

## ***Rural Broadband: The case of one rural county in 2017***

The [Digital Divide](#) (Stanford University) is still here. Although research suggests otherwise, on the ground, disparities exist that distant researchers cannot capture with statistics and surveys alone. The digital divide is more than access to social media and entertainment. When Broadband research includes smart phones, this really means nominal broadband. The definition of rural may be rather broad also. These are my observations and ideas about one case in particular. This is the state of broadband in Ozark County, Missouri.

### ***Ozark County, Missouri***

[Ozark County](#) (United States Census Bureau) is 755 square miles, 10 of which are water, situated in South-central Missouri, along the Northern border of Arkansas. At the time of this article, the population consists of 9237 souls. There are no traffic lights, no Walmart or McDonald's. The county seat, Gainesville has somewhere between 600-750 souls there. The other villages, yes, that is what they are called, have fewer than half of Gainesville's population. They are few in number, and widely dispersed. Most of the county lives in unincorporated areas. According to the Census Bureau, about 28% of Ozark county's population is over 65 years of age, 19% are disabled and under 65 years old. The poverty level is 28%. Around 950 people are reported as employed. There is an unofficial economy that is difficult to count or manage. It consists of barter and unreported/underreported profit and casual (under the table) labor.

The Ozarks is a karst geography and an eroding plateau/steppe, the elevation falling as the plains yield to the mighty Mississippi and the Deep South. The hills are alive with a wall of lush green forest. Interspersed with these woods, are clear cut pastures and creeks that rage in the rain; and rain it does. The karst is uplifted limestone with a network of underground passages that transport water naturally, sandstone outcroppings, chert, and various other minerals. The geology and vegetation, along with population density become relevant when considering broadband deployment.



## Current Conditions

The current state of the broadband network in Ozark County is a mixture of DSL, provided by CenturyLink, satellite provided by a few providers, and LTE when line of sight allows. Verizon's prices are improving. Now, "unlimited" is \$80/month for 1 device/hotspot. Which is reduce to 600 Kbps after the first 10 GB of data. It is \$120/ month for 24 GBs of "MiFi". MiFi is a bridging router that is very fast and reliable. It takes 4G LTE from towers and acts as the default gateway to an internal network of 192.xxx.xxx.xxx addresses. Straighttalk is \$45 a month for "unlimited" but will not tether. The definition of unlimited is now fast for a certain amount of data and then, slow as molasses in January. Tracfone is available for smartphones at good rates depending on usage – no tethering. Straighttalk and Tracfone are piggybacking on Verizon towers. All three are severely limited by the Ozarks three dimensional topology and vegetation. Ozark County Commissioner John Turner and Lutie School Board President, believe fiber runs through our county, but are not sure. MoreNet provides Lutie with broadband but their backbone map does not include the area. President Turner believes Lutie is on fiber. AT&T's fiber locations map does not show fiber here, either. Spectrum Business has a map showing fiber close but is not locally specific. Sho-me Technologies' map is vague but promising. The resolution is such that it is not readable. It appears to reference future outside plant installations locally. The electric coop is uniquely positioned to leverage right-of-way and optical ground wiring to expand access via Show-me Technologies, LLC. Visual inspection indicates an aerial installation of fiber along US Highway 160 through part of the county. The bank, Lutie School, and possibly another school are lit. Logically, as the warning label shows, the fiber belongs to the Sho-Me Technologies initiative as part of the "Mobroadbandnow program. The program musters the USDA's financial muscle. It is a twinkling in the dark and is similar to the early REA initiatives. The other businesses along 160 are connected to dialup or DSL, when within the distance limitations. Commissioner Turner's statistics show only 2% of residents have a wired broadband connection. He also operates a motel/bar/liquor store/pizzeria and laments that internet service to the rooms is not viable in Ozark County's current situation.

Fiber optics are in Ozark County. Few know of it and fewer have been approached with product marketing. Only visual inspection of the outside plant reveals this.



[Pew Research](#) says 67% of rural people have a smart phone (Pew Research). While this an improvement, it does not represent the number of people in rough terrain that actually gets a signal at home. Often to use their smartphone, some folks must walk up the hill to find a signal. Smart phone [plans](#) favored by low income, rural folks, have strict broadband limitations of 8GB at 4G, then 2G after that limit is breached. It is called “unlimited”. A college student would be at a disadvantage if doing a term paper entails going uphill to do research or transmit a document, all on a phone size screen. A Veteran attempting to interact with [myhealth.va.gov](http://myhealth.va.gov) might actually suffer physical harm in this scenario.

An interview with Ozark County Commissioner John Turner:

1. What does the digital divide mean to the commission?

A: “Broadband is necessary and needs improving.

2. How do you feel it impacts your constituents?

A: “Students have access at school, but some are at a disadvantage at homes without broadband access.” He indicates that businesses, telecommuting/work-from-home citizens, and students in distance learning situations would benefit.

3. What is the current state of broadband in Ozark County?

A: Commissioner Turner says, “Some wireless and 2% wired.”

4. What are the commission’s plans going forward?

A: The Commission is encouraging representative s with the National Association of Counties to assist in finding a solution.

5. What solutions are the commission aware of?

A: The commission is waiting for technological advances.

6. Who knows the location of the closest fiber backbone?

A: The Commissioner indicates the local electric cooperative.

7. Which companies have shown interest?

A: Commissioner Turner indicates that the local electric Cooperative and the local POTS telecom.

8. Which schools are already lit?

A: He believes that Thornfield, a small local community school, is, possibly.

9. Is there funding, in the form of grants or loans that might help?

A: The commissioner indicated the National Association of Counties and the local electric cooperative may have funding assistance available.

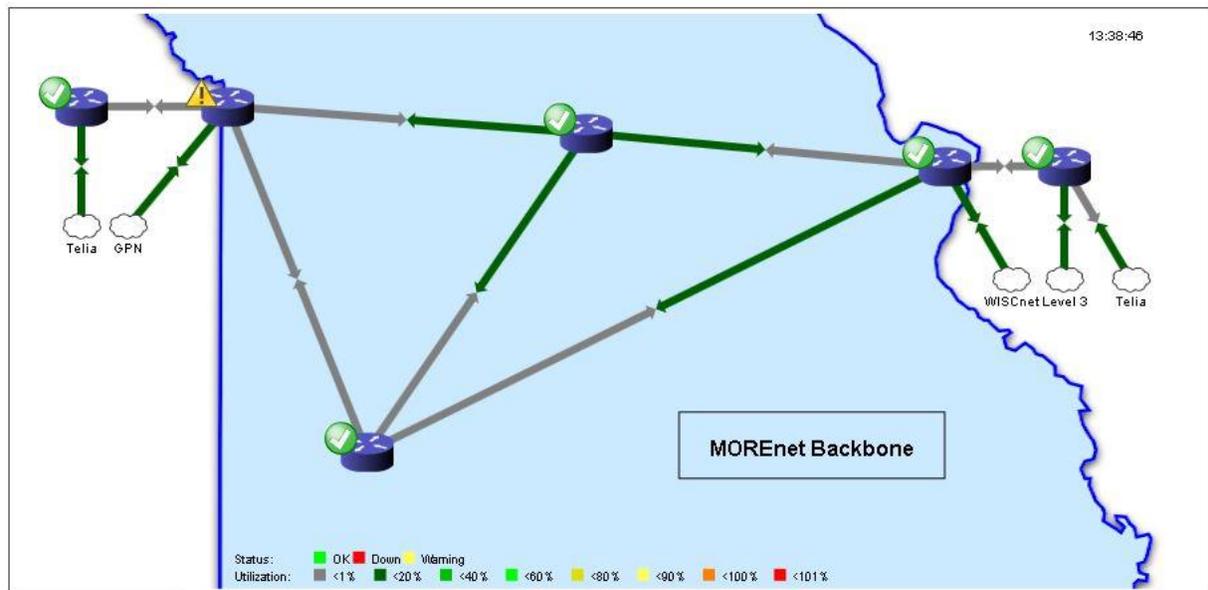
Lutie is a K-12 school situated in Theodosia, along US Highway 160. The graduating classes, generally, consist of about 20 graduates. An Interview with the Lutie School Board:

1. What does “Digital Divide” mean to Board members?  
A: They have heard of it. They believe internet access is poor and expensive.
  
2. What is Lutie’s current situation?  
A: President Turner indicates that Lutie is connected by MoreNet. They believe it is fiber, possibly T1. (Visual inspection indicates fiber.)
  
3. Are we happy?  
A: The Board is very happy with the school’s broadband situation.
  
4. Is there a disparity in the student population caused by the lack of broadband in some homes?  
A: The Board indicates that has not been much of a problem as most required internet usage is accomplished at school.

The Board Members that were present, reveal that all student have access to an internet device when required.

“**MOREnet**” is the **M**issouri **R**esearch and **E**ducation **N**etwork. They are a nonprofit group, affiliated with the University of Missouri, in Columbia and have been providing internet access to public sector groups, like K-12, since 1991. MOREnet’s map, available on their [website](#), does not indicate a fiber presence in Ozark County.

#### Status Maps



Not all of Ozark County citizens are familiar with current terminology and equipment. Technical terms are often confusing and/or misused. This is not a denigration. It is, after all, a foreign language to most.

## Networks

Dial up is dead. It has been for years. Technology moves at lightning speed. The design of websites is no longer simple html and cascading style sheets. Each time we land on a website there is a lot of computing going on. A java script queries the user's devices and gets its display size. This sets a variable to use in an "if-then-else" loop statement to determine which style assets to use. Websites are now dominated by php, which actually generates the html that the device translates into an interactive display. SQL and php is interacting with the webserver, the user, and who/whatever else it needs to accomplish its task. Over 60% of web traffic are "bots", automated programs that do good and, also, more nefarious deeds. Dial-up cannot handle file transfers, graphics, or complex programming. Yet, some on this side of the digital divide are still plugged into a 56kb/s modem. It does not take much math to calculate how long it would take to stream a movie or download a modern program. A student would have to babysit a file upload all night to get a term paper in on time. A student would not be able to download videos fast enough to keep pace. Only people without a cellular signal frustrate themselves in this manner. The FAX still comes in handy from time to time. If located more than 5 miles from a switch, their only other choice is satellite

DSL is actually ADSL. **A**symmetric **D**igital **S**ubscriber **L**ine. CenturyLink is the POTS, local land line, copper wire, telecom provider. POTS is **P**lain **O**ld **T**elephone **S**ervice. Voice and data share the copper at different frequencies Voice uses lower analog and the line uses high pass and low pass filters to separate the streams. It is the attenuation that degrades the system over a distance. At 4 miles from the source, the signal becomes unstable. Without updating the outside plant, DSL is really just for folks living close to town. Jean Andrews says that ASDL is capable of 24Mb/s download and 640Kb/s uploads (Andrews 771). A speed test done while this paragraph was written shows that a helpful, cooperative, client has 0.494 Mb/s, or 494 Kb/s, about 10 times dialup. Uploading is slower in ASDL. It is asymmetrical. This particular client has had several phone company technicians come to his residence, several times. The client lives 4 miles from the switch. In town, a client's system seems to whirl along nicely. On the other side of town, a customer has gone through several DSL routers (one of which was hacked). They are trying to watch Netflix in one room, roku in another, and attempting to play an online game without a glitch in, yet, another room. It is really not possible flawlessly. They are not real happy and believe the "Indian hackers" have taken over, again. The first client understands that streaming video takes time and it is better to let things load. The middle client does not stream from a video service and doesn't play online. That service is more than adequate. All pay equally for the same, unevenly dispersed, service. The ones closer to the switch are much happier with their choice. Some may have misunderstood the product.

It now takes about one Mb per minute to play decent video, more for Blu-ray and high definition. Streaming is done using User Datagram Protocol (UDP), a protocol for broadcasting one direction. It is called "connectionless" because there is no data verification at the end user's device. UDP files seem to go quicker than Transmission Control Protocol. TCP data packets are verified on both ends for completeness and correctness. These data packets are retransmitted if incorrect. Games and programs/apps use TCP if interactions require authorization, acknowledgement, and response (Andrews 719). Any game glitch, micro lapse of service, or latency will make you miss your turn or opportunity to excel in any online gameplay. Latency is the time it takes for signals to span the medium. It is noticeable, even in cell phone voice calls. Satellite is worse.

Copper has reached its usable limits in data transmission. Although, if a good signal, from fiber or fixed radio, went into switches close to the final/first mile network segments, it could suffice as a solution. Several more switches would be required. The low latency analog phone conversations will be missed.

At first, the term *final mile* was used to categorize that portion of an outside plant project that is closest to the end user. This is a perspective from the provider end. *First mile* is a perspective from the customer's viewpoint. It is this "mile" that is the digital divide, the chasm to cross.

The population density of rural America does not a market make. Country folk are not where they are because of the delivery pizza or social networking. In today's world, broadband access is no longer a luxury. It is a public utility. Without which, citizens lack needed access to, what has become, basic services. This is the very same thing that happened during rural electrification. Without the help of the Rural Electric Association, folks would still be lighting oil lamps and cutting ice for iceboxes.

Cable companies do a good job in population dense areas. Ozark County has no cable provider. Coaxial cable is being replaced by fiber and is no longer a viable alternative to twisted pair.

Satellites are, often times, very far away. 20,000 miles in some installations. Those in that range have a latency of nearly half a second. That latency precludes comfortable Voice-Over-IP communications or gameplay. Websites' php and SQL interactions suffer as well. Downloads of up to 112 Mb/s and 3 Mb/s uploads for 10GB @ \$60/month with a free access period during off peak hours is the current [offering](#). A bare bones package was free to those without a descent income and a viable broadband service. The map used to determine that service was 2 dimensional and too generalized. It failed to consider those patrons who were too low in elevation to receive cell signals. Satellites have some difficulty in weather, terrain, and vegetation. It is a partial solution.

[OneWeb](#) is a new project which promises to bridge the digital divide with a constellation of lower orbit satellites. 648 of the little gems will be deployed and by 2028, the divide will be no more. Lower orbits would eliminate most of the latency.

Is this news dependable? Can Ozark County wait another 10 years for digital equality?

4G LTE is good, but not available to those whose line of sight is obscured. With 2 bars of 4G on a Verizon MiFi Hotspot, speed tests show 600 Kbs up and down after reaching the 10 GB threshold. With Verizon's new plan and a Veterans' discount, it comes to \$65/month for unlimited data. But the fine print says after 22 GB, preference is given to those who have not surpassed 22GB or have paid for more. If a hotspot is involved, the limit is 10GB, then it is 600Kbps, max. The router must be placed carefully and if the windows steam up, it is useless. The WiFi in the house, itself, must be fairly unobscured, too. Some days the speeds are way up and with the MiFi Hotspot, the internet is mobile. This is very useful for a tech on a house call who is diagnosing connection issues or expediting a procedure. If only everybody could get the signal.

## ***Possibilities***

The best solution is for fiber to be installed to the end user. Fiber, depending on the installation, is capable of transmitting 160 GB/s (Andrews 771) for backbones and can go for 60 miles without needing signal boost. Underground installations cannot be accomplished using directional boring. A rock

wheel or explosives would be necessary. Aerial installations, while outright ugly, could occur on existing poles and right of ways and replace aging copper wire. The profit impetus must be overcome. That is why the upgrade has not yet occurred.

4G LTE would be great at 100Mb/s to 1 GB/s (Andrews 771), now that prices are coming down and if everyone could get signal. Maybe more towers would suffice. What if the backhaul was handled by the main LTE signal and smaller towers repeat the signal to home or area routers and mobile transceivers. Frequencies of the smaller towers to be designed to minimize interference and to optimize vegetation penetration and obstacle clearance over a shorter range. Getting more towers, coopting the existing towers or signal into a web of localized networks, is an obstacle that is also profit driven and, therefore, not possible at Ozark County's population density.

The FCC refers to something else on the horizon called [BPL](#). **Broadband over PowerLine** (Federal Communications Commission). The claim is that data can be transmitted, as well as DSL, over existing power lines. Right now, it has very few networks working. This is something that should come up at the annual electric cooperative member's meeting in August. That would simplify matters if the plan congealed.

What has not been discussed outright is [WiMAX](#)., **World Interoperability for Microwave Access**. IEEE refers to it as 802.16e. A model system has a **Wireless Internet Service Provider (WISP)** hooked to the Fiber backbone. Transmitting and receiving data on back haul system towers to and from short distance local antennae (Siemens). In a more 2D, flat earth, world, one antenna would serve a great many customers. Even if it was diminutive. Ozark County is not 2D.

Imagine if a fiber spur took off to the nearby high ground. Not a long way off or not at all if the fiber access point was already of sufficient elevation. This goes up a tower to broadcast the backhaul leg to the smaller, close quarters, antennae, on water towers, school buildings, county seats, poles, or towers short enough as to not require lights or interfere with the national air space. Let's make them solar powered with new battery technology or hooked to a nearby power source. From there a router in an unobtrusive residence bridges the signal to a LAN. The small towers would paint the hollows with signal; illuminating the darker corners of the Ozarks. In general, 5GHz back haul for distances of 30miles, 2.x GHz for short distance penetration of obstacles and vegetation. The number of towers and the frequencies have to be determined during a more complete design. There is licensed and unlicensed RF spectrum to use and several different types of licenses to ponder for what would suite the specific plan. [Resolute Partners](#) (Resolute Partners) does this and seems to know how.

The "Digital Divide" still exists in rural America (Perrin). The same philosophy that brought electricity to the farm should be applied to extending, what has become, a public utility. Funding sources seem to be light on grants and heavy on low cost, guaranteed loans. USDA and REA can be useful in this endeavor, but it takes organization first. The community, as a whole, must have the will to implement a plan. The technology is the easy part. Organizing fiercely independent individuals to work interdependently, is the magic trick. There are solutions.

Thanks for playing,

Gary Pearman

## References

- Andrews, Jean. *A+ Guide to Maintaining Your PC*. Boston: Course Technology, 2014. Book.
- Federal Communications Commission. <https://www.fcc.gov/general/types-broadband-connections>. 23 June 2014. Web. 9 July 2017.
- Perrin, Andrew. <http://www.pewresearch.org/fact-tank/2017/05/19/digital-gap-between-rural-and-nonrural-america-persists/>. 19 May 2017. <http://www.pewresearch.org/fact-tank/2017/05/19/digital-gap-between-rural-and-nonrural-america-persists/>. 18 Jun 2017.
- Pew Research. "<http://www.pewinternet.org/fact-sheet/mobile/>." 12 January 2017. *pewinternet.org*. Web. 9 July 2017.
- Resolute Partners. "<http://info.resolutepartners.com/rural-broadband-how-to/>." 2014. *info.resolutepartners.com*. Web. 9 July 2017.
- Siemens. [http://files.wimaxforum.org/sites/Building\\_A\\_Wireless\\_Network\\_on\\_WiMAX](http://files.wimaxforum.org/sites/Building_A_Wireless_Network_on_WiMAX). 2017. Web. 9 July 2017.
- Stanford University. <http://cs.stanford.edu/people/eroberts/cs201/projects/digital-divide/start.html>. 8 Jun 2000. Web. 9 July 2017.
- United States Census Bureau. <https://www.census.gov/quickfacts/fact/table/ozarkcountymissouri/PST045216>. 2010. Web. 9 July 2017.