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# Rural Broadband

## Whitesburg Deployment

November 2017

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**LTEasy, connecting the world one step at a time**

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## EXECUTIVE SUMMARY

### Connecting Rural America with Affordable Broadband

Thirty-seven percent of rural Americans don't have access to basic broadband.<sup>i</sup> That leaves a staggeringly large amount of US citizens unable to take advantage of the economic and educational benefits that many of us take for granted on a day to day basis. But what are the reasons for this disparity? Is it the cost of deployment? Is the technology just unavailable?

Quite simply, yes. Until recently, the cost of providing rural citizens with a sufficient broadband connection was often too expensive to justify the cost of the necessary equipment. This, plus the absence of innovative solutions, stagnated the rate that networks expanded to underserved areas.<sup>ii</sup>

Thankfully, this trend is changing. As the economic importance of rural broadband is becoming more prominent, we're seeing a surge of impactful and affordable network technology along with innovative business models and a growing demand for cloud technology. This is making it possible for service providers to go to areas that are in desperate need for broadband and not only serve these communities, but make it a profitable venture as well.

### A Better Broadband Solution for Whitesburg, Kentucky

In Letcher County, Kentucky, the broadband disparity is worse than most of the US. Kentucky ranks 35th overall for broadband connectivity in America, and in this eastern part of the state only forty-two percent of individuals (both rural and urban) have access to a broadband connection.<sup>iii</sup> Located deep in the heart of the Appalachian Mountains, the roads here wind through unforgiving terrain making it difficult for fiber to be laid to even the county's more populous areas. This, plus the lack of any significant population density that might otherwise encourage businesses to invest in the area, left the county struggling to keep up with the rapid advance of technology.

Seeking a solution to this problem, Rural Strategies - a rural community advocate organization based in Letcher County - contacted FiSci Technologies to see if our solution could be applied to the town of Whitesburg, a small community in Letcher County. Following initial testing and scouting we determined that it would be possible to deploy a fixed wireless LTE network to serve the town, but we would require a local partner that would be responsible for maintaining the network and act as the service provider to the consumer.

Gigabeam Networks, a Virginia-based WISP, agreed to partner with FiSci to bring broadband to the city of Whitesburg. Having been in the business since 1997, Gigabeam was looking to rapidly expand their network into underserved areas.



Figure 1: Eastern Kentucky



## Requirements of the Network

In building the network for the citizens of Whitesburg, FiSci was tasked with building a low cost, quickly deployed, reliable fixed LTE network option for end users in the city of Whitesburg. The internet packages offered would have to be affordable for the citizens and the network would have to be scalable, robust and future-proofed.

By leveraging an exclusive partnership with Baicells Technologies, FiSci would be able to accomplish these goals due to the affordable and scalable nature of Baicells LTE small cells. Savings would be passed to the end-users, ensuring the lowest internet costs in the city. LTE's carrier-grade technology meant that the network would remain robust, reliable and future-proofed as advanced LTE releases become available.

Following testing and taking all above points into consideration, FiSci concluded it would be able to build a network for the citizens of Whitesburg with internet packages that started at \$19.00 a month with speeds at 4 megabytes per second for downloads and 1 megabyte per second for uploads.

## PREDEPLOYMENT

### The City of Whitesburg

The population of Whitesburg was determined to be 3,100 residents according to a data taken after the census of 2000. It was established that there were 1,883 households in Whitesburg, including households that were part of Whitesburg's Housing Project and the Letcher Manor Nursing Home.<sup>iv</sup> According to data collected in 2014, the population density of the city was 590 residents per square mile.<sup>v</sup>

The median age of a Whitesburg citizen is 39.7 years old.<sup>vi</sup> 18.6% of the population is under the age of 18, 7.8% are aged 18-24, 24.2% are aged 25-44, 25.4% are aged 45-64, and 24.1% are 65 years of age or older.<sup>vii</sup> Many living on the outskirts of Whitesburg have no affordable internet options available to them, which is particularly difficult for families with children whom are actively attempting to participate in their educations.



*Figure 2: Whitesburg*

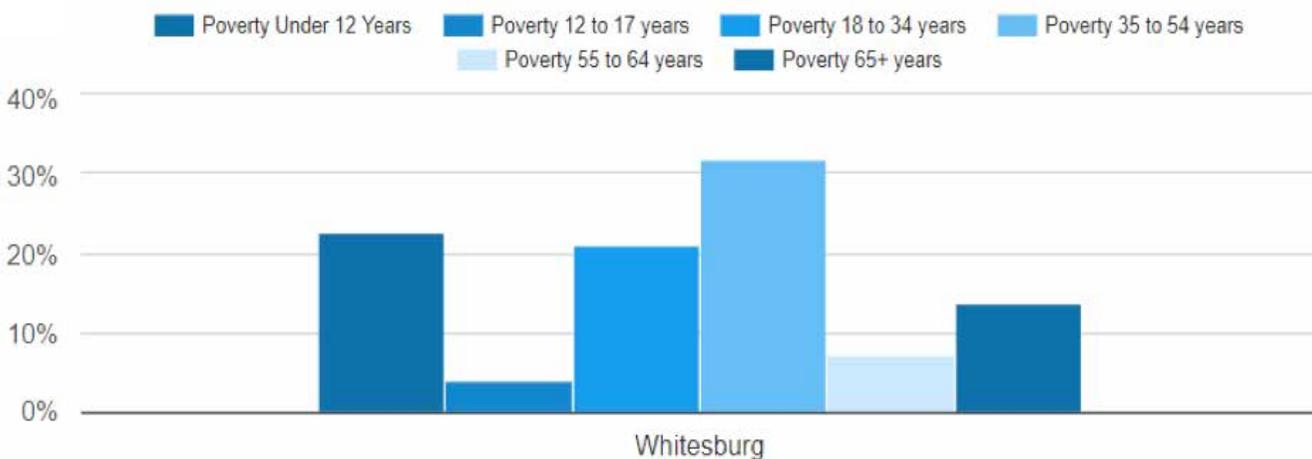
## Whitesburg Economic Information

The median income per household in Whitesburg is \$35,060, with over 20% of total households earning less than \$10,000 a year as seen in *Table 1*.<sup>viii</sup>

**Table 1: Whitesburg, KY Earnings Distribution**



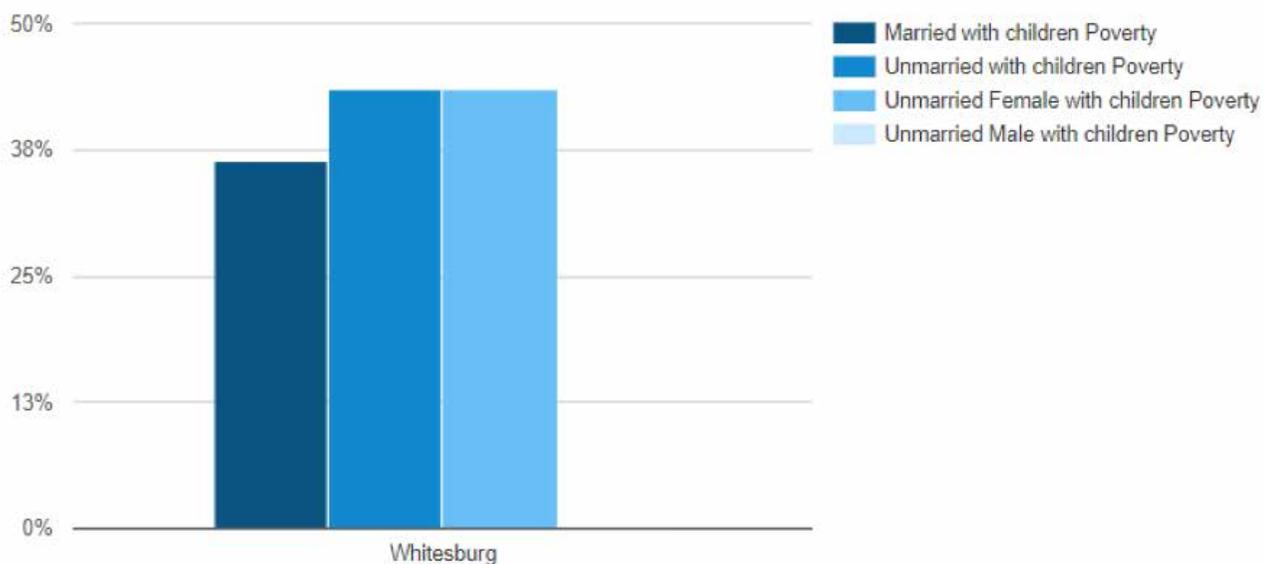
While the median income for families is \$58,362, roughly 34% of families in Whitesburg have a single earner, and 13.9% of families have no one working. Further, we see that 23% of residents below the age of 12, 21% of residents aged 18-34 and 32% of residents aged 35-54 are below the poverty line as seen in *Table 2*.<sup>ix</sup>



**Table 2: Whitesburg, KY Poverty Break out by Age Group**



Broken down even further, we see that 36% of families that are married with children and 44% of unmarried individuals with children are under the poverty line as seen in *Table 3*.<sup>x</sup>



**Table 3:** Whitesburg, KY Poverty and Marriage Status

This is relevant as many of these are families with children which require a reliable internet connection to fully participate in their educations, yet are unable to afford the internet options currently available.



*Figure 3: Outskirts of Whitesburg*

Quite frankly, much of Eastern Kentucky is in a state of economic decline with a sagging coal industry and a lack of viable agricultural space. Paying for overpriced and underserved internet is simply not an option for many residents and as such we had to offer a service that was affordable without sacrificing quality.

## Internet Available in Whitesburg

When we arrived in Whitesburg, there were several companies that claimed to offer different types of internet connections to consumers:

1. **AT&T U-verse**
  - o Offers up to 18 Mbps via DSL
2. **Exede Internet**
  - o Offers up to 30 Mbps via Satellite
3. **HughesNet**
  - o Offers up to 25 Mbps via Satellite
4. **Appalachian Wireless**
  - o Offers internet service via mobile device
5. **Thacker-Grigsby/TVS**
  - o Offers up to 1 gbps in some areas, via cable/fiber.

Generally the speeds were found to be much slower than advertised, with 1,000 consumers having one or fewer wired internet options available to them.<sup>xi</sup> In addition, we found that none of these ISPs offer an affordable, entry level package providing a basic internet connection.

## Partnership with Gigabeam Networks

Citing frustrations from Whitesburg residents with current internet providers speed and price, FiSci Technologies approached Gigabeam Networks with a partnership offer. FiSci offered to help Gigabeam with building out a fixed-wireless LTE system with the intention of providing the back-end infrastructure and financing as part of a revenue sharing agreement.

Gigabeam Networks has been providing internet to Virginia since 2001, and offering fixed-wireless internet across five counties since 2009. Following this, Gigabeam Networks has spread their coverage to cover 7 counties with several more deployments planned. The Whitesburg network is Gigabeam's first foray into Kentucky.

It was never FiSci's goal to operate networks ourselves. Instead, we desire to empower WISPs and other organizations to be able to provide internet using our custom solution.



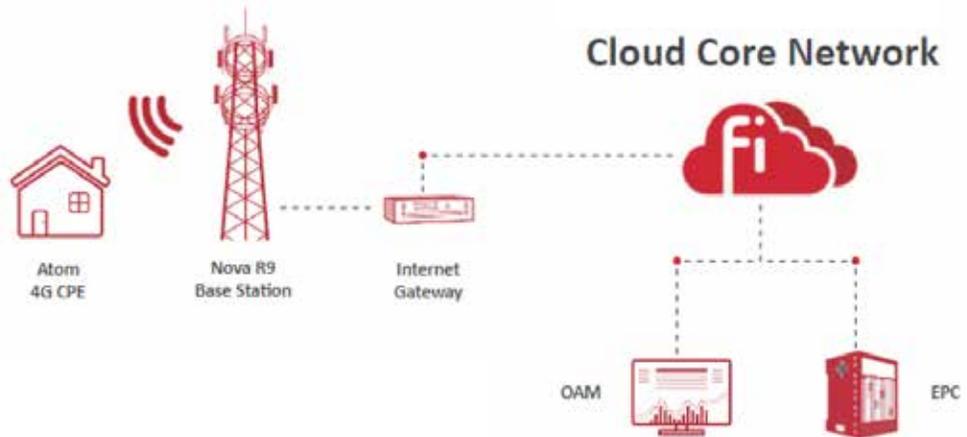
**Figure 4:** Gigabeam Techs Demonstrating the LTE Network

# TECHNOLOGY SOLUTION

## a. Technology Overview

The FiSci solution for Whitesburg, KY, is an LTE-based platform, provided by Baicells Technologies, a China-based company. This solution is unique in its use of a cloud-based core architecture, including EPC (evolved packet core), OMC (operations and maintenance console), and BOSS (Billing and Order Support System) implementation.

**Figure 5:**  
*FiSci's Fixed-Wireless  
LTE Solution*



The RAN (Radio Access Network) uses the Baicells Nova R9 Base station (eNodeB), a full-feature carrier-grade LTE base station.

For this particular implementation of the Baicells solution, the decision was made to use the 3.65-3.70 GHz spectrum band, which is available for fixed broadband use within the US. Long term, this will allow for network expansion as part of the expected 2018/2019 FCC rollout of the Citizens Broadband Radio System (CBRS). CBRS will allow for an additional 100 Mhz of spectrum (3.55 GHz to 3.65 GHz) to be used as the Whitesburg network grows from both a capacity and a coverage perspective.

Additional details regarding each piece of the technology solution and its implementation within the Whitesburg network are discussed below.

## b. Network Architecture

### 1. RF

The Baicells Nova R9 is a full featured LTE base station, supporting TDD LTE operation. The base station has a power output of 1 Watt, with 2x2 MIMO capabilities, and operates on 48 VDC. The Nova R9 weighs less than 10 pounds, and requires only a DC power cable and an ethernet cable to be fully functional, allowing for very simple compact installations.

### 2. CloudCore

The Baicells Cloudcore is a SaaS solution providing full LTE core functionality without the typical upfront costs and deployment time of more traditional EPC implementations. The Cloudcore is a Microsoft Azure-based solution, hosted in North America.



*Figure 6: Baicells Nova R9 1 Watt Base Station with Antenna*

### *The Cloudcore can be viewed as three distinct elements:*

**EPC:** The evolved packet core is a 100% IP-based design, providing connection management for network eNodeBs, interface to external packet networks (i.e. the internet), along with providing authentication services, Quality of Service management, and overall management of network resources.

**OMC:** The Operations Management Console provides an interface allowing management and monitoring of elements within the overall network.

**BOSS:** The Business Operations Support System provides an interface for the management of SIM card and subscriber activities.

### 3. Backhaul

Interconnection between eNodeBs and the Cloudcore may take several forms: fiber, ethernet, and microwave, either licensed or unlicensed.

In the case of the Whitesburg project, unlicensed microwave was selected for multiple reasons, including:

1. available for immediate deployment, eliminates waiting for point to point circuit delivery
2. Full control over installation, operation, modification, and maintenance
3. No monthly opex incurred
4. No waiting for FCC authorization/licensing to operate.



#### 4. Ancillary Equipment

Along with one or more eNBs and backhaul links at each site, the remainder of the required equipment, including power system, requires minimal space in a standard equipment cabinet. Housed In the cabinet is a cluster of batteries providing several hours of backup power in the event of an outage, a Cloudcore router, Netonix switch, and a Digital Logger power control system. Cabinet equipment is able to be monitored remotely for proper operation, and configured or reset as needed.

This economical design is able to be standardized across each site, which is both beneficial from an economics standpoint, and from an ease of maintenance standpoint.



**Figure 7:** Equipment cabinet



**Figure 8:** Baicells Atom R9 Outdoor 19.5dBi CPE

#### 5.CPEs

Baicells offers three options for CPEs (*Customer Premise Equipment*).

Two devices are outdoor-mounted units, differing only by the gain of the built-in antenna.

Also available is an indoor CPE, eliminating the need for professional installation as is the case with the outdoor units, and providing what is literally a plug-and-play CPE solution.



**Figure 9:** Baicells Atom R9 Indoor CPE

### **c. Spectrum**

The Whitesburg network has initially launched using an NN license on behalf of Gigabeam Networks. The NN license allows us to operate between 3.65 GHz to 3.70 GHz, using two 20 mhz channels. The network has launched using these two 20 mhz channels at the two on-air sites.

In early September, the FCC granted FiSci a one year experimental license, allowing us to do a variety of tests using the entire CBRS spectrum (3.55 Ghz to 3.70 Ghz). This additional spectrum will also allow us to expand the Whitesburg network with less reuse, resulting in better SINR across the network, and hence, better network performance. It will also allow us to position the Whitesburg network as a test bed for FiSci to test and evaluate various Baicells products and implementations, along with third party testing of such things as SAS (Spectrum Access System), which is key to the eventual rollout of a fully compliant CBRS network.

### **d. Upstream Connectivity**

Securing upstream internet connectivity proved to be a challenge both from a cost standpoint, and a timeline/implementation standpoint. We looked at 3 options:

1. Upstream connectivity provided from a connection to the Gigabeam network in VA to Whitesburg via licensed microwave, using a relay tower on Pine Mountain, which borders Whitesburg. This was a workable solution but we could not secure the required dish mounting height on the Gigabeam side of the link, hence this option was abandoned.
2. AT&T fiber, brought to the ATC tower, where facilities are existing, so no new construction by AT&T required in order to fulfill an order. While this was the most economical option, it was not the best short-term option to meet an aggressive on-air schedule. The decision was made to place the order as our long-term solution, and locate a short term upstream solution.
3. A 150 mbps connection at Letcher County Courthouse, provided by Eastern Telephone and Technologies. This option met our on-air timeline, though the cost of the circuit, and the required one year commitment, were not optimum. We were able to share the cost of the circuit with Letcher County, with FiSci using 100 mbps of the 150 mbps circuit. As we get closer to cutting over to the AT&T circuit, we'll plan to use this circuit as a backup, and, potentially find creative ways to recoup our monthly cost for the circuit by offering this extra bandwidth to other potential non-traditional customers.

### **e. Network Design and Deployment**

The initial design for the Whitesburg network consisted of 3 LTE sites, and ultimately evolved into a launch design of two LTE sites, and a third location providing purely upstream connectivity.

**West Whitesburg**--FiSci initially approached the local Housing Authority to discuss locating a tower on their property. Being a HUD agency, HUD would have to provide their approval for a site on Housing Authority property. HUD's monthly lease proposal did not fit into the budget model for the project, and this location was abandoned.



After further investigation, a second location was identified. This location was a city-owned parcel, undeveloped, and too small for any kind of residential or commercial use. Its location was optimum for the network, and with it being city-owned, securing permission to develop the site for our use was an easy process.

It should be noted that a key factor in the relatively fast deployment of the Whitesburg network was the minimal leasing, zoning, and permitting challenges that were faced overall. The West Whitesburg site was essentially leased on a handshake, instantly permitted, and land clearing support provided by the city of Whitesburg.



*Figure 10: ATC tower, on the right*

**American Tower**--This location is an existing tower owned by American Tower Corporation, with a standard application and leasing process. This site and the processes we had to follow for this site is more the norm in a typical wireless network deployment.

**City Water Tank**--Originally thought to be an option for fill-in coverage into parts of downtown, closing the gap between West Whitesburg and ATC, multiple site visits and discussion brought us to the conclusion that the site is not feasible due to accessibility, cost to build, structural integrity uncertainty, and timeline.

At this point, In order to meet an aggressive on-air target date of end of August, we decided to focus on the two secured sites for launch, and revisit a third site location after launch.

**Courthouse**—This location serves as an aggregation point to provide upstream (internet) connectivity to the rest of the network. From the Courthouse we were able to deploy a microwave link to each of the LTE sites, providing the necessary network connectivity.

As another example of how quick access to site locations benefitted us, we were again able to proceed with the installation of two microwave links at the courthouse without having to wait for a formal agreement to be executed.

# SITE LOCATIONS & CONSTRUCTION



Figure 11: Whitesburg Site Locations

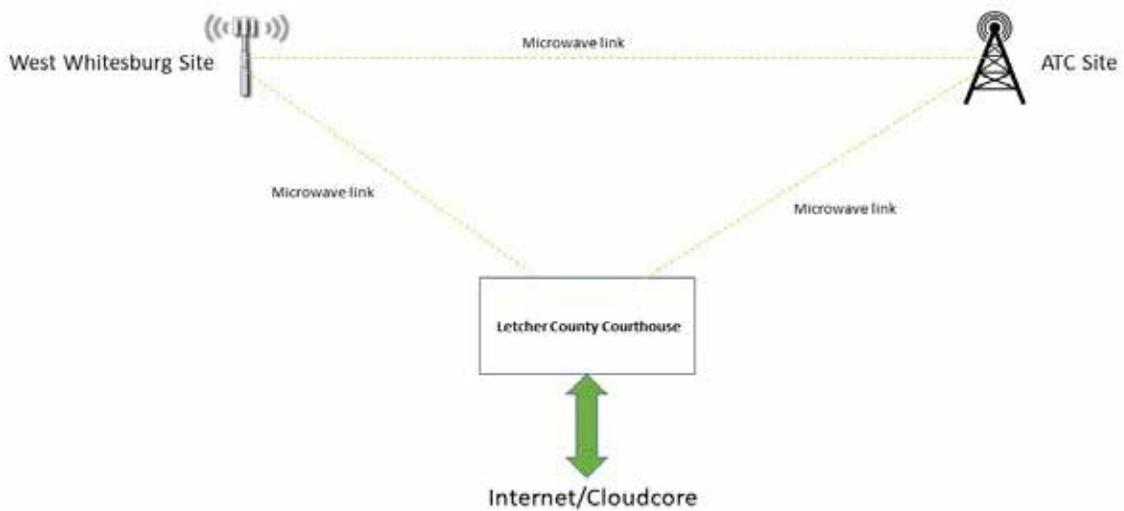


Figure 12: Whitesburg Network Diagram

## Construction of the three initial locations presented three relatively different scenarios.

**West Whitesburg:** This site required us to provide our own tower structure, with the challenge of it being a relatively small parcel of land. After significant research, FiSci selected ARE Telecom to provide one of their towers for this location.

The ARE solution is unique in that it provides a monopole-type structure, but with an above-ground foundation system, eliminating costly and time consuming foundation design and construction.

ARE's design provided us a 100 foot monopole, with a foundation structure measuring approximately 22 feet in diameter, and approximately 7 feet high. The ballast material for the foundation was 105 tons of common aggregate material.

Construction of the monopole structure, along with installation of equipment, took less than two weeks. Concurrent with the monopole construction, commercial power was delivered to the site location.

**American Tower:** This location is an existing tower structure, owned by American Tower Corporation. Three months were spent on the application and leasing process for this site.



*Figure 13: West Whitesburg ARE Tower*

From a construction standpoint, there were two major tasks. First, commercial power needed to be brought to our cabinet location within the ATC compound; second, actual installation of tower-mounted equipment and our standard equipment cabinet.

Inclement weather provided some challenges during the construction process for this site, with the two major tasks being completed in less than three weeks.

**Courthouse:** This third location, supporting our upstream connectivity requirement, was the easiest of the three sites to build. Construction consisted of installation of two microwave dishes on the exterior of the building and installation of a rack housing our fiber circuit interface equipment inside the building. Interconnection between the rack and the microwave equipment via cat-5. Total installation time for this location was less than 2 days.



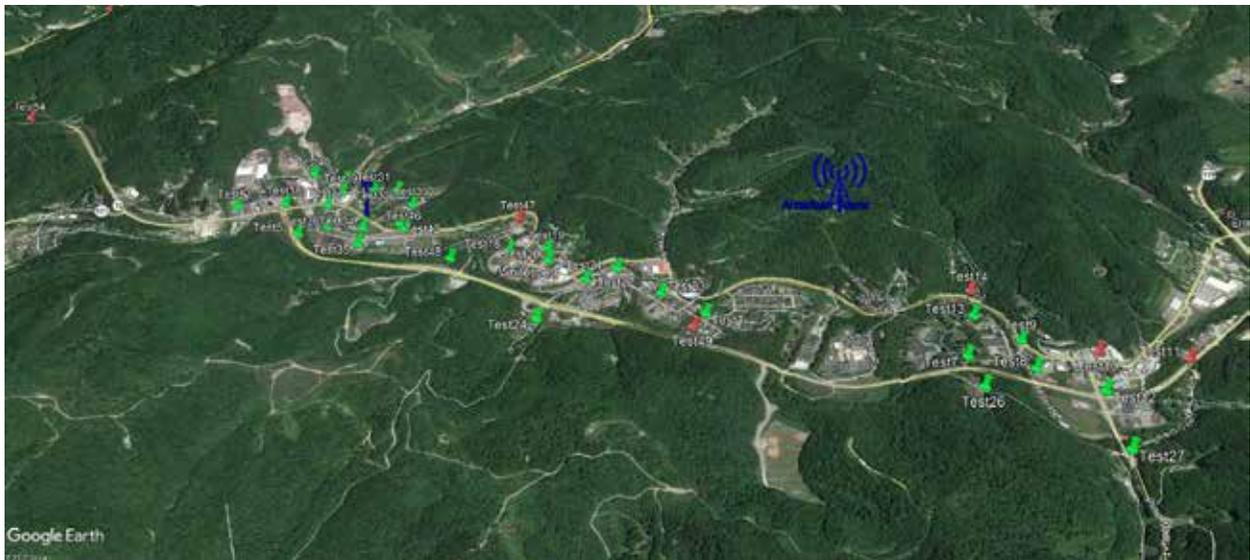
*Figure 14: Courthouse microwave installation*

# Integration and Pre-Launch

The **West Whitesburg** site was brought on-line August 14th, followed by the ATC site the following week. Prior to the formal launch event on September 9th, several key tasks were performed to confirm operational readiness.

## 1. Network Testing

Network verification and testing was done in a very simplistic manner, consisting of two CPEs (the indoor CPE, and the 11 dBi gain outdoor CPE), and a laptop. Test points were identified across the network, and throughput measurements were recorded, along with ping time, RSRP, and SINR. While this serves to give a quick and easy picture of how the network is performing, it does not provide a full coverage mapping of the network. In some cases, where no service was recorded using this process, an outdoor modem, elevated as it would be in a typical installation, would be functional.



**Figure 15:** Whitesburg Network Test Points



**Figure 16:** Network Speed Test

## 2. Complete Microwave Ring

In order to provide an alternate backhaul path in the event of a failure of either courthouse microwave link, a third microwave link was added between the West Whitesburg site and the ATC site, thereby completing a ring between the 3 site locations.

## 3. Trial Customers

Along with our own internal testing throughout the coverage area of the network, we selected seven individuals to use the service and provide feedback. These individuals were offered free service for 60 days, and then a 10 dollar/month discount for their first year of service, assuming they decide to continue as a customer after the 60 day test period expires.

## 4. Operational Readiness

OMC and BOSS access were verified as functional, with the test customers being treated and added as regular customers.

### a. Service Plans

Gigabeam Networks offers a choice of four service plans for Whitesburg customers:

Download Speed (mbps)	Upload Speed (mbps)	Monthly Cost (\$)
4	1	19.00
10	1	39.00
25	2	59.00
50	3	79.00

### b. Installation

For customers needing an outdoor CPE, a one-time installation fee is incurred. Cost of installation is either \$49.00 or \$79.00, dependent on whether the customer signs a one year contract for the service, or chooses to subscribe month to month.

The availability of the indoor CPE eliminates the install process in some areas of the network. FiSci and Gigabeam continue to work together to refine a method to accurately determine if a customer will receive optimum service with the indoor CPE.

### c. Customer Support

Customer support, including billing, is provided by Gigabeam personnel, with the Gigabeam web portal providing information on any customer affecting outages.



## POST DEPLOYMENT

### Launch Event

The network was officially launched on September 9th, 2017, commencing with a launch party held at Whitesburg's Riverside Park. Service, at launch, covered over two-thirds of the city of Whitesburg with build outs already planned to cover the remaining areas. Prices began at \$19.00 a month with speeds at 4 megabytes per second for downloads and 1 megabyte per second for upload with a guarantee that the price would never increase and there were no data-caps. Other packages were available for purchase, as seen above.

### Marketing

While the launch party served as the primary marketing driver for new end-user subscriptions, promoting the event prior to launch was critical to its success. To this end FiSci Technologies utilized targeted Facebook ads, local radio and print outlets, and key local figures and influencers (including Rural Strategies) to spread the word of the event. To further encourage attendance, FiSci provided free food and entertainment via local catering and musical talents. Due to these efforts, local event organizers projected attendance for the event at five-hundred individuals from the city and surrounding areas.

The launch party lasted five hours, and was attended by key figures in the area, many of whom expressed enthusiasm for the new service. Gigabeam was in attendance to further promote the new service and answer any questions citizens might have concerning connectivity, cost, and what set the new service apart from others that had attempted to bridge the digital divide here in the past. At the end of the day, Gigabeam estimated they had signed up forty households for the new service with many more showing intense interest. Overall there was an estimated ten-percent conversion rate of attendees to new subscribers for the new service, due to the success of the launch-event.

The marketing strategy following the launch event was simple. Let the product stand on its own. In small cities such as this, word spreads quickly and due to our confidence in the service's price and reliability there was very little need to actively promote the product as the consumers would do that job themselves. Our primary concern was establishing an initial user-base that would be able to accomplish this, which was alleviated by the success of the launch party.



*Figure 17: FiSci's General Manager, Jesse Raasch, with Whitesburg Mayor, James W. Craft*

## Expansion

Fisci and Gigabeam have started working on expansion of the network, looking to expand coverage eastward, including communities outside of Whitesburg proper. As of October 2017, FiSci has entered into a lease agreement to install a site on Pine Mountain, which will not only expand coverage eastward along Kentucky Highway 15/119, but also will provide coverage in the Pine Mountain area itself.

The site is expected to be completed and in service sometime in November 2017.



## CONCLUSION

Whitesburg, Kentucky lies in an area where only 42% of the population has access to a broadband connection. It's a utility that many of us take for granted on a day-to-day basis, yet for many Whitesburg residents the internet is being over-charged and underserved. However, this is changing. As the economic importance of rural broadband becomes more prominent, we're seeing an increase in technologies and business practices that are making it possible and profitable to get internet to these underserved areas.

FiSci Technologies is one of these companies that is striving to bring internet to these areas suffering under the digital divide. By partnering with Gigabeam Networks, FiSci was able to build a fixed-wireless LTE network using Baicells equipment. This network is a low cost, quickly deployed and reliable internet option for end users in the city of Whitesburg. The internet packages offered are affordable for the citizens and the network is scalable, robust and future-proofed.

While the partnerships we developed within Whitesburg were critical for the speed at which the network was deployed, this network serves as a proving ground for future rural deployments demonstrating the success and profitability of the FiSci subscription model. In addition, creates a perfect environment for a testbed of upcoming Baicell's equipment; providing an opportunity where all parties will benefit from the network.

Overall, FiSci Technologies successfully and quickly built a private fixed-wireless LTE network to serve the residents of Whitesburg, Kentucky. By using Baicells equipment, FiSci kept capital costs low, and passed these savings onto the consumers.

Following the launch of the network on September 9th, 2017, FiSci handed day to day control of the network to Gigabeam Networks, as originally planned. FiSci continues to work closely with Gigabeam on network expansion and upgrade efforts, and long-term strategic planning.

**For any questions concerning this document, or to learn more about  
FiSci Technologies LTEaaS subscription program, please feel free to contact us at:**

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## ENDNOTES

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