America’s Broadband Heroes:

Fixed Wireless Broadband Providers

Delivering Broadband to Unserved and Underserved Americans

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This paper was sponsored and developed for wireless internet service providers by the Wireless Internet Service Providers Association to underscore the necessity and advantages of wireless technology in rural America.

CONTENTS

Executive Summary 2

Fixed Terrestrial Wireless and How It Works 3

- Fixed Wireless vs. Mobile Wireless 3
- Victory of the Commons – Unlicensed Spectrum 6
- Evolution vs Stagnation 9

WISPs In America: Bridging The Digital Divide 13

- Sustainable Business Models-Success Without Subsidies 13
- WISPs Bridge the Digital Divide 15
- Telco Bypass Surgery: Overcoming the Obstacles in the Middle Mile 19

The Third Pipe – More Competition Means Lower Prices and Better Services 21

- The Broadband Duopoly 21
- Breaking the Duopoly with Fixed Wireless 22

Conclusion 24

EXECUTIVE SUMMARY

The future of broadband in America is at a crossroads. While wireline and mobile wireless carriers focus on regulatory gaming and manipulation of the Universal Service Fund to benefit their bottom lines, many Americans are left without access to broadband services because they reside in places that are deemed to be unprofitable by traditional carriers. Even more Americans have substandard or overpriced broadband access and no alternatives for obtaining better service because of the lack of competition in the broadband market. It is clear that the current system is broken, and the absence of competition[i], abuse of USF [ii]and the lack of access to critical network facilities for competitive entrants puts our nation into a position of disadvantage compared to other OECD countries[iii].

Fortunately, a solution for many of these broadband issues already exists and a rapidly growing segment of the country is able to take advantage of broadband services provided by fixed wireless broadband providers. Fixed wireless broadband providers, also known as WISPs (short for Wireless Internet Service Providers) utilize fixed terrestrial wireless (FTW) networks to deliver broadband to unserved and underserved areas of the country, rural and urban, providing badly needed access to broadband in many areas and the competitive pressure to keep prices low in places that are already served by existing providers. The majority of WISPs are privately owned, locally focused and entrepeneurial operations that expand into areas that either do not have broadband or do not have good choices for broadband service. The best way to improve broadband access to unserved and underserved populations in the US is to foster the development of smaller independent providers that can quickly address the needs of their communities using the most efficient technology available.

This paper will provide a brief overview of the technical and economic advantages of fixed terrestrial wireless systems, show how WISPs are successfully overcoming roadblocks within the current system to deliver broadband, and outline how fixed wireless can deliver better broadband and competitive choices for consumers faster and with fewer outside subsidies than wireline and mobile wireless networks.

Fixed Terrestrial Wireless and How It Works

Wireless Internet Service Providers (WISPs) have been using fixed terrestrial wireless technology to deliver Internet connectivity since the late 1990s. As of 2011, there are nearly 2000 documented WISPs[iv] across the United States, providing broadband access to over 2 million subscribers. The WISP market is growing at a substantial pace with over 100,000 new subscriber units shipping from equipment manufacturers every month for use in WISP deployments. While there are a few WISP operations that utilize licensed spectrum such as Clear and Digital Bridge, the majority of WISPs use unlicensed spectrum in the UNII and ISM bands or lightly licensed spectrum in the 3.65Ghz band. Fixed wireless broadband is often mixed in with mobile wireless broadband, but they are quite different and fixed networks maintain substantial advantages over mobile in capacity and overall network performance. Due to wide availability of equipment, open spectrum availability, high performance and low cost, fixed wireless networks can be deployed quickly and inexpensively to deliver broadband to nearly any location.

Fixed Wireless vs. Mobile Wireless

Fixed wireless networks have a long and colorful history within our nation's telecommunications infrastructure. In the 1950s, AT&T constructed the Long Lines network of microwave relay stations that carried long distance traffic from one side of the continent to the other. Until fiber optics became prevalent in the 1980s, the majority of long-distance capacity in the United States was provided by point-to-point microwave links. Railroads, utility companies and rural telephone companies have long used fixed microwave systems to connect remote locations, deliver traffic to areas without adequate landline infrastructure or serve as backup connectivity. As compression and modulation technology has advanced, the carrying capacity of fixed wireless networks has grown substantially, with current backhaul radios able to carry gigabit speeds across multi-mile distances and customer premise radios that can deliver up to 50 megabit speeds to end users.

The fixed wireless networks deployed by most WISPs were engineered from the start to deal with interference and noise. The basic design principles inherent in modern fixed wireless networks have their roots in military designs that were focused on interference resistance and rapid deployment. Improvements in antenna technology, gps synchronization and modulation techniques have enabled these systems to evolve very rapidly. In 1999, total capacity of the typical fixed wireless base station was about 1.5Mbps. By 2011, the capacity of a common fixed wireless base station has grown to over 150Mbps[v]. A cluster of base stations on a typical tower installation can deliver several hundred megabits to customers within a five to ten mile radius.

The ability to maintain a high signal to noise ratio is critical to the maintenance of a broadband network. Signal to Noise Ratio (SNR) is a consideration of all transmission systems. A basic rule of information theory, Shannon's Law, dictates that the absolute maximum bit-rate capacity of a transmission system is a function of both its bandwidth and SNR. This is why current DSL networks have distance limitations – as their loops get longer the SNR and bandwidth goes down and the system cannot carry as much data. Lower signal to noise ratio also leads to retransmissions when bits of information do not get through. This leads to higher latency and packet loss that can cause problems with many network applications. The ability to maintain a high SNR is the main reason that fixed wireless networks can maintain much higher capacities than mobile wireless networks.

In a fixed wireless deployment, each customer has a high gain directional antenna/radio combination, typically mounted outside, that focuses the signal toward the base station. By focusing the signal toward the base station, the fixed wireless customer radio is less prone to interference from other sources and is able to deliver a stronger signal to the base station. The higher SNR enables higher speeds, lower latency and more resistance to interference. The stronger signal from the fixed client radio also enables higher upload speeds which facilitates better performance for users that upload a lot of content.

Mobile wireless networks are unable to reliably maintain the same levels of network performance that a fixed wireless network can due to the tradeoffs needed to enable mobility. The typical mobile client antenna is small and inefficient, with very low gain, and has a difficult time maintaining the signal strengths required for broadband. Each client on a mobile wireless network is also subject to wide variations in signal strength because of constant changes in location and signal variations across all of the users on a cellular base station.

On some mobile systems, when users with low signals attempt to place calls or use broadband, the base station loses a substantial amount of capacity because it has to "downshift" modulations in order to deliver data to the low signal users and this reduces speeds even for users who have a strong signal. Even if a mobile wireless user installs a fixed antenna to improve their signal, they are still affected by other users with low signals that drop the total throughput to the base station. Mobile wireless systems are also heavily oversubscribed and share capacity with voice-only users. A heavily loaded fixed wireless base station will typically service 50-100 users, but cellular base station capacity is divided up between hundreds or thousands of devices, local or transient, all at constantly varying signal levels and with various amounts of data going through the network. As more users are added to these systems, network performance degrades and within a matter of months the initial benefits of system upgrades have been negated by the additional demands of new users and data hungry smartphones.

As many mobile phone users can attest, dropped calls and "no service" notifications are common in all areas of the country. Voice service is a very low bandwidth service, and only requires a fraction of the capacity needed to deliver broadband, so it should come as no surprise that mobile broadband networks consistently fail to deliver the speeds that cellular providers have promoted. Heavy oversubscription of mobile wireless systems means that a system that is not suitable for delivering broadband in the first place, is being taxed beyond its limits and users are being charged a premium for this access. Cellular carriers are now implementing bandwidth caps - limits on the amount of data that users can download – and tacking overage fees onto data plans that are already two or three times as much as regular fixed broadband connections.

Mobile wireless is useful for low bandwidth applications such as Twitter, email or light web browsing, but simply cannot meet the full featured broadband needs of most users. Common broadband applications such as videoconferencing, audio and video streaming and telecommuting require multimegabit speeds and latency of 200 milliseconds or less. Even under ideal conditions, mobile wireless networks have difficulty meeting these requirements. In real world conditions that are experienced in most of the unserved and underserved parts of the country, mobile networks are either unavailable or only capable of delivering less than 1 megabit speeds, with 300-500ms latency.

Mobile wireless systems are not delivering the speeds and network performance that are needed to take full advantage of broadband. Smartphones and mobile wireless networks have their place, but they are not a substitute for a fixed wireless or wireline broadband system.

Victory of the Commons – Unlicensed Spectrum

One of the key factors that has enabled the rapid growth and evolution of fixed wireless broadband providers is the availability of unlicensed spectrum. There are many devices that utilize the unlicensed spectrum bands, with the most visible and important one being the WiFi wireless network standard. WiFi is a multi-billion dollar industry and plays a key part in our nation’s broadband infrastructure. None of the wild success of WiFi would have happened without access to unlicensed spectrum. Most fixed wireless broadband providers in America utilize unlicensed spectrum, often the same spectrum as WiFi.

In most cases, the ability to transmit radio signals requires the use of a license from a government body, such as the Federal Communications Commission (FCC) in the U.S., and has a wide set of restrictions on how that spectrum can be utilized and the kinds of equipment that can be used. These licenses are often hard to obtain, and the cost and regulatory requirements of these licenses are substantial hurdles for small businesses and communities. The spectrum licenses used by mobile carriers are exclusive, and auctioned off to the highest bidder. This generally limits their availability to the biggest corporations with the deepest pockets. They are even suspected of acquiring more spectrum than they need in order to keep smaller competitors from gaining access to it.

In contrast to licensed spectrum, unlicensed spectrum is available to anyone at no cost. Unlicensed spectrum use is governed by the FCC Part 15 rules and standards. According to the FCC Rules (Title 47 of the Code of Federal Regulations):

> "Operation of an intentional, unintentional, or incidental radiator (transmitter) is subject to the conditions that no harmful interference is caused and that interference must be accepted"

Fixed wireless providers were early adopters of unlicensed spectrum, with the first systems going online in the mid-1990s. Many experts claimed that unlicensed spectrum was not suitable for the deployment of broadband data networks because of potential interference and reliability issues. A common theme was the "tragedy of the commons" – where overuse of a public resource (spectrum in this case) leads to degradation of its usefulness. As more operators deployed gear and customers were brought online using unlicensed fixed wireless, many of the fears of the tragedy of the commons turned out to be unfounded.

Instead of a "tragedy of the commons", there was a massive "victory of the commons" – where resilient system design, clever RF engineering, more efficient modulation schemes and the use of higher gain fixed antennas combined to create a dynamic, rapidly evolving broadband ecosystem.

WISPs generally utilize spectrum in the ISM and UNII bands. WISPs commonly use three pieces of unlicensed spectrum: 26mhz of unlicensed spectrum just above 900mhz, 50mhz in 2.4ghz and 100mhz in 5.8ghz. Each spectrum type has advantages and disadvantages. 900mhz is useful for NLOS (Non Line of Sight) situations, but has limited capacity because of the smaller channel sizes. 2.4ghz can deliver higher speeds with limited NLOS capability, but it has to share space with many other devices that also utilize 2.4ghz spectrum such as cordless phones, baby monitors, microwave ovens, Bluetooth devices and indoor home networking devices. 5ghz can deliver even higher speeds, but clients must have a clear path to the access point/tower with no obstructions. Many WISPs use a combination of all three types of spectrum for different terrain and deployment requirements.

Other bands of unlicensed spectrum play lesser parts in fixed wireless deployments. There is spectrum available for unlicensed use around 5.2ghz and between 5.4ghz and 5.7ghz, but this spectrum has radar sensing requirements and lower power limits which has restricted its usefulness and added cost and complexity to radios. The FCC authorized the use of 3.65ghz spectrum in late 2007 by enabling the licensing and use of the spectrum via an innovative “licensed-lite” approach. WISPs have been early adopters and users of this 50MHz of spectrum (3650 to 3700MHz) despite many exclusion zones around the country. There is also 250mhz of spectrum in 24ghz that is used for short range, high capacity point-to-point backhaul links. WISPs have been able to utilize all of these bands in innovative ways to build broadband networks.

From an economic standpoint, unlicensed spectrum has enabled the creation of many grass-roots networks. Traditional licensed spectrum is treated as an asset, with substantial acquisition costs that range from the tens of thousands to multi-million dollar auction fees for large geographic areas. The auction fees for licensed spectrum in many cases exceeds the total network equipment investment for smaller WISPs. This limits the number of smaller or undercapitalized entities that can deploy networks and the scarcity of the spectrum keeps the costs high. ISPs using unlicensed spectrum do not have to invest in spectrum and can use their financial resources to build broadband networks. Most spectrum licenses have onerous legal and financial bookkeeping requirements and the process of obtaining or leasing a license can take months or years. Unlicensed operators can deploy immediately, to the places where there is a valid need or business case, and are not limited by geographic or legal requirements of a spectrum license. The flexibility and ease of deployment of unlicensed fixed wireless networks gives them a key advantage over licensed carriers in a competitive environment.

Opening up access to more unlicensed and licensed-lite spectrum is a key to unlocking the potential benefits that WISPs can bring to all parts of the country. White-spaces spectrum is able to go through trees and obstacles and would be invaluable to WISPs in parts of the country that have heavy tree cover or very large distances to cover with low customer density. WISPs have shown the ability to use spectrum that may not be useful for end-user devices but works very well for building backhaul networks. More spectrum will be needed to meet the increasing demands of consumers hungry for broadband, and WISPs have shown that they will utilize unlicensed spectrum to deliver broadband quickly and efficiently.

The same chunk of spectrum that could only deliver 1meg speeds in 1999 can now deliver 100meg of capacity. WISPs have been riding this wave of innovation and evolution to bring broadband into the homes and businesses of Americans all across the country. Adding more unlicensed and lightly licensed spectrum will increase the capacity and coverage of WISP operators and will let them deliver faster broadband to more Americans.

EVOLUTION VS STAGNATION

Fixed wireless broadband operators using unlicensed spectrum have evolved quickly and are now able to deliver high speed Internet to unserved and underserved areas quickly and inexpensively compared to wireline networks. Comparing the last ten years of advances in broadband deployments highlights how fast fixed wireless has evolved compared to wireline technologies.

Ten years ago, DSL technology capable of delivering 1.5 to 2meg speeds was commonly used in telco DSL deployments. End user speeds of 512K and 1meg were common, but were limited to places where the copper infrastructure was adequate to carry a DSL signal. Advances in DSL technology and the deployment of more remote DSLAMs (DSL Access Multiplexers) has improved the capacity and coverage area of DSL. DSL speeds of 3meg and 5meg are now common in places where DSL is available. In many places across the country, the copper infrastructure is still inadequate in a majority of the locations for DSL deployments and availability is limited by loop lengths and wire center footprints. The majority of DSL systems are also engineered to be asymmetrical, pushing higher speeds down to the user at the expense of slower upload speeds.

In the cable world, the DOCSIS 2.0 standard was approved in December of 2001 and is still the most commonly deployed cable broadband standard. DOCSIS 2.0 is capable of 42.88Megabit download speeds and 30Megabit upload speeds. This capacity is shared across all of the users on a cable node. By 2005, cable operators were advertising 5-15meg speeds to end users. The DOCSIS 3.0 standard released in 2006 enables cable operators to dedicate multiple channels to broadband to increase capacity. The most common DOCSIS 3 configuration uses 4 downstream channels to deliver 152Megabit download speeds for each node. [vi] Cable operators with DOCSIS 3 deployments are now commonly offering download speeds of 15-20megabits to customers on upgraded systems.

Early fixed wireless platforms were based on the 802.11b standard and were capable of 11meg speeds across all of the users of an access point. Early WISPs offered 128k and 256k speeds to residential subscribers and speeds up to 1meg to business customers. Fixed wireless platforms using the 802.11g and 802.11a standards started to appear in 2004, delivering 54megabit raw speeds under ideal conditions. One of the first wireless systems designed specifically for fixed wireless deployment, Motorola's Canopy system, was also introduced in 2003 and early versions of that platform were capable of delivering 21Megabit speeds on an access point. By 2007, WISP operators were commonly offering 1meg to 4meg speeds to subscribers using the newer platforms. In October 2009, the 802.11n wireless standard was released and integrated into fixed wireless systems such as the Ubiquiti AirMax. Deployments with the AirMax system are capable of delivering over 100Megabits of aggregate bandwidth on an access point. Later revisions of the Canopy system are able to deliver the same kind of speeds. The Canopy and AirMax systems utilize TDM (Time Division Multiplexing) to ensure even distribution of capacity between customers, overcoming one of the primary drawbacks of early WiFi based systems which was only designed for very short distances between stations. Fixed wireless manufacturers have adapted the mass-produced chips used for wireless LANs to provide additional capabilities over longer distances at low cost.

To put these numbers into perspective, it makes sense to look at how these different networks are deployed in the real world. DSLAMs, cable nodes and a fixed wireless base station are the gateways to the last mile for each of these technologies, so the capacity for each of these is a good baseline to show how they would be used in a broadband network. Here is a table showing capacities for each kind of technology in **2001**:

Technology	Ports	Typical End User	Total Capacity	Notes
DSLAM	48	1meg	76 meg	Limited by loop lengths and backhaul
DOCSIS 2.0	~100	3meg	42 meg	Shared capacity between all users
802.11b wireless	120	.5meg	10 meg	Four sector base station

Now look at the same table of capacities in **2011:**

Technology	Ports	Typical End User	Total Capacity	Notes
DSLAM	48	3meg	240 meg	Limited by loop lengths
DOCSIS 3.0	100+	10meg	152 meg	Shared capacity between all users
AirMax Wireless	200+	10meg	200 meg	Four sector base station

Wireline systems show a 3x increase in capacity, while fixed wireless networks have increased by 20x. Ten years ago, fixed wireless was barely able to deliver broadband, and now fixed wireless providers can often offer their customers much faster speeds than DSL and match the speeds offered by cable systems.

In addition, fixed wireless is available to every household within the service range of the base station and does not require plant extensions or line conditioning that may be needed to deliver DSL in remote areas. This means that fixed wireless can be deployed much faster than DSL or cable, without the added expenses of plant maintenance and can be done profitably in areas where the number of households per square mile is much lower than wireline deployments.

Deployment costs are considerably less for fixed wireless when compared to wireline networks. In 2000, customer premise radios were $400-$500 per radio. In 2011, most end user radios are under $100. A four sector base fixed wireless base station in 2001 would have cost about $15,000. Today, a 4 sector AirMax basestation delivering 20x the capacity costs less than $5000. During the ten year time frame, DSL and cable modem prices have remained about the same, but the cost of plant maintenance has increased due to increases in labor, fuel and supply costs. Fixed wireless has no cable or wireline plant to maintain.

Fixed wireless providers also have the advantage of flexibility, since they are not burdened by right-of-way issues, franchise agreements or legal borders. There are many places across the country where the line between the people who have broadband and the people who don't is a street or county line. Wireline operators must negotiate for right of way access into each home or business, and many face LATA restrictions or borders that keep them from expanding into nearby areas that do not have broadband. WISPs can cross city, county or state lines to provide service for people who are either unserved by a wireline provider or do not have adequate broadband available to them.

Fixed wireless broadband technologies have evolved rapidly and are now capable of matching or exceeding the performance of cable and DSL based wireline networks. Fixed wireless networks can be deployed very quickly and are not constrained by artificial borders or right-of-way restrictions. Fixed wireless provides the fastest path to better broadband for an unserved or underserved area.

WISPs In America: Bridging The Digital Divide

Fixed wireless broadband providers are the only source for broadband in many places and can serve as the badly needed "Third Pipe" of broadband competition to consumers who are underserved by broadband providers. WISPs have been able to deliver badly needed broadband to these places without access to traditional government subsidies or low interest loans for telecommunication infrastructure. WISPs often have to compete with telephone companies and cellular carriers that receive a substantial amount of support from the USF (Universal Service Fund). To top it off, most WISPs utilize unlicensed spectrum while cellular carriers, rural phone companies, schools and speculators are sitting on vast reserves of spectrum that they are not using and will not lease to competitive providers. In spite of these hurdles, WISPs are able to survive and prosper. WISPs are succeeding where the subsidy model has failed and are poised to grow their coverage areas to more unserved areas and provide valuable broadband competition to existing providers.

Sustainable Business Models-Success Without Subsidies

The Telecommunications Act of 1996 mandated the creation of a Universal Service Fund. The Fund was intended to foster quality and reasonably priced telecommunications service, access for rural, low-income and high-cost areas in the US with a specific and predictable price structure, and access to advanced telecommunication services for schools, health care and libraries. USAC, the Universal Service Administrative Company, was established to manage the contribution of all interstate telecommunications carriers, including mobile carriers, long distance companies, local carriers who resell long distance and VOIP service providers. To offset the cost of contributions, carriers added charges for USF support to end user bills, moving the burden of universal service to consumers. USF payments are only available to Eligible Telecommunications Carriers (ETCs), and carry a very high paperwork load, with several companies dedicating large staff resources to filling out paperwork and filing legal documentation. The majority of ETCs are rural incumbent telephone companies. A few competitive providers, including wireless carriers and CLECs, are certified as Competitive ETCs (CETCs), enabling them to collect subsidies on customers they serve in areas served by incumbent ETCs.

Many of the services covered by USF are related to traditional telecommunications services, such as POTS (Plain Old Telephone Service) lines, and a very complex set of regulations and cost support mechanisms has been established based on the technology and legal framework of the late 1990s. The development and widespread proliferation of new telecommunications technology such as VOIP (Voice-Over-IP), mobile phone service and fixed wireless broadband has made much of the original USF regulatory structure obsolete and reduced the amount of revenue generated from voice and long distance services. Thus the contribution rate (a tax in all but name, adjusted quarterly to ensure adequate collection) has risen from around 3% in the 1990s to around 15% at present. In addition, cellular carriers have become CETCs and are now pulling revenue from the fund, though some have agreed to give this up over time as a merger condition. As the fund faces revenue shortages, the FCC is now considering the expansion of USF to include broadband providers.

Most WISPs are on the outside looking in at the USF system. Many of the independent ISPs grew frustrated with the anticompetitive behavior of the telephone companies and turned to fixed wireless in order to survive. As the technology behind fixed wireless has improved and the costs of deployment drops, fixed wireless providers are able to deliver the same broadband and voice services as the ETCs, but for far less money.

Many USF advocates have made the assertion that universal broadband should be given the same priority and consideration that was given to the universal provision of electric service to all parts of the country. However, this argument fails when advances in broadband technology are brought into consideration. Electrical power delivery is dependent on the construction of a massive wired infrastructure to every user location and an expensive support system for that infrastructure.

Traditional landline broadband is similar, as DSL, fiber and cable have substantial plant and plant maintenance requirements. In a wireline network, facilities must be built out to every potential customer location, even if those customers are not using the service. This drives up the cost of deployment and maintenance. A high penetration rate is required for a wireline network to be profitable and costs are fixed at a high rate. With widely dispersed rural customers, the cost of wireline is so high that it can never be profitable without subsidies. USF permits incumbent ETCs to spend whatever they want to provide wireline telephone service, guaranteeing their profits regardless of the take-up rate.

Fixed wireless broadband networks do not have these same challenges.

When a fixed wireless broadband system is brought online, a landline network is only needed when the aggregate demand of the base station exceeds the capacity of a wireless backbone system. Once a base station is brought online, everyone within range is able to obtain service and there are no additional plant maintenance costs beyond the installation of the customer premise radio. With fixed wireless, a base station can be profitable even with a very small number of customers and the total cost of operation goes down with every additional customer added to the base station. This simple difference in the economics of deployment enables WISPs to survive and prosper without government subsidies while landline operators are dependent on USF to maintain their wireline plants.

In a wireline broadband deployment, fixed expenses are constant throughout the lifetime of the system and these expenses are used as part of the equation for determining USF support. In many cases, USF funding does not go to the providers that are delivering the best product – it goes to the companies that deliver the most expensive product and do the best job of filling out paperwork. Until the system is changed so that efficient providers are rewarded and inefficient providers are not, USF has the potential to do more harm than good to rural broadband deployment in America.

WISPs Bridge the Digital Divide

In 2008, the NTIA was tasked with collecting data from broadband providers to inventory broadband availability across the United States. This data included information about speeds offered, type of connection and coverage areas by census blocks. As part of this effort, each state gathered data on broadband availability within their borders. One of the most comprehensive state data collection and analysis reports was done by Partnership for a Connected Illinois (PCI).

As PCI put their report together they noted that the "broadband availability maps have been met with some skepticism" because of the difficulty of checking carrier data against other resources. To improve the quality of data for their study, they utilized additional data sets from the Gadberry Group and speed test information from the NTIA/FCC National Broadband Map to verify the broadband availability information provided by carriers. PCI also worked very closely with the broadband providers in the state to ensure that their data was represented as accurately as possible.

One of the decisions made by the PCI group was to exclude data from satellite and mobile wireless broadband providers. The report concluded:

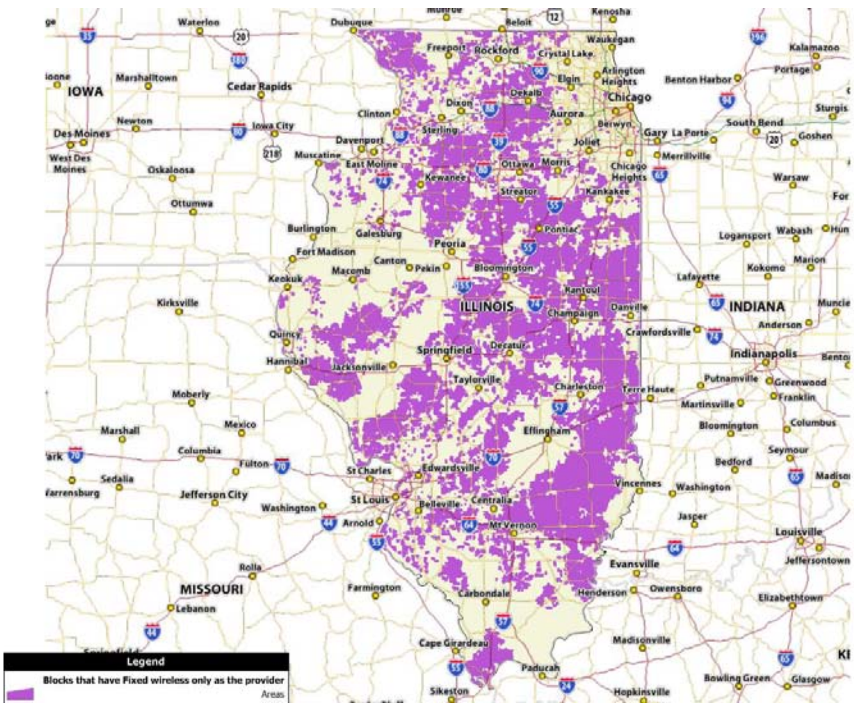
> "In looking at speed test results from all the cellular technologies, it was discovered that the typical real world speeds over a 12-month period were in many instances different than the maximum advertised speeds. It is also known that providers in the cellular technologies do not have different speed tier data plans, which might otherwise skew a reading of speed test results. In other words, all users have equal access to the maximum available cellular speeds offered – unlike, for example, digital subscriber line (DSL) or cable modem service. Another major factor against inclusion of mobile broadband in the same field of analysis are the data caps in place by carriers. These caps generally limit the ability for users to download more than 5 Gigabytes (GB) of data per month, without paying overage charges. This kind of cap can limit the ability of users to access the range of services traditionally associated with broadband. "

It was found during the testing process that mobile wireless broadband was "not well suited as a primary connection in the home or business" so it was placed in a different category from the wireline and fixed wireless providers. Removing this data affected some parts of the state, but not others. This same logic was applied by the FCC in their rural broadband report released on June 17, 2011.

Outside of the urban area around Chicago, there are many telecommunications providers, including branch operations of large telcos such as Frontier and Verizon, several rural cable operators and many independent rural telephone companies. The large number of providers and service areas in Illinois lead to a patchwork of broadband availability. Some places have decent access while others have no broadband at all. Many census blocks outside of city limits are completely unserved by wireline providers.

Fortunately, Illinois is also home to nearly 100 WISP operators, a very active group that has steadily built broadband in urban, suburban and rural areas across the state. For many people in Illinois, the only source of broadband is from a WISP using fixed terrestrial broadband to deliver service. Here is a map of the areas of Illinois that can only get service from a fixed wireless provider:

Illinois Census Blocks that have a WISP as the only broadband provider:

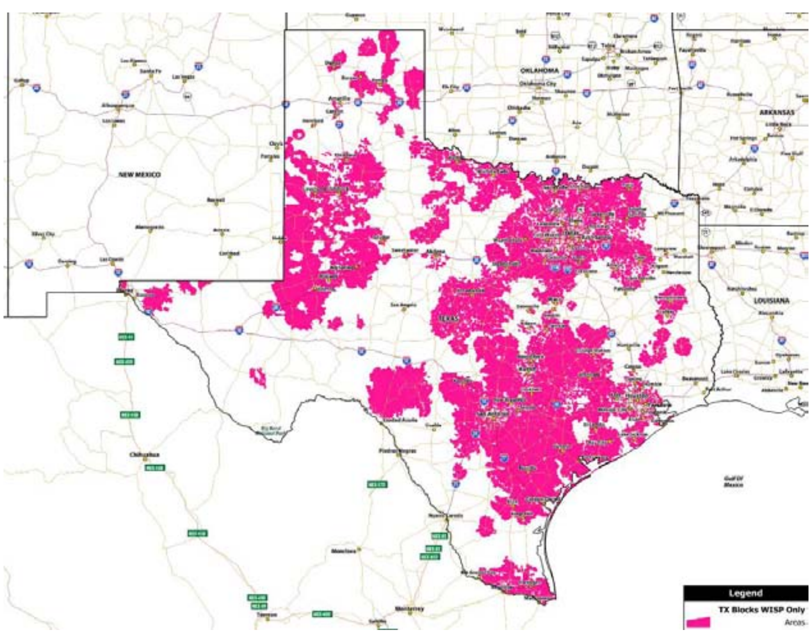


All of the areas in purple on this map can get broadband from a WISP, and not from any of the traditional providers. This area includes 137,330 households and covers 21,062 square miles of the state. One third of the entire State of Illinois can only get broadband service from a WISP.

Several other states, especially large ones with a lot of rural areas, show similar results. Here is a table showing the numbers for WISP-only coverage in several states:

State	Occupied Households Passed by WISP's 2008	Total Occupied Households 2008	% Households passed by WISPs only	Land Area in Sq. Mi. Uniquely passed by WISP's	Total Land Area	% land area uniquely covered by WISPs	Households Per Square Mile Statewide	Households Per Square Mile of WISP Only Served Blocks
MI	173,834	4,009,186	4.34%	14,513.30	56,809.00	25.55%	70.57	11.98
OR	142,760	1,516,658	9.41%	31,321.17	96,003.00	32.63%	15.80	4.56
TX	2,094,479	8,924,973	23.47%	199,899.00	268,808.00	74.36%	33.20	10.48
WY	10,517	215,923	4.87%	12,458.45	97,105.00	12.83%	2.22	0.84
NE	77,845	730,577	10.66%	45,227.25	77,243.02	58.55%	9.46	1.72
IN	61,140	2,543,090	2.40%	5,505.05	35,870.00	15.35%	70.90	11.11
OH	151,893	11,870,733	1.28%	11,925.10	40,953.00	29.12%	289.86	12.74
ID	51,646	562,067	9.19%	16,888.70	82,751.00	20.41%	6.79	3.06
IL	137,330	4,851,822	2.83%	21,062.00	55,593.00	37.89%	87.27	6.52

Here is a map of Texas, a state where WISPs are the only source of broadband for 2 million households:



WISPs using fixed wireless systems are delivering broadband to the most unprofitable and difficult to serve segment of the population. Despite limited spectrum, subsidization of competitors and restrictions on access to middle-mile infrastructure, WISPs are thriving and expanding their services. The work done by WISPs to bridge the digital divide cannot be understated.

Telco Bypass Surgery: Overcoming the Obstacles in the Middle Mile

Provisioning broadband services is heavily dependent on the ability to connect up to the Internet backbone and distribute traffic to the access points that serve the end users. The segment of the network between the Internet backbone and the access point is commonly known as the “middle-mile” and is just as important as the “last-mile” connections that service the end users. In the traditional ISP model, middle-mile infrastructure consists of T1s, DS3s, ATM and frame relay circuits provided by the landline telcos. As new fiber networks were built out in the late 1990s, new connectivity options such as metro Ethernet and dark fiber access (IRUs) became available from non-telco companies such as Cogent and Level3. Connectivity through these new fiber networks is generally much faster and priced more competitively than access through the traditional telco circuits. Middle-mile connectivity needs can also be met by microwave backhaul options. Early microwave backhauls were limited to carrying a few T1s of traffic, but now there are many microwave options, using both licensed and unlicensed spectrum, that are capable of carrying up to 1GB of traffic.

As WISP networks developed, they usually started with the traditional connection options such as T1s. A single T1 connection can carry 1.5Mb of traffic, which was sufficient for the early fixed wireless providers but is quickly outgrown as more customers are added. The price of these lines is very high, with providers in rural areas paying backbone connectivity costs of $500 to $800/month per 1Mb of Internet backbone connectivity. Bonded T1 lines and DS3 circuits are often utilized when more capacity is needed, but costs for these circuits remain high and do not make technical sense when a single client of an advanced fixed wireless base station is capable of saturating one of these circuits.

In urban areas, fiber providers often have high capacity connections available at fractions of the cost of rural connections. Carriers such as Cogent and Hurricane Electric offer Internet backbone connectivity at rates as little as $1/Mb. Rural areas often see rates of $400 to $800/Mb for Internet backbone connectivity using telco circuits. The high rates for connectivity in rural areas serves as one of the major bottlenecks for higher speed broadband connectivity to rural users.

To remedy the vast pricing differences in IP backbone connectivity many WISPs have built their own middle-mile networks using microwave radios. By obtaining less expensive IP backbone connectivity in urban or suburban areas, or from network access locations along fiber networks, WISPs are able to reduce the operational cost of their networks while delivering higher speeds to their customers than many wireline carriers. Many of these middle-mile networks are also built with redundancy as one of the primary considerations, utilizing multiple points of interconnection and rings to enable traffic to route around outages.

This practice shatters the myth that rural wireless broadband networks are dependent on incumbent wireline providers. Middle-mile networks utilizing microwave technology have evolved quickly and are now able to deliver very high capacity bandwidth to remote areas. It is not uncommon for rural WISPs to deploy thousands of miles of microwave backbone to deliver broadband in remote areas, while completely bypassing the incumbent wireline network providers.

The Third Pipe – More Competition Means Lower Prices and Better Services

Wireless broadband access has long been thought of as the potential "third pipe" of broadband for American consumers. Most of the attention for third pipe status has been focused on mobile wireless broadband, but the easiest way to get real broadband competition for cable and DSL is through fixed wireless providers. In addition to providing the only broadband service available in many communities, WISPs are also providing badly needed competition for consumers who are dissatisfied with the service provided by DSL and cable providers.

The Broadband Duopoly

One of the intentions of the Telecommunications Act of 1996 was to promote competition in telecommunications services. A key feature of this act was the separation of services (voice, video or data) from the underlying infrastructure that delivered those services. This separation and the newly legislated open access to telco facilities fostered the creation of independent Internet Service Providers (ISPs) and Competitive Local Exchange Carriers (CLECs) that provided competitive pricing and innovative service offerings. The ISPs and CLECs were very successful in the late 1990s, building out DSL and other related services and delivering much needed competition to the incumbent telephone companies.

After heavy lobbying by telephone companies and a change in administration at the FCC, the theory of intermodal competition became the dominant view of the market. In this model, competition between each type of service (cable, telco, satellite and wireless) was deemed to be dynamic enough that there was less need for competition within the types of services. As a result, the sharing of network resources was curtailed. Competitive carriers were denied access to fiber optic lines and the unbundled network elements needed to provision DSL circuits and carry broadband traffic. This created a monopoly in DSL for the incumbent telephone companies. The Brand X decision classified broadband Internet access as an "information service" rather than a "telecommunications service" and gave cable companies a monopoly over their cable plant.

Unable to compete without access to the wireline networks, many of the independent ISP operators and CLECs either sold out or went out of business. The practical result of these changes was a substantial reduction in the number of competitors and the creation of a broadband "duopoly" – where the only competition was between the DSL providers and the cable providers. The concentration of control into a smaller number of providers reduced innovations in service, pricing and footprint. For most broadband users, the choice has been between two providers – one cable and one DSL. With competitors gone from the marketplace, broadband users are dealing with price increases, long term contracts and bundled service offerings that tie broadband to voice or cable services that the customer may not want or need. The duopoly system is proving to be a failure for consumer choice and service.

Breaking the Duopoly with Fixed Wireless

As fixed wireless broadband technology matured and gained ground on wireline networks in performance and reliability, many of the surviving independent ISPs started to deploy wireless broadband to meet the needs of their customers. With access to cable and telco networks denied to competitors, fixed wireless became the only other cost effective way for competitive providers to build out last-mile networks.

After the introduction of the Canopy wireless platform and several other second generation wireless systems, fixed wireless networks were able to surpass the speed and coverage footprint of DSL providers. With no restrictions on service area or the constraints of wireline plant, WISPs were able to compete head to head with DSL while also picking up customers outside of the wireline footprint.

With the release of the latest generation of fixed wireless broadband platforms, WISPs have the ability to deploy broadband services that are comparable to cable systems. A WISP with access to a sufficient amount of open spectrum and adequate Internet backbone connectivity can build a broadband network that is fully competitive with cable and can easily outperform DSL.

There is also room for competition within the fixed wireless broadband market. Many areas across the country are served by multiple WISPs. WISPs have the ability to focus on their marketplace and deliver what the customers want – whether it is price, performance, added services or a combination of the three.

There are many benefits to competition in broadband. Consumers in a competitive broadband market have more choices in price, speed, latency and support options. WISPs generally focus on building data networks, and do not require the consumer to add other non-data services such as voice or television service in order to receive the best prices. More competition means also means less need for Net Neutrality legislation. Net Neutrality is about regulating ISP behavior in a monopolistic market. If WISPs can provide an alternative for a user who doesn't like cable or telco usage policies or prioritizes certain traffic to the detriment of other traffic, there is less need for legislation to impose conditions on all ISPs.

There are many benefits to consumer who has access to multiple providers for broadband. Better pricing, more options for speed or network performance and access to local service are just a few of the reasons why competition in broadband is good for consumers. For the increasing number of American consumers, the Third Pipe is here and it is being delivered by fixed wireless broadband providers.

Conclusion

Fixed wireless providers have been quietly building out broadband networks across America, bringing advanced broadband services to many places that would not have access otherwise and providing badly needed competition in underserved areas.

While media and legislative attention primarily focuses on mobile wireless broadband deployments, fixed wireless operators are doing the heavy lifting in rural areas, delivering higher speeds over robust networks that can handle the demands of bandwidth intensive applications like videoconferencing, multimedia streaming, telecommuting and VOIP. Mobile broadband networks are barely capable of delivering broadband performance, especially in rural areas, and have exponentially higher deployment costs. Mobile wireless is the sizzle in America's broadband diet – full of noise and lacking in substance, while fixed wireless is the steak – the high capacity broadband network that can deliver rich content at a fraction of the cost.

Wireless ISPs are also dynamic users of available spectrum. The majority of WISP networks are built using platforms that utilize unlicensed spectrum and are positioned to take advantage of any new types of spectrum that might be designated for wireless broadband. Advances in dynamic spectrum allocation, access to white spaces frequencies and the allocation of additional unlicensed spectrum will give WISPs the tools needed to extend their footprint to more places in America that badly need broadband. The fastest way to turn empty spectrum into broadband users is to open it up for use by fixed wireless broadband providers.

WISPs have successfully built their own middle-mile networks and are able to operate independently of wireline providers. As the demand for advanced broadband service increases, WISPs will have a need for reasonably priced access to fiber networks to use as backhaul and access to Internet traffic exchange points. Enforcement of open network access provisions of existing middle-mile projects and including open access requirements as part of any government subsidized network will ensure that WISPs can get the access needed to meet the needs of their customers now and in the future.

The rapid evolution of fixed wireless platforms has enabled WISPs to provide the same quality of services that wireline DSL and cable providers are offering, with a lower cost of deployment and without the need for subsidization. Unsubsidized WISP operators are the only source of broadband for many households in rural and suburban areas that are on the fringe or outside of the wireline networks. The broadband subsidy model should be adjusted to remove the crutch from system abusers and level the playing field for competitive providers.

Finally, restoring competition to the broadband market will lead to lower prices and better services for Americans. WISPs are perfectly positioned to provide the "Third Pipe" needed to facilitate competition in the broadband space. This will also reduce the need for legislation to regulate monopolistic behavior. America was built on the idea of fair competition, and WISPs have earned the right to engage incumbent telephone and cable companies in the battle for market share.

The best way to resolve our digital divide issues and bring about a prosperous broadband future to all Americans doesn't involve subsidies or spectrum auctions. Useful and affordable broadband service is not going to come from a smartphone, it will come from a fixed wireless or wireline provider. Providing fixed wireless broadband providers access to unlicensed and lightly licensed spectrum, cost effective middle mile connectivity and a fair competitive environment represents the most efficient and cost effective way to improve broadband access to unserved and underserved places in America.

[i] Based upon Dec. 31, 2010 data collected by the NTIA for its National Broadband Map, about 40% of Americans have access to more than two wireline broadband providers; 11.6% have access to only one, and 4.1% have none at all. Some of the wireline providers are competitive local exchange carriers offering DSL services to business, not mass-market services, and their geographic coverage is quite limited.

[ii] A February, 2011 report by Scott Wallesten of the Technology Policy Institute found that "of each dollar distributed to recipient firms, about $0.59 goes to "general and administrative expenses" Source: http://www.scribd.com/doc/49404956/Wallesten-Universal-Service-money-Trail-Final

[iii] 1d (1). OECD Fixed (wired) broadband subscriptions1 per 100 inhabitants, by technology, December 2010 cites the US in 15th place with 27.7 subscriptions per 100 population. The Netherlands and Switzerland lead with 38.1 subscribers.

[iv] Source: WISP Directory http://www.wispdirectory.com/

[v] http://www.ubnt.com/airmax - Manufacturer of AirMax fixed wireless broadband platform

[vi] http://www.wikipedia.org/wiki/Docsis