rural economic growth.

### Mosaik Solutions®

As a leader in world-class geospatial solutions and telecom business intelligence, we deliver a range of analysis and software services to meet the growing needs of companies with interests in the telecommunications sector.

One of our most popular solutions is MapELEMENTS®, which provides wireless operators, infrastructure firms, M2M providers, and other related segments with a robust mapping and analytical software that allows users to evaluate assets against telecom network service areas, tower locations, demographics and other critical data.

Companies with internal mapping expertise can leverage CoverageRight™ and MarketRight™, which include detailed GIS datasets representing global network coverage areas by technology and licensed spectrum geographies.

Mosaik Solutions now offers a platform solution that combines the flexibility of everyday smartphones and the scalability of the cloud to deliver concurrent testing and analysis of multiple wireless networks (including Wi-Fi).

To learn more about how Mosaik Solutions® can help you make better decisions, visit [www.mosaik.com](http://www.mosaik.com).

And for farms in rural America, the availability of broadband connectivity is becoming critical to productivity, as will be demonstrated in greater detail below. But the issue of low population density in rural America is worsening. Consider that, according to the U.S. Census, the total U.S. population grew by 2.255 million people between 2012 and 2013, equivalent to a 0.72 percent increase. The population of the metropolitan statistical areas grew by 2.283 million people over the same period.

This means that the population of rural areas *dropped* by 28,000 between 2012 and 2013. And this is a long term trend: counties dependent on farming saw their population grow a meager 0.3 percent between 2000 and 2010, and only 29 percent of those counties actually gained people. The availability of broadband networks is key to reversing this trend.

Overall, according to the U.S. Census approximately 46.2 million people live in rural areas – just 14.6 percent of the U.S. population.

So while the demand for mobile bandwidth is increasing, the population of rural markets is declining. This presents a challenge for the mobile industry as it tries to attract investment for new wireless networks and technologies.

That said, it should be noted that overall, the number of devices per person is increasing – this is true of rural markets as well as metro areas. According to *iGR's* research, in 2013 there were, on average, 1.11 mobile devices per subscriber. Research forecasts a 52 percent increase by 2018, to 1.69 mobile devices per person. Consumers are activating more tablets, connected cars, smart homes, M2M devices and services and assorted other devices that require a data connection. As Pew Research noted, nearly all people in the U.S. already have a mobile phone. For the industry to continue to grow, it must therefore sell more mobile devices to the existing population. For the rural markets, this trend improves the economic justification for building broadband data networks.

# The Business Case for Rural Broadband

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Many people choose to live in smaller towns and rural areas for the quality of life, or to avoid the challenges and costs associated with large metropolitan areas. But the availability of mobile broadband services in rural markets is increasingly seen as a necessity by larger numbers of people.

Aside from enabling increased productivity for agriculture, mobile broadband would also improve the quality of life and economic opportunities in several areas:

- Public safety/security
- Community and economic development and participation
- Healthcare
- Energy independence and efficiency
- Education
- Worker training.

One major issue caused by a population shift toward urban areas is that, as towns shrink, there is less demand for everyday services that create jobs. For example, a school with smaller class sizes might have to lay off teachers or a business could abandon plans to open up a new plant, further siphoning off jobs and depriving the area of additional tax dollars. A reduced tax base impacts the availability of capital for local infrastructure and services, such as road repair and improving emergency services.

This is a regrettable cycle: as more people leave and investment in and services offered by the community fall, more people are inclined to move to a large metro market. The challenge, therefore, is to maintain the services offered in rural areas and quality of life, and ultimately grow the population. This is where broadband connectivity can benefit the community and break the cycle of population decline.

As examples, consider how broadband networks would support several industries and services in rural areas:

- Enhanced public safety and security: by providing public safety organizations with increased functionality, mobile broadband shortens their response time in natural disasters and accelerates their recovery efforts. More extensive rural broadband would allow for remote monitoring of properties and equipment,

## PEG Bandwidth

PEG Bandwidth is a premier provider of bandwidth and infrastructure solutions for the wireless industry. We maintain a focus on solving our customers' most challenging network issues, such as cell site backhaul in rural America and turnkey small cell solutions.

Founded in 2009, PEG Bandwidth has developed strong relationships with the nation's largest wireless operators by virtue of providing communications infrastructure in rural markets to support 4<sup>th</sup> Generation broadband deployments.

Although PEG Bandwidth occupies colocation space within the largest carrier hotels in the US such as 60 Hudson in New York City, 350 Cermak in Chicago and Equinix in Ashburn, Virginia, these are merely aggregation points where we backhaul traffic from the smallest markets oftentimes hundreds of miles away. Our customers continue to lean heavily on us as their 4G deployments continue in the most remote markets where little to no communications infrastructure exists today. Having access to significant capital and maintaining a long-term view of bringing infrastructure to "prairies and mountaintops" allows PEG Bandwidth to be a trusted partner for the wireless industry.

additional in-home security and monitoring services (including video cameras), and personal security services. For rural businesses and homes that are located far from frequently-traveled highways and major roads, services enabled by broadband could save lives.

- Community and economic development and participation could be enhanced with services such as Skype, to connect remote homes to town meetings, etc. Some communities also have websites specifically designed for rural citizens. Obviously, these types of services need reliable Internet connections to be of value. Remote workers can use broadband to work from any part of rural America, bringing in a whole new economic base and new opportunities to create or expand businesses.
- Healthcare in rural areas could be significantly enhanced with reliable broadband connectivity to link up remote clinics and hospitals to specialists in metro markets, for example. And with advances in telemedicine, it is not unrealistic to imagine that a surgeon will soon be able to perform basic operations remotely. In addition, home healthcare for the elderly could be improved with home broadband services through remote monitoring, remote consultation with a nurse or doctor by a care giver, or enabling a nurse to connect to a specialist or doctor in a metro market directly from the patient's home. Along with improving the healthcare services available, this would also cut costs by reducing the need for a patient to travel to a metro market for treatment, especially as the population ages.
- Energy efficiency has been improved in metro markets through the use of remote home monitoring and control (for example, wireless-enabled thermostats to control heating/cooling systems, remote control of lighting, and smart meters). These solutions require a reliable Internet connection to the home or business to be effective. With improved rural broadband coverage and availability, these benefits could be extended to rural communities. Moreover, telecommuting reduces energy consumption.
- Rural broadband services improve education opportunities in many of the same ways as healthcare. By connecting rural schools to remote classes via telepresence, additional subjects can be taught cost-effectively and schools can expand the scope of existing class offerings. Classes from metro community colleges, online universities and conventional universities can be available to rural communities through broadband. For example, Starbucks recently announced a program to offer free online classes from Arizona State University to its employees throughout the country—a program that rural Americans could take advantage of, provided their community has sufficient broadband availability. Finally, the availability of broadband Internet service improves student test scores and engagement.

### Crown Castle

As the nation's largest provider of shared wireless infrastructure, Crown Castle is helping enable the essential services that people rely on to stay in touch, conduct business, and live their lives every day. Since 1994, we've worked diligently to build our US footprint—collaborating closely with wireless carriers, communities, governments, and local property owners to provide access to the infrastructure they need. Today with over 40,000 towers, 12,000 deployed small cell nodes and over 6,200 route miles of installed fiber in the US, we offer significant wireless communications coverage nationwide.

- Remote worker training via improved broadband connectivity would enable companies able to train workers without the need to travel to a metro area office or facility. Further, companies can conduct online training classes, increasing remote worker engagement and improving workplace efficiencies.

As shown above, the benefits of increased broadband availability in rural markets goes far beyond agriculture—it is needed to maintain quality of life and increase economic opportunities in rural areas. As society finds more ways to use—and benefit from—broadband connectivity, the need to provide the same of level of service to rural communities will increase.

## Wireless Leads to Greater Agricultural Productivity

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Rural America is economically indispensable to the country. According to the USDA, agriculture is responsible for 1.2 percent of the U.S. annual gross domestic product (GDP), which translates into more than \$200 billion. The U.S. economy is by far the largest in the world, with a GDP of nearly \$17 trillion—more than two times larger than China, the next largest economy—meaning any increase to U.S. agricultural productivity would have global implications.

The following table shows some key statistics for the U.S. agriculture industry, reinforcing agriculture's key role in the U.S. economy.

### Farming Facts and Statistics

There are 2.2 million farms in the United States.

About 46 percent of the country is farmland.

The agriculture industry employs more than 21 million American workers, representing 15 percent of the country's total work force (and more than six times as many workers as the U.S. automotive industry).

U.S. farms sell approximately \$370 billion in goods each year, which is larger than the gross domestic product of nearly 200 countries.

American farmers grow 40 percent of the world's corn.

One in three U.S. farm acres is planted for export.

Each year, \$115 billion worth of American agricultural products are exported.

Americans spend 9.5 percent of their income on food—less than any other country.

*Sources: United States Department of Agriculture, Center for Food Integrity, Farm Policy Facts*

For U.S. agriculture, there is an increasing need for mobile broadband coverage in the fields. Farms use a large amount of high-cost machinery (tractors and combine harvesters, for example), as well as numerous automated systems for irrigation, crop management, and livestock feeding. All of these systems can be monitored and controlled by M2M applications and solutions, just as their equivalents are in U.S. factories.

A Hudson Institute paper, "Broadband for Rural America: Economic Impacts and Economic Opportunities," examines the growing broadband gap between rural and urban areas and argues that the gap will lead to significant economic losses for rural America. The study discusses the role broadband plays in agriculture including

innovations in precision farming as well as use of real-time data for sales, purchases, machinery performance, etc.

“When combined with the capacity of broadband, agricultural equipment that began as a tractor is evolving into a ‘mobile geospatial data-collection platform with the capacity to receive, use, sense, store and transmit data as an integral part of its . . . performance.”

“Information technology . . . could have at least as big an impact on agriculture in the next half century as mechanization had in the previous century.”  
— *Hudson Institute Paper quoting the conclusion of a group of University of Illinois scientists.*

M2M on the farm would improve productivity and strengthen the American farmer’s capacity to compete in global markets. This, in turn, would help sustain the economies of many small towns, cities, and rural areas. Every day, many agriculture sector employees use multiple devices that require data connectivity and bandwidth from mobile networks. The challenge, of course, is that the cellular data networks necessary to support M2M solutions are often not available.

There are also potential benefits of extending mobile broadband service to the cab of the tractor, combine, or farm pick-up. For example, the combine driver could coordinate harvesting with the other vehicles (fuel trucks and grain carts, for example). Farmers could also be connected in real time to agriculture experts to help solve specific problems—a video or teleconference could be arranged to demonstrate the problem or show specific crops.

Further, the systems on the combine could be monitored in real time and in detail to ensure that everything is working as efficiently as possible. This would reduce operating costs, increase yields, and improve productivity.

Increased productivity is key to the continued global success of U.S. agriculture. According to the USDA, both nominal and real crude oil prices are assumed to increase over the next decade as global economic activity improves. At the same time, prices for many major crops are projected to decline in the near term as global production responds to high prices of recent years.

## John Deere

Over the past several decades, technology enabled farmers to achieve ever greater levels of productivity. The first wave focused on optimizing the vehicle. The second wave focused on optimizing the fleet. The third wave is focusing on connecting the farmer “in the cab” to the cooperative, agronomist, or other agriculture service providers who can help reduce input costs, increase yields, and further enable sustainable farming practices. Our machines are now being designed to communicate with each other, the owners, operators, dealers, and agricultural consultants, with the ultimate goal of making farmers more productive and profitable.

Improvements in efficiency and productivity are in the use of data, which depends on mobile broadband for communications and data flow to provide intelligent products and services. This technology brings more precision, convenience, and up-time to operations in several categories as listed below:

- **Machine Optimization:** Provides solutions that will get the most out of your machine using precision technology and wireless, mobile data networks for higher levels of productivity and increased up-time.
- **Logistics Optimization:** Will better manage logistics and machinery use from remote locations through fleet management solutions and increased machine to machine communication.
- **Ag [define] Decision Support:** Provides user-friendly monitors, sensors, and wireless, mobile networks to provide easy access to machinery and agronomic data essential to making proactive management decisions for operations.

This means that farm costs will increase while revenues fall. Hence, agriculture profits will decline unless productivity can be improved.

That said, the demand forecast for agriculture products is high:

- Developing countries will have a growing role in the global economy and food demand and will continue to account for most of the growth in U.S. agricultural exports.
- Over the long run, steady global economic growth provides a foundation for continuing strong crop demand.
- U.S. corn production rebounded from the weather-reduced 2012 crop, resulting in declining prices and increased domestic use and exports in the 2013-14 season. Moderate growth in demand is projected over the next decade.
- Strong global demand for soybeans, particularly in China, boosts soybean trade over the projection period—China accounts for all of the increase in world soybean imports. Even though U.S. soybean exports are projected to rise, competition from South America leads to a reduction in the U.S. share of global soybean trade from 38 percent in 2013-14 to about 32 percent in 2023-24. Brazil continues to be the largest exporter of soybeans.
- U.S. acreage planted for long-grain rice is projected to rise moderately through the projection period, but plantings for medium- and short-grain rice hold flat.
- Farm sales of horticultural crops are projected to grow by 1.2 percent annually over the next decade, reaching \$74 billion in calendar year 2023, up from \$66 billion in 2013.
- The livestock sector is slowly recovering from high feed prices and drought in the Southern Plains of the United States over the last few years. Improving returns have provided incentives for increased production in the livestock sector. As a result, total U.S. red meat and poultry production is projected to rise over the projection period, as is per capita consumption of red meat and poultry.

## American Tower Corporation

As a leading independent owner, operator and developer of wireless communications infrastructure in the United States, American Tower partners with customers to help them optimize their wireless networks. Our portfolio of more than 51,000 U.S. communications sites provides coverage for national, regional and local wireless carriers, TV and radio broadcasters of all sizes, wireless internet service providers, government agencies and first responders, the Oil & Gas industry and other private organizations and vertical markets.

Following the increase in demand for broadband coverage throughout the U.S., our focus has been helping our partners grow the coverage and capacity of their networks in new ways and in all regions. Our ever-growing inventory of 28,000+ wireless and broadcast towers, including 3,800+ sites located near USDA designated croplands, has proven critical for customers looking to extend modern network technologies, such as 4G broadband, to rural and agricultural communities across the country. Our collocation model benefits customers with expedited network development. By utilizing existing structures for their wireless equipment and implementing our streamlined process, customers can get on air quickly and efficiently.

American Tower is committed to growing and developing our site portfolio to best serve the needs of our customers. We strive to understand their network goals and develop customized solutions to address them. We also recognize the importance and benefit of making broadband network accessibility available throughout the nation. For more information on our wireless network solutions and working with us, please visit [www.americantower.com](http://www.americantower.com).

- Milk production is projected to continue rising over the projection period. The long-term upward trend in output per cow continues, while milk cow numbers rise through 2017 and then fall. The United States is expected to be well positioned to expand exports of dairy products.

If we only focus on fixed broadband to farm buildings, however, we will overlook the important benefits of cropland blanketed with mobile broadband—coverage necessary to fuel extensive farming operations which, in turn, will spark essential economic activity and provide jobs throughout rural communities.

The increased crop exports that experts are forecasting should help the U.S. agriculture industry compete with other economic powerhouses like China and Brazil. The efficiency and productivity of U.S. agriculture, however, must also improve over the next decade for our country to remain competitive with global markets. While mobile broadband and M2M solutions alone cannot solve all of these problems, the availability of improved wireless networks will likely contribute to improved productivity.

## Challenges of Rural Broadband Coverage

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Mobile coverage has always been a challenge in rural areas due to the relatively high number of cell sites needed to cover an area combined with the low population density. Investment has focused on the metropolitan markets mainly because wireless providers can cover a lot of people with a cellular network and get a good return on the initial investment. In a rural market, the same investment in the same number of cell sites would cover far fewer people and hence the resulting revenues would be far lower.

While the economic calculations used in metro markets may not add up in rural areas, rural consumers have shown a demand for broadband and the services and applications that broadband enables. A different economic equation is therefore needed to justify the costs of bringing broadband to rural America.

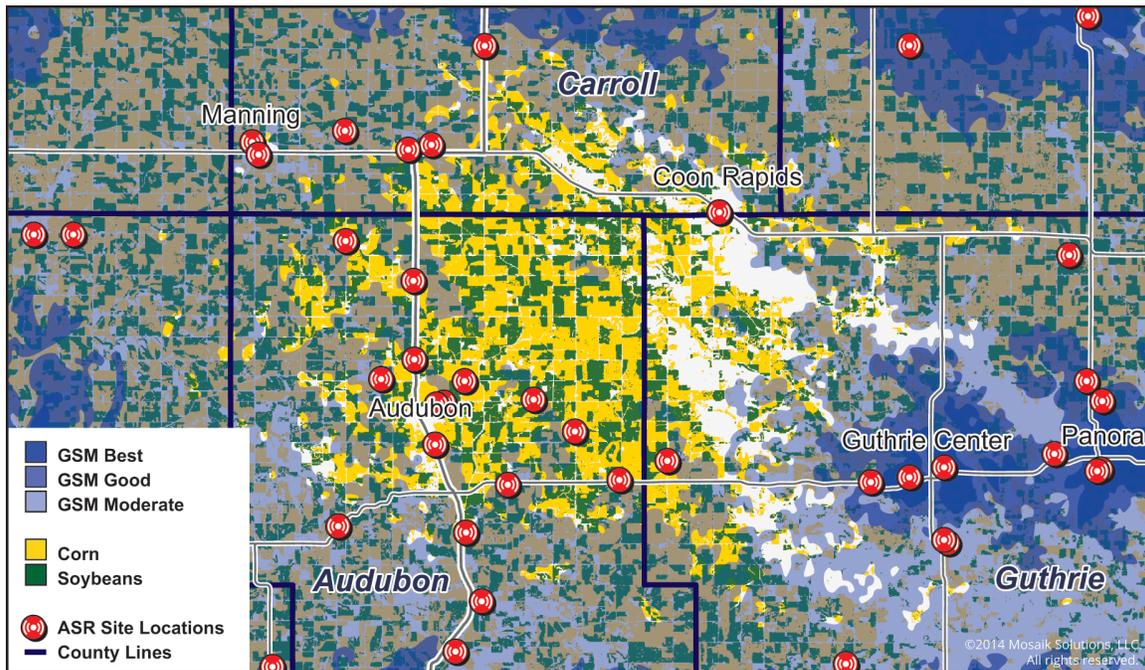
There are challenges that must be addressed in the rural markets:

- Mobile technologies are currently designed to provide service in a densely populated market—as demonstrated by the newer releases of the 3<sup>rd</sup> Generation Partnership Project (3GPP) LTE specifications, mobile standards tend to focus on the need to add capacity to a given area and deliver higher speeds. Rural networks need to provide broadband coverage over a wide area but likely to fewer numbers of people, devices, and machines. The challenge for rural America is not one of broadband density, but of providing cost-effective and efficient coverage.
- LTE may be cost prohibitive to deploy in many rural areas simply because the user density is not high enough to justify investment. Plus, interoperability issues with tier 1 carriers and limited access to handsets with the required band support make LTE deployment by smaller, rural carriers challenging and in some cases, prohibitive.
- Many smaller carriers are being acquired by tier 1 carriers (for their spectrum in particular smaller markets), which can remove the smaller carriers' former focus on rural markets.
- 2G cellular data speeds are not sufficient to support many of the services and applications needed in rural markets. A minimum of 3G data speeds are needed to support the hour-to-hour mobile broadband requirements of the agriculture industry. The current 2G networks servicing agriculture should be upgraded to 3G technology to meet these needs; in some cases, existing 2G services will be turned off in the next several years.
- While satellite services can provide basic voice and messaging service in remote areas of the world, they are qualitatively different and often much more expensive and therefore not economically viable for mobile broadband data services.

- Rural market entry and competition is complicated by the fact that spectrum licenses have meager buildout requirements. For example, a spectrum license will likely cover a wide area and have a requirement to cover a given percentage of the population in that area. The mobile carrier can usually meet this requirement by building out the towns and cities in the license area and is therefore not required to cover more rural populations and farms, etc.

As an example of the challenges of getting mobile broadband service in a rural market, consider the following: In this geospatial map image provided by Mosaik Solutions (Figure 1), major crop fields in Audubon County, Iowa are represented in yellow (corn) and green (soybean). On top of the crop fields are layers representing GSM-based network coverage (shades of blue). The areas in bright green, yellow and white (no blue overlay) show areas that have no GSM network coverage, indicating large swaths of corn and soybean fields lacking coverage. Areas with the lightest blue overlay have service, but with a weaker signal level than those shown in dark blue.

**Figure 1: Audubon County, Iowa Cropland, GSM Coverage and Towers**



Source: USDA CropScape, Coverage © Mosaik Solutions®, 2014

The red dots represent a sample of tower assets (those antenna structures that can be utilized for collocation) in central Iowa, taken from the Federal Communications Commission Antenna Registration System database. Of particular interest are the tower assets that exist in areas where wireless broadband coverage is not currently available. These tower assets could possibly be utilized for expanding wireless broadband coverage in those areas, enabling, for example, M2M capabilities and “in cab” broadband connectivity for farmers.

As this example shows, in many cases there may be sufficient tower assets available in a rural market to provide coverage, which in turn can bring down costs and bolster the

economic justification a carrier needs to build out its network. A more detailed assessment would be required of these tower assets to understand which ones would be available and/or suitable for an LTE deployment.

## Economic Justifications for Rural Broadband Networks

To justify investment in rural broadband networks, the industry needs to use different metrics than are used in metropolitan markets. For example, while a metro mobile broadband network can be justified based on 1) population, 2) ARPU and 3) the amount of data consumed by the subscribers, a model using the same assumptions may omit opportunities and potential users in a rural context.

Rather than simply looking at population densities, the economic model for rural broadband deployment should consider the following:

- The model should consider broadband—not just mobile broadband—holistically across the rural region to be covered. Private-sector investment, including from corporations who have vested interest in the rural region, should also be considered. For example, if a hospital chain wishes to build a clinic in the local town and needs fiber for broadband access, could the hospital be then used as a backhaul hub (backhaul provides a broadband connection from the cell site back to the network core) for connecting local cell sites? Would the hospital be willing to share the fiber access in exchange for lower monthly rates? These types of models are not often used in metro markets (but are being discussed for large buildings) but in rural areas, lateral and out-of-the-box thinking is needed.
- The network design for rural markets should not simply mimic that used in metro areas. For example, could cell sites be spaced more widely in the rural market and then use repeaters to reach areas farther out? Can fewer, taller towers be deployed in rural areas? This underscores the importance of the 700 and 600 MHz lower spectrum bands as their propagation characteristics allow for greater reach from a given transmission point.
- The economic model for mobile broadband should be based on the number of *devices* and *connections*, not simply the number of people to be covered. This would therefore include tablets, security devices, home monitoring,

### ADRF Case Study: Pretty Prairie, KS

#### Overview

The town of Pretty Prairie, Kansas had poor LTE service on a leading carrier's 700MHz band. Given the low density nature of the coverage scope (Area: 0.610 sq. mi, Population: 691), the carrier decided to cost-effectively enhance coverage utilizing the AXM700-9543-ICS, ADRF's 20W Outdoor Repeater with patented Interference Cancellation System (ICS)™.

#### Goals and Process

Benchmark testing showed low throughput speeds throughout the town, due to low RSRP and multiple PCI. Pretty Prairie had multiple neighboring BTS towers, the nearest 7.1 miles away. An outdoor DAS, with its equipment, installation, and maintenance costs as well as fiber backhaul and tower leasing fees, would have been cost prohibitive. Instead, the carrier decided to deploy a high power repeater to amplify one of the neighboring BTS tower's signal and provide the town with a single, dominant signal. With its patented ICS™ technology to overcome isolation issues common in outdoor applications, ADRF's AXM700-9543-ICS was the easy choice.

#### Solution and Outcome

Deployment of the AXM700-9543-ICS repeater was completed much more quickly and efficiently than an outdoor DAS and resulted in a substantially improved end-user experience for Pretty Prairie residents, thus meeting or exceeding the stringent demands of the carrier. Should coverage on other frequency bands warrant enhancement in the future, the carrier can continue to rely on ADRF's class-leading AXM-ICS Series, now available in Cellular, PCS, and AWS variants.

healthcare and a host of M2M devices and applications. The revenue for each device will be different from that of a smartphone, but also the data usage will follow a different pattern. Each should be modeled carefully, but the overall result should be a holistic view of *all* devices and services to be supported by the network.

- The need for public safety broadband services requires coverage in rural areas (such as FirstNet) and will help drive the need more towers and backhaul. This also creates new opportunities for shared infrastructure between private and public users. Federal and state investment in public safety networks and subsequent buildout of backhaul and antenna structures will be key drivers in extending mobile broadband coverage to rural areas.
- The opportunity for job creation and economic growth should also not be overlooked. Once a broadband network is deployed, economic activity will follow and will likely lead to an increase in population.

Finally, it will be important to publicize the successes, no matter how small. If one rural market develops an economic and investment model that works for broadband deployment, tell others about it and make sure the benefits are seen nationwide. Imitation is the sincerest form of flattery—if there a model that has been successful, other markets will want to know and adopt it for themselves.

## APC Towers

APC Towers LLC (APCT) is a fast growing wireless infrastructure company expanding nationally. With the majority of its towers located in rural areas, APCT is committed to building the wireless infrastructure that helps eliminate rural communication gaps. APCT's core mission is built on a simple premise: investing in wireless communications opportunities that leverage its principals' experience and relationships. By relying on this principle, APCT offers its clients cost-effective and timely solutions to its infrastructure problems. This focus is even more important for our clients with Connect America Mobility Funding. Recipients of these funds have turned to APCT to optimize funding capital and recognize the value and experience that APCT brings to the table.

## Conclusions and Recommendations

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Increasing broadband availability in rural areas is a problem without a simple solution. Multiple parties must be involved and the economics to justify investment differ from those of metropolitan areas. But the importance of expanding rural broadband should not be underestimated—as discussed above, additional mobile broadband services are needed to preserve rural communities and develop rural economies, including the agriculture industry (which is of critical importance to the overall U.S. economy).

While a strong business case to support rural broadband deployment can be justified, the reality is that specific inducements to mobile carriers will incentivize deployment. For example, proposed legislation in Iowa provided an accelerated depreciation deduction for income tax, a 7 percent tax credit, and a 100 percent property tax exemption for broadband infrastructure deployed in targeted areas. Enacted legislation in Colorado used a state sales and use tax refund program to encourage broadband investment in targeted areas.

One key incentive should be for carriers to be eligible to receive funding for middle mile facilities that support wireline backhaul for mobile broadband infrastructure, not just for infrastructure serving end users or middle-mile facilities to support wired last mile connections. Obviously, mobile broadband sites need reliable backhaul connections that may be provided by landline carriers or by the mobile carriers themselves. And neutral host mobile broadband backhaul can be used so that the cost can be shared among all mobile carriers.

Other infrastructure policies that will promote expansion of wireless broadband include:

- **Uniform cell siting legislation** - respect for municipalities' zoning authority, recognition of reasonable siting regulations and a predictable and timely process for applicants are required to speed the deployment of additional cell towers.
- **Demand-based collocation** - some public/private organizations need mobile coverage based on geography (and not population density) and public/private "partnership" collocation on cell towers should be encouraged. For example, public safety (such as FirstNet), transportation, utilities and agriculture organizations could all share infrastructure.
- **Supply-based collocation** - encourage infrastructure sharing between cell carriers providing mobile broadband and wireless internet service providers (WISP) who provide a fixed broadband service to households and businesses.
- **Dig once notifications** - Notify providers of any utility trenching project to deploy fiber, or partner with neutral host fiber providers, for mobile backhaul if the right-of-way is already opened up for a gas, water, or power project.

- **Conduits along highways** - Require that broadband conduits be installed along and under highways as part of certain construction projects.
- **Directing resources at Rural Utilities Service (RUS) programs** - RUS has a sizeable portfolio of loans to borrowers that derive a significant portion of their revenues from the Universal Service Fund (USF), which means there must be a predictable level of support so carriers can plan, borrow and invest in infrastructure, including neutral host fiber backhaul.
- **USF** - USF, also called the Connect America Fund (CAF), provides long-term support for expansion of broadband services to high-cost areas. CAF is an ideal and sustainable cost-recovery mechanism for rural areas where subscriber densities are too low to motivate providers to build infrastructure and offer service. The CAF has a wireless component, the Mobility Fund, targeted at the expansion of mobile broadband networks. Phase 1 of the Mobility Fund provided over \$300 million to over 30 service providers in one-time support to accelerate the deployment of mobile broadband in unserved areas. Phase 2 provides ongoing support to deploy and maintain mobile broadband and voice service in high-cost areas, with up to \$500 million will be available every year. These federal programs can also be coupled with state universal service programs.
- **Federal lands process reform** - The Middle Class Tax Relief Act of 2012, Executive Orders from the Clinton and Obama Administrations, and agency guidance has made clear that the siting of mobile broadband infrastructure on federal lands and properties is a priority for the delivery of broadband service and efficient use of our nation's resources. The federal government owns or administers nearly 30 percent of all land in the United States, including thousands of buildings, and provides funding for state and local transportation infrastructure. However, national and regional carriers currently face significant challenges when working to secure access to federal rights-of-way and buildings to deploy broadband infrastructure. Both legislative and internal agency solutions are need to effectively leverage federal property to meet national public policy and broadband deployments goals. Many of the lands and properties that would benefit from streamlined siting are by definition rural. It is important for the public and private sector to work together to ensure that buildout can accelerate.