November 20, 2013

***Ex Parte* Notice**

Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: ***Connect America Fund,* WC Docket No. 10-90; *High-Cost Universal Service Support,* WC Docket No. 05-337; *AT&T Petition to Launch a Proceeding Concerning the TDM-to-IP Transition; Petition of NTCA for a Rulemaking to Promote and Sustain the Ongoing TDM-to-IP Evolution,* GN Docket No. 12-353; *Technology Transitions Policy Task Force*, GN Docket No. 13-5**

Dear Ms. Dortch:

On Monday, November 18, 2013, Shirley Bloomfield, Chief Executive Officer of NTCA–The Rural Broadband Association ("NTCA"), and the undersigned met with Jonathan Sallet, Jonathan Chambers, and Stephanie Weiner of the Technology Transitions Task Force regarding matters in the above-referenced proceedings. Materials distributed during the meeting are provided with this letter.

NTCA explained that its November 2012 petition to promote and sustain the ongoing TDM-to-IP evolution proceeds from the premise that the Federal Communications Commission (the "Commission") has an essential, statutorily-defined role to play in defining regulatory frameworks to govern essential communications services regardless of underlying technology. NTCA emphasized that technological evolution (as well as consumer preferences and market shifts) should certainly inform regulatory constructs, but that such changes standing alone neither necessitate nor eliminate the need for any given regulation. Rather, statutory principles – including those relating to consumer protection, competition, and universal service – must guide and foster policies, regardless of underlying technological network transitions. This is not to say that all regulations should be maintained in current form, but only that regulatory certainty and sound public policy require the thoughtful evaluation of any potential changes to determine how core statutory objectives can be fulfilled and better served in the face of shifting consumer preferences, technological developments, and dynamic market forces.

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Citing its *2012 Broadband/Internet Availability Survey Report*, NTCA described the achievements of its members in already helping to lead the IP evolution thus far. Both subject and pursuant to well-tailored regulatory incentives that date back over a decade, NTCA members have deployed fiber deeper into their networks over time to respond to consumer demands for higher speeds and additional capacity, and have supplemented wired facilities with wireless and other innovative offerings. Many have also deployed soft switches either to replace or supplement existing TDM Class 5 switches. Yet even as NTCA members have taken remarkable strides toward modernizing their networks, the persistent challenges of distance and density must continue to be addressed if the IP evolution is to take root and remain sustainable in rural areas. Moreover, while such challenges may remain constant, financial confidence and investment incentives are affected by regulatory changes. In this regard, NTCA notes the findings of a January 2013 survey which revealed that nearly 70 percent of member company respondents had postponed or cancelled broadband network deployment projects due to regulatory uncertainty in the wake of the 2011 universal service and intercarrier compensation reforms.

Turning to what the Commission might do to help overcome such challenges and promote and sustain this technological evolution, we discussed the need for policies that enable a broadband future in all areas of the United States and that help establish greater regulatory certainty. First, we discussed the need for refinement of universal service support in high-cost areas served by rate-of-return-regulated rural local exchange carriers ("RLECs") to facilitate consumer choice and stimulate adoption of broadband. Specifically, NTCA observed that it is contrary to generally accepted policy desires for an IP-evolved communications environment – and contrary to the very notion of consumer choice – for customers to be compelled to take "Plain Old Telephone Service" in order to obtain affordable broadband services on the same network. Yet this is precisely the result required by the current rules governing distribution of universal service to RLECs, despite the fact that the rules for Connect America Fund support in larger carriers' areas were updated in 2011 to support broadband-capable networks even where consumers choose not to *buy* voice telephony service. NTCA further noted that RLECs are both committed to the continuing offer of voice telephony service and also that they already provide the transmission networks underlying broadband Internet access service on a tariffed, Title II-regulated basis, providing further justification for supporting those networks regardless of any given consumer's choice of services atop those networks.

NTCA therefore argued that addressing the need for straightforward, common-sense updates to current universal service rules should be seen as an essential component of broader efforts to promote and sustain ongoing technological evolution for the benefit of consumers. We noted that stakeholders had already submitted detailed rules explaining how such updates could transition legacy support mechanisms to a Connect America Fund for consumers in areas served by RLECs. *See* Comments of NTCA, *et al*., WC Docket No. 10-90 (filed June 17, 2013), at 1-10 and Attachment 1. Such changes are important for consumers in RLEC-served areas to participate meaningfully in an IP-enabled world while having a panoply of service options from which to choose on a supported network. NTCA also urges the Commission to consider more closely the need for sufficient support, including at a minimum the application of an inflationary factor to any budget for high-cost support similar to that applied to the budget for the Schools and Libraries program.

NTCA next raised the need for greater regulatory certainty to help stimulate and sustain investments in broadband-capable networks. We specifically discussed the need for changes to the quantile regression analysis ("QRA")-based caps to restore transparency, accuracy, and predictability to universal service distribution consistent with statutory mandates. NTCA highlighted a recent proposal to establish a Capital Budget Mechanism as an alternative to the current application of QRA caps. *See Ex Parte* Letter of Michael R. Romano, Senior Vice President-Policy, NTCA, to Marlene H. Dortch, Secretary, Commission, WC Docket No. 10-90, *et al*. (filed Sept. 12, 2013), at 8. We explained that this Capital Budget Mechanism should satisfy the objective of fiscal responsibility within support mechanisms (including any new standalone broadband support program) while dispelling the substantial confusion caused by application of the QRA to past investments and allowing for clearer definition of what limits, if any, might apply to recovery of universal service support for future investments.

Finally, we discussed whether certain trials might help the Commission and other stakeholders examine the effects and implications of technology transitions. NTCA noted initially, as discussed above, that its members have already been undertaking such underlying network transitions without specific regulatory relief or the need for technical "trials." This being said, consistent with prior comments, NTCA suggested that there is certainly a need for in-depth, multi-stakeholder examination and discussion of important technical issues relating to interconnection, routing, and numbering databases and other matters. There may also be ways in which carefully defined and closely monitored individual trials (or "structured observations") could be useful as part of a broader "smart regulation" review – provided, however, that the scope of any such trials are indeed carefully defined in advance and that core statutory objectives relating to consumer protection, public safety, competition, and universal service continue to serve as the backdrop for any trial terms and conditions. *See* Comments of NTCA, GN Docket No. 13-5 (filed July 8, 2013); Reply Comments of NTCA, *et al*., GN Docket No. 12-353 (filed Feb. 25, 2013).

Thank you for your attention to this correspondence. Pursuant to Section 1.1206 of the Commission's rules, a copy of this letter is being filed via ECFS.

Sincerely,

/s/ *Michael R. Romano*
Michael R. Romano
Senior Vice President – Policy

Enclosures

cc: Jonathan Sallet
Jonathan Chambers
Stephanie Weiner

NTCA 2012 BROADBAND/INTERNET AVAILABILITY SURVEY REPORT

March 2013

DISCLAIMER: Data from the survey has been presented as reported.

To get more information on this report please contact Rick Schadelbauer at NTCA (703-351-2019, richards@ntca.org).

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EXECUTIVE SUMMARY

For the more than a decade, NTCA–The Rural Broadband Association has conducted its annual Broadband/Internet Availability Survey to gauge the deployment rates of advanced services by its member companies. In the late fall and early winter of 2012, NTCA sent an electronic survey form to each of the companies in NTCA's e-mail database; 132 members (25%) responded.

One hundred percent of the 2012 survey respondents offer broadband to some part of their customer bases compared with the 58% of the 2000 survey respondents who offered the then-lower definition of broadband service.[1] Respondents indicated that they use a variety of technologies within their respective serving areas to provide at least basic levels of broadband to their customers: 88% of those who offer broadband utilize copper loops (only 29% of 1999 survey respondents offered DSL service), 74% fiber to the home (FTTH), 48% fiber to the node (FTTN), 16% cable modem, 15% licensed fixed wireless, 14% unlicensed fixed wireless, and 7% satellite. Seventy-four percent of 2012 survey respondents provide broadband via both digital copper loops and fiber broadband service, while 14% offer digital copper loops but not fiber and only 10% fiber but not digital copper loops.

Eighty percent of respondents' customers can receive 200 to 768 kilobits per second (kbps) downstream service, 83% 768 kbps to 1.0 megabits per second (Mbps), 76% 1.0 to 1.5 Mbps, 76% 1.5 to 3.0 Mbps, 67% 3.0 to 4.0 Mbps, 65% 4.0 to 6.0 Mbps, 51% 6.0 to 10.0 Mbps, and 40% greater than 10.0 Mbps. The overall take rate for broadband service is 69%.

The typical respondent is 79 miles from its primary Internet connection. Eighty-nine percent of those who recently changed backbone providers did so for price reasons. Eighty-five percent of respondents indicated they are generally satisfied with their current backbone access provider, while 15% are generally dissatisfied.

Ninety-seven percent of survey respondents indicated they face some type of competition in the provision of advanced services from at least one other service provider in some portion of their service area. By comparison, only 66% of respondents to the 2003 survey indicated they faced competition and only 43% in the 1999 survey. Current competitors include national Internet service providers (ISPs), cable companies and fixed and/or wireless Internet service providers (WISPs.) Respondents are taking numerous marketing steps to increase broadband take rates, including free customer premise equipment installation, bundling of services, price promotions, free modems, free

[1] For the purpose of this survey, broadband is defined as throughput of at least 768 kbps in one direction. Previously, the commission had defined broadband as service of at least 200 kbps in one direction.

introductory service and free education and training. More than half of respondents find it difficult to compete with price promotions offered by competitors.

Fifty-three percent of those respondents with a fiber deployment strategy plan to offer fiber to the node to more than 75% of their customers by year-end 2015, while 61% plan to offer fiber to the home to at least 50% of their customers over the same time frame. Deployment cost remains the most significant barrier to widespread deployment of fiber, followed by regulatory uncertainty, long loops, current regulatory rules, low customer demand, obtaining financing, and obtaining cost-effective equipment. Throughout the history of the survey, deployment cost has been respondents' most significant concern.

Fifteen percent of respondents currently offer voice over Internet protocol (VoIP) service, up slightly from 11% last year. Forty-seven percent of respondents not currently offering VoIP have plans to do so in the foreseeable future, virtually unchanged from last year. Seventy-nine percent of respondents offer video service to their customers, up slightly from 72% last year.

INTRODUCTION

In the late fall/early winter of 2012, NTCA–The Rural Broadband Association surveyed its members on their activities in the areas of providing broadband services and Internet availability to their members/customers. NTCA is a national association, and at the time the survey was conducted served approximately 575 local exchange carriers in 44 states that provide service primarily in rural areas.[2] All NTCA members are small carriers that are "rural telephone companies" as defined in the Communications Act of 1934, as amended by the Telecommunications Act of 1996. Only four NTCA member companies serve 50,000 lines or more; the largest serves just over 90,000. Population density in most member service areas is in the 1 to 5 customers per square mile range.

This latest broadband survey is a follow-up to similar surveys conducted in recent years by NTCA, and seeks to build upon the results of those surveys.[3] This year's survey asked about technologies used to provide broadband service, broadband availability and subscription rates, prices charged quantity and type of competition, broadband marketing efforts, fiber deployment, emerging technologies, Internet backbone connections, finance and availability of capital. The survey also provided an opportunity for respondents to provide any specific comments they wished to share.

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[2] This survey was conducted prior to NTCA's unification with OPASTCO which took place in March 2013. All demographics provided here are those of pre-unification NTCA.

[3] Copies of this and previous NTCA survey reports may be downloaded from the NTCA web site, www.ntca.org.

OVERVIEW OF SURVEY

The 2012 NTCA Broadband/Internet Availability Survey was conducted online. Every effort was made to minimize the reporting burden on the survey respondents.

The survey was comprised of general questions about the respondent's current operations, competition/marketing and current and planned fiber deployment. Additional questions dealt with the Internet backbone, voice over Internet protocol (VoIP) and video. The survey also provided an opportunity for respondents to offer any miscellaneous thoughts.

SURVEY RESULTS

The survey URL for each part of the survey was distributed via e-mail to all member companies in NTCA's e-mail database. The message contained instructions for online access to the survey. Responses were received from 132 member companies, a 25% response rate.[4]

Forty-five percent of survey respondents' service areas are 500 square miles or larger; 19% are at least 2,000 square miles. Nearly three-quarters—71%—have customer densities in their service area of 10 residential customers per square mile or less. More than one-fourth—28%—have customer densities of two residential customers per square mile or less.

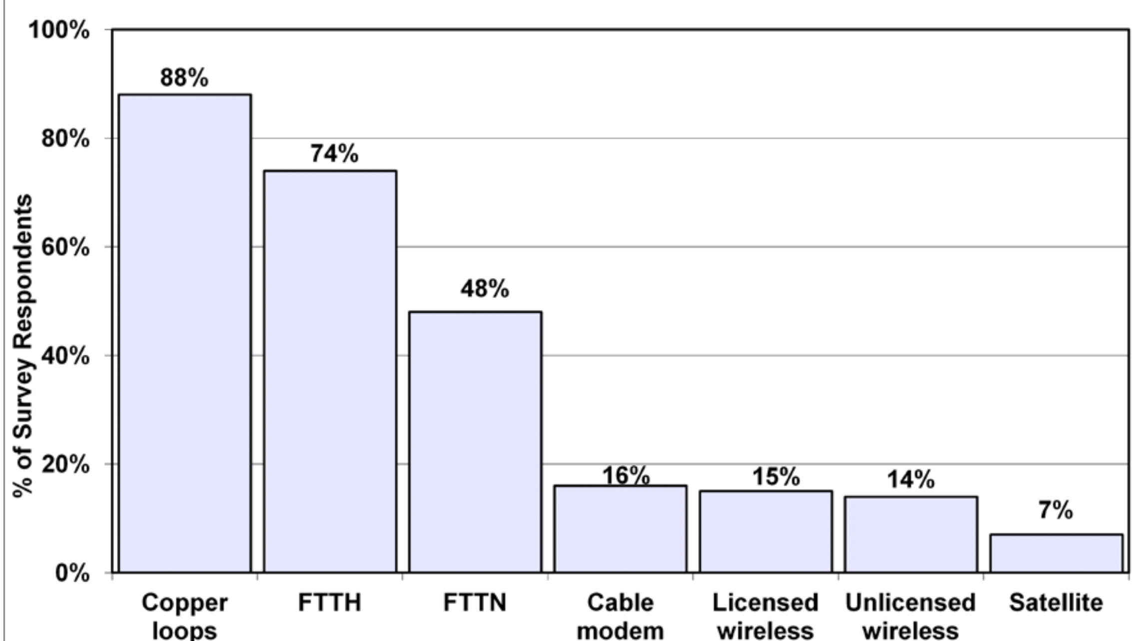
The average survey respondent serves 4,259 residential and 1,428 business voice grade access lines; a few larger companies skew these numbers upward, hence the median respondent serves 1,785 residential and 443 business lines. One hundred percent of survey respondents offer broadband[5] service to some part of their customer base. Respondents indicated that they use a variety of technologies, even within individual serving areas, to offer at least basic levels of broadband to their customers: 88% utilize digital copper loops, 74% fiber to the home (FTTH), 48% fiber to the node (FTTN), 16% cable modem, 15% licensed fixed wireless,14% unlicensed fixed wireless, and 7%

[4] Based on the sample size, results of this survey can be assumed to be accurate to within ± 7% at the 95% confidence level.

[5] For the purpose of this survey, broadband is defined as throughput of 768 kbps in at least one direction. This was the definition implemented by the FCC in 2008. According to the Commission, throughput speeds of between 200 kbps and 768 kbps are classified as "first generation data" and throughputs between 768 kbps and 1.5 Mbps are classified as first tier "basic broadband." This report adopts those FCC conventions.

satellite.[6] (See Figure 1.) Eighty-nine percent of survey respondents are providing either FTTN, FTTH or both, a significant increase from 67% in the 2011 survey and 68% in 2010. Seventy-four percent of survey respondents provide both digital copper loops and fiber broadband service, while 14% offer digital copper loops but not fiber and 10% fiber but not digital copper loops. Thus, ninety-eight percent of those respondents that offer broadband service include either digital copper loops, fiber, or both among their service offerings.

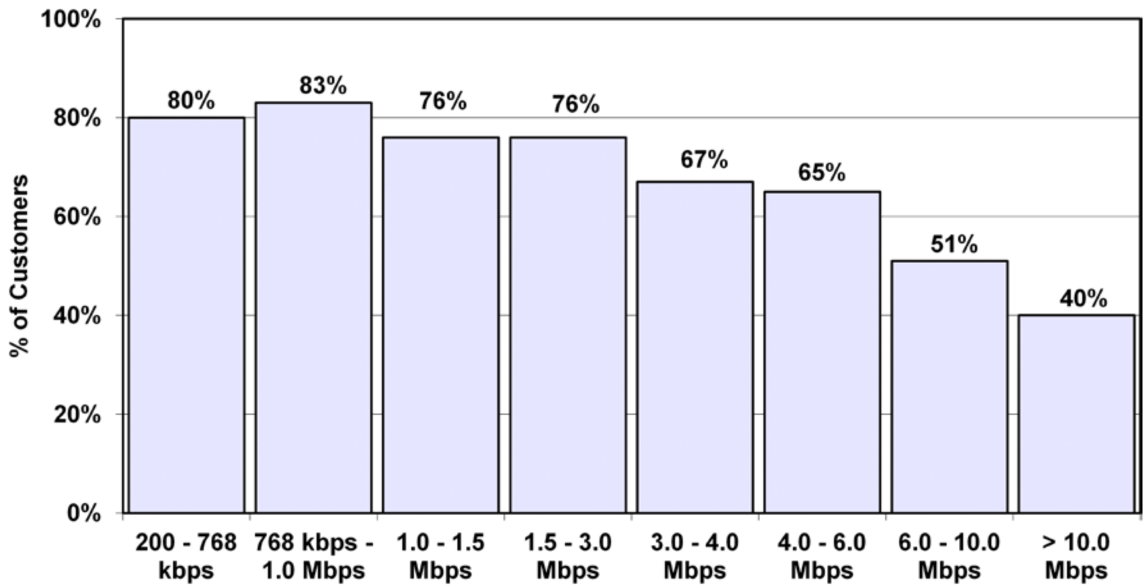
Fig. 1: TECHNOLOGIES USED TO PROVIDE BROADBAND



[6] Percentages sum to greater than 100% as some respondents utilize more than one technology to serve their customers. For example, a provider may utilize FTTH to serve some portion of its serving area, while relying upon copper plant and DSL technology to serve the rest of its customers.

Eighty percent of respondents' customers can subscribe to 200 kbps to 768 kbps downstream service, 83% to 768 kbps to 1.0 megabits per second (Mbps), 76% to 1.0 to 1.5 Mbps, 76% to 1.5 to 3.0 Mbps, 67% to 3.0 to 4.0 Mbps, 65% to 4.0 to 6.0 Mbps, 51% to 6.0 to 10.0 Mbps, and 40% to greater than 10 Mbps service. (See Figure 2.)

Fig. 2: AVAILABILITY OF FIRST GENERATION DATA AND BROADBAND SERVICE



Survey results indicate an overall broadband take rate from NTCA member companies of 69%, up from 66% a year ago.[7] Typical prices charged range from $34.95 to $44.95 for cable modem service, $29.95 to $49.95 per month for DSL service, $39.95 to $49.95 for wireless broadband service, and $39.95 to $59.95 for fiber service.

Fifty percent of survey respondents indicated they offer their customers so-called "stand alone DSL"—DSL service without a voice component. Take rates for stand alone DSL service are relatively low, with the majority of those respondents offering stand alone DSL reporting take rates of 5% or less.

[7] Keep in mind that the take rate provided here is for customers taking service from NTCA member companies only. Total rural broadband subscription rates are likely higher, as survey respondents may be joined by a variety of competitors in the provision of broadband services within portions of their service area.

Twenty-seven percent of respondents estimate that they could bring all of their customers currently receiving service below 25 Mbps up to that speed for $1 million or less in additional capital investment. An additional 30% could do so for between $1 million and $10 million, 15% at a cost of between $10 million and $20 million, 9% between $20 million and $50 million, and 18% estimate the total cost would exceed $50 million.

Internet Backbone

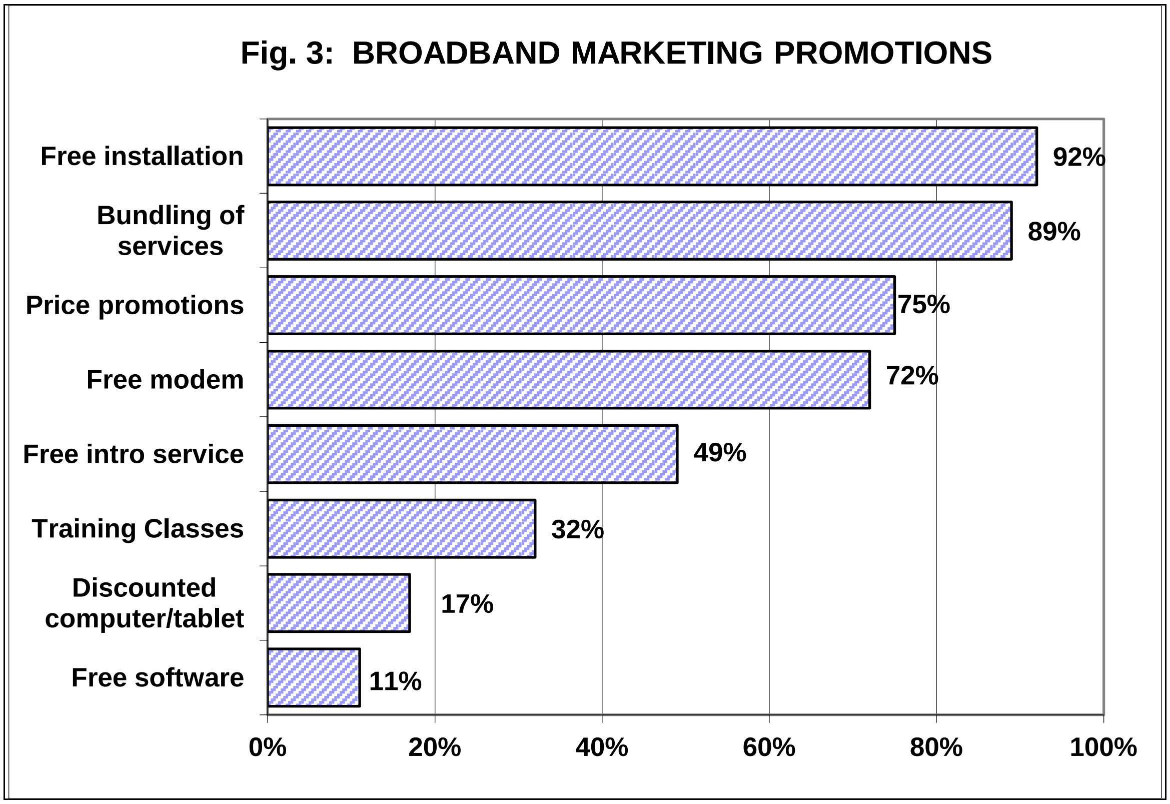
The typical respondent is 79 miles from its primary Internet connection. Eighty-nine percent of those respondents who have recently switched Internet backbone access providers did so for price reasons, while 22% switched due to quality of service concerns and 17% for other reasons, such as obtaining diverse routing or gaining the ability to access the Internet backbone using Ethernet transport.[8] Eighty-five percent of respondents indicated they are generally satisfied with their current backbone access provider, while 15% are generally dissatisfied. More than three-quarters of all survey respondents expect to need additional backbone capacity in one year or less.

Competition/Marketing

Competition in broadband is becoming more prevalent and more varied: 97% of survey respondents indicated that they face competition from at least one other service provider in some portion of their service area. Survey respondents typically compete with national ISPs, fixed and/or mobile wireless Internet service providers (WISPs) and satellite broadband providers. Other potential competitors include cable companies, electric utilities, local ISPs and neighboring cooperatives.

Rural incumbent local exchange carriers are taking numerous steps in the marketing arena to increase broadband take rates. Ninety-two percent are offering free installation, 89% are bundling services, 75% are offering price promotions, 72% are offering free modems, 49% are offering free service for an introductory time period (such as 30 days), 32% are offering free education/training classes, 17% are offering discounted computers or tablets, and11% are offering free software.[9] (See Figure 3.) Fifty-six percent of respondents find it difficult to compete with price promotions offered by competitors, while 39% struggle to match competitors' service bundling. Respondents consider their bundling of services, free installation and price promotions to be their most effective marketing promotions.

[8] Totals exceed 100% as respondents were allowed to select more than one reason for switching providers.
[9] Totals exceed 100% as respondents' companies may be offering more than one marketing promotion.



Fiber Deployment

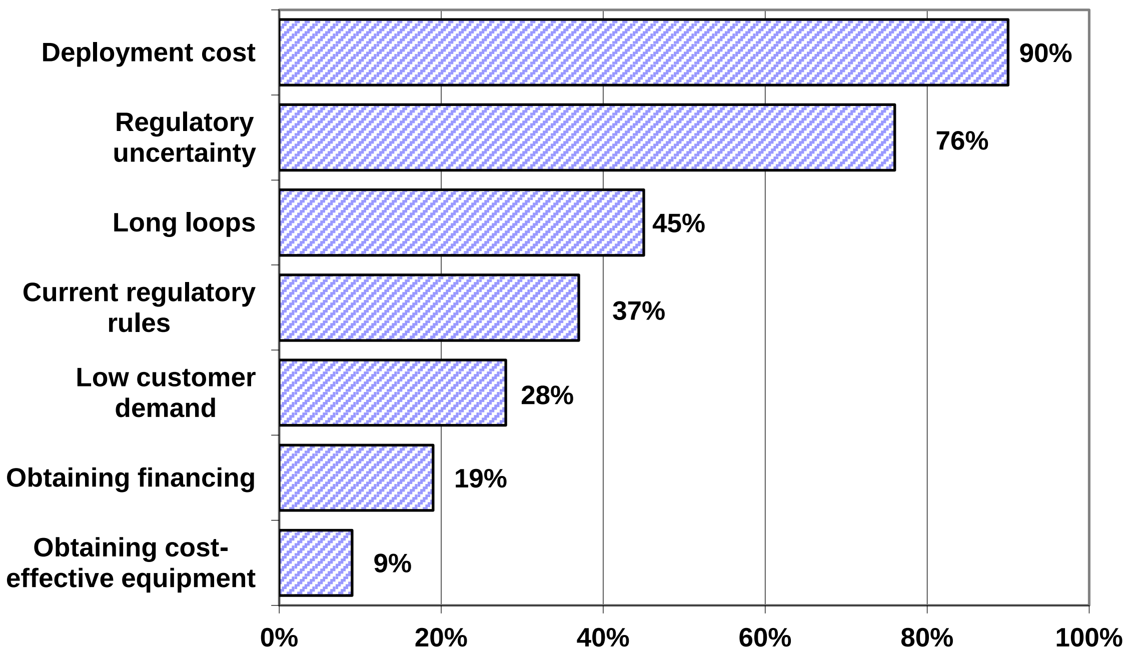
Thirty-three percent of those survey respondents currently deploying fiber serve at least 50% of their customers using fiber to the home, while 37% serve 20% of their customer base or less.

Survey respondents described their companies' plans to deploy fiber to the node (FTTN) and fiber to the home (FTTH) to their customers. Fifty-three percent of those survey respondents with a fiber deployment strategy expect to offer fiber to the node to more than 75% of their customers by the end of 2015. Sixty-one percent of respondents expect to be able to provide FTTH to at least half of their customers by year-end 2015 (up from 46% last year.)

Ninety percent of survey respondents identified the cost of fiber deployment as a significant barrier to widespread deployment. Regulatory uncertainty was the number two barrier (76%), followed by long loops (45%), current regulatory rules (37%), low customer demand (28%), obtaining financing (19%), and obtaining cost-effective equipment (9%).[10] (See Figure 4.)

[10] Totals exceed 100% as respondents were allowed to select more than one barrier.

Fig. 4: BARRIERS TO FIBER DEPLOYMENT



Other Services

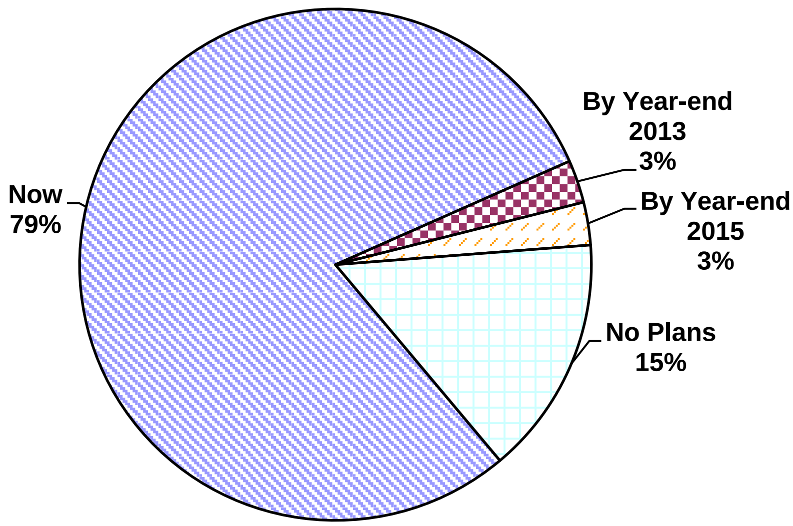
- **VoIP**

Fifteen percent of survey respondents currently offer voice over Internet protocol (VoIP) service to their customers, up from 11% one year ago. Forty-seven percent of those respondents not currently offering VoIP have plans to do so in the foreseeable future, unchanged from last year.

- **Video**

Seventy-nine percent of survey respondents offer video service to their customers. Thirteen percent of those respondents not currently offering video (3% of all respondents) plan to do so by year-end 2013, and another 13% expect to do so by year-end 2015. The remaining 73% of those not currently offering video (15% of all respondents) currently have no plans to offer video service. (See Figure 5.) Half (50%) of those not currently offering video intend to offer Internet protocol television (IPTV) service in the foreseeable future.

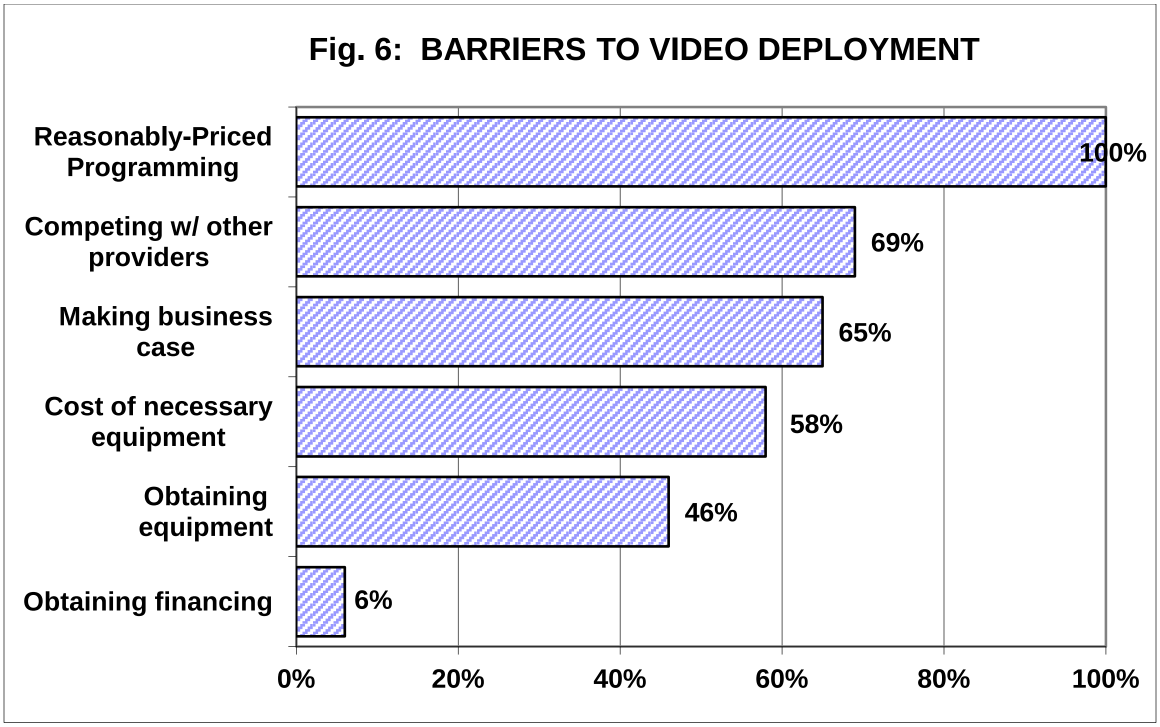
Fig. 5: OFFERING VIDEO SERVICE?



Of those respondents currently offering video services, 76% offer legacy coax (CATV) service, while 55% offer IPTV and 5% offer direct broadcast satellite (DBS).[11] Fifty-eight percent of those providing CATV service use an analog system, while 42% use a digital system. The average respondent offers their customers three "tiers" of entertainment television packages from which to choose, down from four last year.

The main barrier facing those survey respondents providing video service is access to reasonably-priced programming, as cited by 100% of survey respondents. Sixty-nine percent cited difficulty competing with other providers, 65% the challenge of making a business case for video service, 58% the cost of necessary equipment, 46% difficulty obtaining necessary equipment, and 6% difficulty obtaining necessary financing. (See Fig. 6.)

[11] Totals exceed 100% as respondents may offer more than one type of video service.



Miscellaneous

Survey respondents were asked what specific obstacles they have encountered in their efforts to deploy fiber to their customers, and how conditions would need to change to allow them to successfully overcome those obstacles. Their responses are presented in Appendix A of this report.

CONCLUSIONS

Regulatory uncertainty is an increasingly serious problem for rural carriers. Though deployment cost retains its long-held position as the top barrier facing survey respondents, regulatory uncertainty is a strong number two, cited by more than three-quarters (76%) of all respondents, up from 67% last year. More telling are the open-form answers to a question about challenges being faced, presented in Appendix A of this report. It is patently clear from these answers that regulatory uncertainty is a major impediment to providers, and weighs heavily upon their minds. More importantly, the uncertainty is leading to carriers slowing their forward progress by cancelling or postponing planned projects. Paradoxically, this is the exact opposite of the intent of the proposed reforms that are the source of the lion's share of uncertainty. Until regulations are imposed that allow carriers to plan their future with some degree of certainty, the telecommunications industry in rural America will not be able to realize its full potential.

In spite of the uncertainty, fiber deployment continues to grow at an impressive rate. Seventy-four percent of respondents in this year's survey offer fiber to the home to some portion of their customer base (up from 64% last year), and 48% offer fiber to the node (up from 29%.) A fiber network is absolutely essential for those providers who wish to offer their customers today's state-of-the-art, bandwidth intensive services. A carrier's decision to deploy capital-intensive fiber plant can only be made with some reasonable certainty of ongoing viability and stability.

Access to fairly-priced video content is a universal impediment for survey respondents. As video increasingly becomes a "must have" service, the stakes become even higher for small carriers trying to negotiate fair prices for video content. Every single respondent to this survey---100%--cited obtaining access to reasonably-priced content an impediment to their provision of video services. The ability to obtain fairly-priced video content will be critical for rural providers' ability to survive and compete.

NTCA THE RURAL BROADBAND ASSOCIATION

APPENDIX A

Q: What specific obstacles have you encountered in your efforts to deploy fiber to your customers, and how would conditions need to change to allow you to successfully overcome those obstacles?

[My company's] major obstacle is the availability of money to fund the deployment of FTTH in a reasonable time frame. We applied to RUS for a loan to cover our FTTH project about two years ago and are struggling through the process (still no approval/rejection decision). RUS' major concerns are the reduced revenues and uncertainty that result from the FCC's 2011 access reform order. Once the funds are available we could be 100% FTTH within three years.

High cost, low density service area. We need predictable, sufficient and specific USF support.

It all comes down to predictable future recovery. How are we to invest with such a volatile, unknown future they have thrown at us?

The changes in revenue sources (i.e., USF and ICC) make the future too uncertain to spend additional monies on deploying Fiber-to-the-Home (FTTH).

We have installed fiber to about half our customers in [a particular town.] We are waiting for the right financial time. So much is in flux with our revenues right now with the government that we are in a hold pattern until things are more certain.

Our biggest obstacle is cash flow. We currently have a loan with CoBank that will not be paid off until 2018 or so. Management has decided that with the uncertainty created with all of the changes at the FCC, along with our state PUC, all future construction will be funded with cash on hand. They do not want to run the risk taking on additional debt not knowing if the funds will be there in the future to pay off the debt. This has significantly reduced the number of construction projects that we can undertake and has pushed back other projects' start dates.

As we deploy fiber deeper into our network, customer density continues to become more of an issue. The number of customers that we can reach with a mile of fiber continues to go down as we get deeper into our network. Unfortunately, the risk of not being able to recover the cost of these customers is beginning to outweigh the reward of getting them on our fiber network.

My brief answer for the CLEC: Insufficient return on investment (not enough return for rural CLEC's to become very aggressive with fiber deployments). My ILEC answer is: Concerns about future return on investment (in lieu of reasonable and stable subsidy system).

We started our fiber to the home deployment in 2005 in a staged rollout. We did the in-town customer in 2005/2006, then started our rural deployment in a two phase project starting in 2008 and finishing phase two construction in 2009, with final customer cutover to the new

FTTH being completed in 2011. We used RUS financing in all three projects with no issues. Our story has been one of success and no real problems. We have now started to venture outside of our LEC area with a redundant fiber route that has given us access to new business opportunities on the non-regulated side of the business and this is also turning into a success.

A broadband based versus landline based recovery system. We still require a landline for any customer who wants to subscribe to Internet and likely turn away customers every day who do not want to pay for a landline. Unfortunately, the NECA tariff is not conducive to offering a naked DSL product. In order to make the investment in fiber deployments there must be some sort of recovery based upon broadband usage or broadband customers. Cash flow – the large up-front investment makes cash flow tight.

First part response: Dollars and Sense and not Dollars and Cents would be my answer. It takes a lot of $$$$$ to do a project such as FTTH or FTTN. It also has to make sense to do for your company. If switching and access revenues go away it makes it very hard to do projects such as this. Second part response: Continued support from USF, financing with low interest rates and funding from RUS, population growth not dwindling population, video service from programmers without 10-20% increase each year. Customers willing to pay for the bandwidth they are using in their home and not a one rate for whatever they want to use. Being able to compete with our local/state networks to provide backhaul opportunities to other carriers or big businesses. With all of this I can do a better job of attracting new and small businesses to my communities I serve.

Lack of affordable middle mile transport (currently satellite only) eliminates the need for fiber distribution network. Copper is sufficient. Need fiber middle mile to change economics.

[My company] spent $4m putting in a FTTN system about 5yrs ago. We offer DSL at a variety of speeds and currently meet the FFC's numbers. Out of 1200 customers – only 5 take the 10 MB package and none are taking anything faster. Although my response to "what is your 5 year plan?" is "we're built out" I'm told this will not suffice. With the competition of two 4G choices, satellite and a Motorola canopy system in place in our area, a fiber to the home plant would still face competition and I fear would bankrupt us. Our FFTN build will take 15 years to get a return on investment and FTTH would add at least another 20 (if we don't lose any customers.) And the massive increases in TV programming costs are making video no longer a viable product. We will probably start putting interduct in ground anyway but my customers just won't spend anything more than they are now. I would be ahead to just lower my price and not do anything than take on heavy debt. They are ditching cable and Dish to watch Netflix, though, so my mind might change soon.

Our obstacle is financing, and a predictable return on investment would be the solution to overcome this.

Clearly cost of construction and implementation is the biggest issue. Cost recovery mechanisms like Universal Service or government grants are necessary for widespread FTTH deployment in rural areas. Competitive rate structure requirements for content providers would provide substantial cost relief in the video offering capabilities of provider companies. Elimination of penetration requirements would be the mother ship of reducing costs.

Uncertainty over USF funding and a dearth of revenue streams for broadband services makes it difficult to forecast revenues in the future that will allow for more long term business planning and capital expenditures. The FCC has made a decision, and in my opinion the correct one, that access revenues will be phased out over time due to declining minutes and technology changes that allow for voice services to simply be an application on the broadband network. However, what they fail to understand is that without replacing this revenue stream with a comparable one on the broadband network compromises the long term viability of these networks. Just like with traditional long distance voice service, it was understood that all parties who receive financial compensation for use of the network have an obligation to fund an appropriate share of that network for everyone's benefit. The fact that there is no consideration of broadening the base for users of broadband services (i.e. benefactors such as fee based websites) who use the broadband network for financial benefit have an obligation to pay for an appropriate share of that network as well. If all users of the broadband network who receive financial benefit fund the network, it will be more robust and provide for lower retail prices that will lead to more ubiquitous adoption and use by the general public.

There are several obstacles [my company] is encountering: 1.Sparsely populated area; 2. Cost to provide fiber; 3. Keeping services affordable in a limited income area; and 4.Recovery of expense to provide fiber. Conditions that would need to change: 1. Support from FCC/NECA/etc. to recover cost; 2. Majority of our subscriber base wanting higher broadband speeds; 3. Support to keep monthly services affordable.

It's pretty simple for us. The issues are the overall high cost to install fiber to very sparsely populated areas, and having a viable funding mechanism that would give us anything close to a viable ROI for that investment.

Enormous costs associated with materials, construction, and installation. We need more long-term certainty about revenue streams impacted by USF/ICC reform.

Obstacles are primarily construction costs and limited universal service funding. CAF funding for rate-of-return carriers focused on speed goals comparable to urban areas is needed to overcome this obstacle.

The FCC has hampered [my company's] ability to provide fiber to the home/business because of the ICC/USF Reform Order. [We] filed a Petition for Waiver with the FCC which is pending a decision from them since June, 2012. Providing fiber to our customers would be part of [our] long range plan absent the Order.

To make a long answer short; under present circumstances, it is cost and lack of funds that prevent [my company] from deploying fiber to all our customers. A remedy to this situation would be for the FCC to grant its waiver to [my company] so that it can meet the FCC's objective of deploying broadband to a larger percentage of its customer base.

The biggest obstacle is the continued uncertainty coming from the FCC. We have the need to deploy fiber because our copper plant is 40 years old. We have an RUS loan to fund the project. But I can't determine if we can actually pay the loan back.

Cost recovery in order to repay loans.

PROVIDING WORLD-CLASS BROADBAND:

THE FUTURE OF WIRELESS AND WIRELINE BROADBAND TECHNOLOGIES

Rural Telecom Educational Series

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"And we should stretch beyond 100 megabits. The U.S. should lead the world in ultra-high-speed broadband testbeds as fast, or faster, than anywhere in the world. In the global race to the top, this will help ensure that America has the infrastructure to host the boldest innovations that can be imagined."

FCC Chairman Julius Genachowski
NARUC Conference, Washington, DC
February 16, 2009

PROVIDING WORLD-CLASS BROADBAND:

THE FUTURE OF WIRELESS AND WIRELINE BROADBAND TECHNOLOGIES

I. INTRODUCTION

It has been said that "the broadband of today is the narrowband of tomorrow." Less than 10 years ago, a 56 kbps modem was the most common method for accessing the Internet. Today, consumers are demanding 10 to 20 Mbps, or higher. Many experts agree that customers will want 100 Mbps broadband access within the next five years and 1 Gbps within the next 10 to 15 years.

Both wireless and wireline broadband access networks are used by consumers predominantly to access the global Internet. Companies that have historically been known as cable television companies, telephone companies, and cellular companies are in the process of remaking themselves into broadband companies. The goal of these broadband companies is to provide their customers with the best connection possible to enable faster Internet access and advanced services—many of which have not been invented yet.

It is difficult to overestimate the importance of broadband access to the United States' future. Broadband is becoming the lifeblood of our very economy. The Economist stated:

> "In eras past, economic success depended on creating networks that could shift people, merchandise and electric power as efficiently and as widely as possible. Today's equivalent is broadband: the high-speed internet service that has become as vital a tool for producers and distributors of goods as it is for people plugging into all the social and cultural opportunities offered by the web. Easy access to cheap, fast internet services has become a facilitator of economic growth and a measure of economic performance."[1]

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[1] The Economist, Broadband Access, January 17, 2008.

Technology advances have allowed broadband service providers new methods for providing broadband to their customers and provided significant improvements in broadband speeds. Both wireless and wireline broadband providers have benefited from technology advances, however the best *wireline* broadband technologies have historically been capable of broadband speeds that are 10 or 20 times faster than the best wireless broadband technologies. Rysavy Research stated it this way:

> "Given that the inherent capacity of one fiber optical link exceeds the entire available radio frequency (RF) spectrum, data flow over wireless links will never represent more than a small percentage of the total global communications traffic."[2]

Both wireless and wireline broadband services play important roles in the lives of most consumers and one will never displace the other. Most consumers will require the greater broadband speeds provided by a wireline provider when at home or work and need the mobility provided by the wireless provider, albeit at a slower speed. Rysavy Research also recognized that while wireless and wireline technologies sometimes compete, they are complementary in most cases.[3]

Deployment costs also vary greatly from one broadband technology to another. Some of the broadband access methods leverage existing infrastructures, while next generation broadband technologies often rely on the deployment of new infrastructures and significant investments by the broadband service provider.

This paper explores the most common methods for deploying broadband to customers along with each of their advantages and disadvantages. The broadband access methods discussed in the following pages include:

Wireless Broadband Options

- 4th Generation Wireless Broadband
  - WiMAX
  - LTE (Long Term Evolution)
- Satellite Broadband

Wireline Broadband Options

- DSL (Digital Subscriber Line)
- Cable Modems
- FTTP (Fiber-to-the-Premises)

It should be noted that there are other broadband technologies available, such as Broadband over Powerline (BPL), another wireline broadband option, and municipal Wi-Fi, another wireless broadband option. We have chosen not to address these technologies, since they are not widely deployed and many implementations have proved to have significant financial or technical challenges.

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[2] Rysavy Research, EDGE, HSPA, and LTE Broadband Innovation, 3G Americas, pg. 5, September 2008.

[3] Ibid., pg. 5.

II. BROADBAND CAPABILITY OVERVIEW

(TABLE 1) As consumer appetite for more bandwidth increases, broadband networks will be required to deliver more bandwidth per user. More bandwidth allows for the delivery of new and exciting applications to consumers.

Most consumers will require a wireless and wireline broadband network connection to meet their broadband needs. The wireline broadband connection is required to provide adequate bandwidth for the rich multimedia experience consumers expect in their home or business and a wireless broadband connection is required to meet their bandwidth intensive mobile requirements.

There are many ways a wireless or wireline broadband provider can deliver their broadband connection to their customers. The various methods for deploying broadband differ in cost and quality. The quality of a broadband connection is determined by four basic metrics. These are:

- the connection's speed (size of the "pipe")
- the connection's latency (delay)
- the connection's jitter (variation in packet delay)
- the service reliability

In order for consumers to realize all the benefits of broadband, they must have high quality broadband connections that meet their needs today and in the future. From the service provider's perspective, it is important that the networks they deploy today can be easily scalable to meet the broadband needs of tomorrow without a significant additional investment. Deploying broadband in rural areas and areas of low customer density present its own unique challenges. It is not uncommon for the broadband infrastructure of a rural customer to cost up to 10 times more than for an urban customer. Since the replacement costs are so high in rural areas, it becomes more crucial that the infrastructure deployed be easily upgraded to meet the customer's rapidly increasing broadband needs of the future.

> "Bandwidth-intensive applications could very quickly become the norm in the U.S.—even in rural areas. Technologies that cannot be upgraded easily could make Internet applications less than five years from now look like the dial-up downloads of today."[4]

TABLE 1: BROADBAND SPEEDS AND CONNECTIONS

Upstream and Downstream Speeds	Applications
500 kbps – 1 Mbps	Voice over IP, texting, basic e-mail, Web browsing (simple sites) streaming music (caching), low quality video (highly compressed and on a small screen)
1 Mbps – 5 Mbps	Web browsing (complex sites), e-mail (larger size attachments), remote surveillance, Standard Definition (SD) IPTV, file sharing (small/medium), telecommuting (ordinary), streaming music
5 Mbps – 10 Mbps	Telecommuting (converged services), file sharing (large), SD IPTV (multiple channels), High Definition (HD) video downloading, low definition telepresence, gaming (graphical), medical file sharing (basic), remote diagnosis (basic), remote education, building control & management
10 Mbps – 100 Mbps	Telemedicine, educational services, SD and HD IPTV, gaming (complex), telecommuting (high quality video), high quality telepresence, HD surveillance, smart/ intelligent building control
100 Mbps – 1 Gbps	HD telemedicine, multiple educational services, gaming (immersion), remote server services for telecommuting
1 Gbps – 10 Gbps	Research applications, telepresence using uncompressed HD video streams, live event digital cinema streaming, telemedicine remote control of scientific/medical instruments, interactive remote visualization and virtual reality, movement of terabyte datasets, remote supercomputing

Adapted from California Broadband Task Force, January 2008

[4] Federal Communications Commission, *Bringing Broadband to Rural America: Report on a Rural Broadband Strategy*, Michael J. Copps, Acting Chairman, May 22, 2009.

Using history as our guide, one thing is clear—the broadband of today is not adequate as the broadband of tomorrow. Over the last 10 years, consumer demand for broadband has grown even more rapidly than most experts believed it would and there is no end in sight. Even though downstream bandwidth demand is growing at a breakneck speed, upstream bandwidth is growing even faster as user-generated content becomes more widespread.

III. WIRELESS BROADBAND CAPABILITY

Wireless broadband has become a mainstream requirement for consumers. What began with simple text messaging has grown to include Web browsing, file transfer, and streaming video. There are many ways that a wireless broadband provider can deliver a broadband connection to the customer. Each method varies in cost and quality. We begin by exploring the cellular and fixed wireless methods for deploying broadband.

A. CELLULAR AND FIXED WIRELESS BROADBAND

(TABLE 2) There have historically been two distinct groups of wireless carriers. Those that are primarily focused on serving the mobile user, which we will refer to as "cellular" carriers and those that are primarily focused on serving the stationary user, which we will refer to as "fixed" wireless carriers. Normally, fixed wireless carriers can provide greater bandwidth (or throughput) to their customers at the sacrifice of mobility. As depicted in **Figure 1**, both cellular and fixed wireless technologies are converging on what is referred to as a 4th Generation (4G) network—an all-IP network having essentially the throughputs of the fixed wireless carriers along with the mobility of a cellular carrier. There are two dominant wireless technologies that fall under the 4G umbrella today—Mobile-WiMAX and Long Term Evolution (LTE).

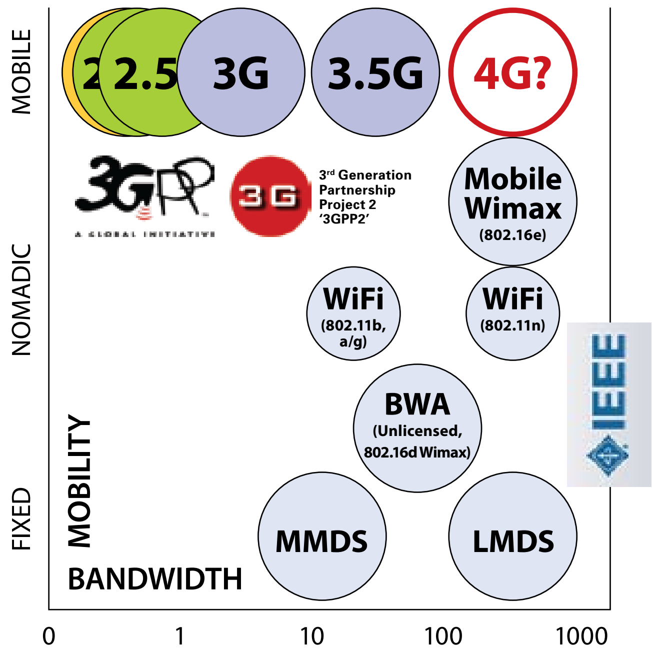


FIGURE 1: CELLULAR AND WLAN CONVERGE ON 4G

The International Telecommunication Union (ITU) has tentatively defined 4G, which it calls "IMT-Advanced," as 1Gbps capability for stationary users and 100 Mbps for mobile users—although a typical end user customer would

TABLE 2: CELLULAR AND FIXED WIRELESS BROADBAND PERFORMANCE SUMMARY

Broadband Capability	• For each wireless access point, such as a tower, the theoretical maximum is 1 Gbps for stationary users and 100 Mbps for mobile users. The bandwidth available is shared among many subscribers, and speeds are dependent upon the number of subscribers sharing the access point. Practical implementations could allow customers to burst up to 10 or 20 Mbps for short periods of time.
Latency/Delay	• Typically low latency
Other Considerations	• Since bandwidth shared among subscribers, available bandwidth per subscriber decreases as density of subscribers increases • Available bandwidth decreases as distance of subscriber from access point increases
Overall Assessment	• Bandwidth typically adequate for limited broadband access, some data, and small screen video

only realize a small fraction of this throughput. The throughput achieved by wireless technologies is dependent upon many factors, including:

- Customer distance from tower—As the distance from the tower increases, the speed of the connection decreases.
- The number of customers sharing the same connection point.
- Available spectrum bandwidth, which is normally licensed by the Federal Communications Commission (FCC)—More spectrum bandwidth means higher connection speeds.
- Frequency of spectrum—Generally, the higher the frequency the shorter the distance.
- Obstacles (trees, hills, buildings, etc.)—Obstacles attenuate wireless signals and can reduce or prohibit broadband.
- Environmental effects—Some operating frequencies are highly susceptible to attenuation due to rain, fog, or snow, which reduces the broadband speed.

Today's two "4G" technologies (Mobile-WiMAX and LTE) can achieve 2.5 bps of actual throughput per Hz of spectrum bandwidth. This means, if a carrier has 10 MHz of spectrum, they could potentially deliver 25 Mbps to their customers. However, wireless technologies share their bandwidth among many customers. For example, if 100 customers were to share 25 Mbps, each would effectively receive 250 kbps if all were using the system at the same time. New technologies are becoming available that could increase the spectral efficiency by a factor of two to four, which experts believe is the limit of spectral efficiency. 4G wireless technologies also provide DSL-like latency (on the order of one-fourth that of 3G technologies), which is also very important for making real-time IP multimedia such as gaming and interactive video possible. As these wireless throughput speeds increase, the wireless carriers increasingly rely on the high capacity fiber optic backhaul available from the wireline providers.

Wireless carriers in the United States rely on spectrum allocated by the FCC in the 700 MHz, 850 MHz (cellular), 2 GHz (PCS and AWS)[5] and 2.5 GHz (BRS/EBS) licensed bands. Many carriers have spectrum in several of these frequency bands. In order to deliver more broadband to their customers, 4G technologies will allow wireless carriers to combine the spectrum in multiple bands to effectively make them appear as a single broadband channel.

B. SATELLITE-BASED INTERNET

(TABLE 3) Satellite broadband is normally delivered to customers using geostationary satellites. Geostationary satellites orbit the earth at the same speed as the earth's rotation, so the satellites appear to be stationary above the earth. In order to do this, they are placed into orbit more than 22,000 miles above the equator. Since the wireless signal must travel so far, satellite broadband services have very high latency and typically are not suitable for the delivery of interactive multimedia services.

To decrease the latency, there have been some efforts to deploy medium and low earth orbiting satellites, where the satellites are only a few hundred miles to a few thousand miles above the earth. At these altitudes, the satellites are orbiting the earth rapidly; many satellites are required to ensure that a subscriber has a satellite in view at all times. When used for broadband delivery purposes, these

TABLE 3: GEOSTATIONARY SATELLITE BROADBAND PERFORMANCE SUMMARY

Broadband Capability	• Shared bandwidth between subscribers • Typical packages of 512kbps to 1.5Mbps for home subscribers
Latency/Delay	• High latency
Other Considerations	• Latency not suitable for interactive applications (such as voice and videoconferencing) • Can be susceptible to rain fade (outages) • Can provide data services to very remote areas that may not be feasible for wireline or other wireless technologies
Overall Assessment	• Bandwidth capacity insufficient to meet long term needs of customers • High latency limits broadband applications

[5] (PCS) Personal Communications Service and (AWS) Advanced Wireless Service – specific spectrum bands defined by the FCC

satellite systems have historically proven to be very complex and expensive to deploy and not an effective method of broadband delivery.

While advancements in satellite technology have increased the amount of bandwidth that can be delivered to customers, the bandwidth is shared among many subscribers. Like other broadband delivery systems that have a shared access network, as the number of customers increase, the available bandwidth per customer decreases.

IV. WIRELINE BROADBAND CAPABILITIES

There are several ways a wireline broadband provider can deploy a broadband connection to their customers.

A. DSL OVER TWISTED PAIR CABLE

(TABLE 4) A telephone company's core service has historically been voice service. Twisted pair copper cable was the cable of choice and telephone companies have deployed millions of miles of twisted pair copper cable in the United States since the days of Alexander Graham Bell. Digital Subscriber Line (DSL) technologies have allowed operators to deliver broadband access to their customers over the existing copper cables. Unfortunately, broadband speeds drop quickly as the length of the twisted pair copper cable is increased due to the physical characteristics of the cable. Delivering broadband over copper cable is like water in a leaky hose—as the hose gets longer, more water leaks out along the way and less water makes it to the end of the hose.

To reduce the copper cable length and increase broadband speeds, service providers have been moving their electronics closer to the customer and connecting these electronics back to the central office using fiber optic cable. **Figure 2** shows the basic network elements for a DSL deployment. As shown, DSL networks are normally divided into serving areas where the subscribers near the central office (normally within one to three miles) are served directly from the central office and the remaining subscribers are served from remote field terminals. The size of the serving area is dependent on the type of DSL technology being used and the customer bandwidth required.

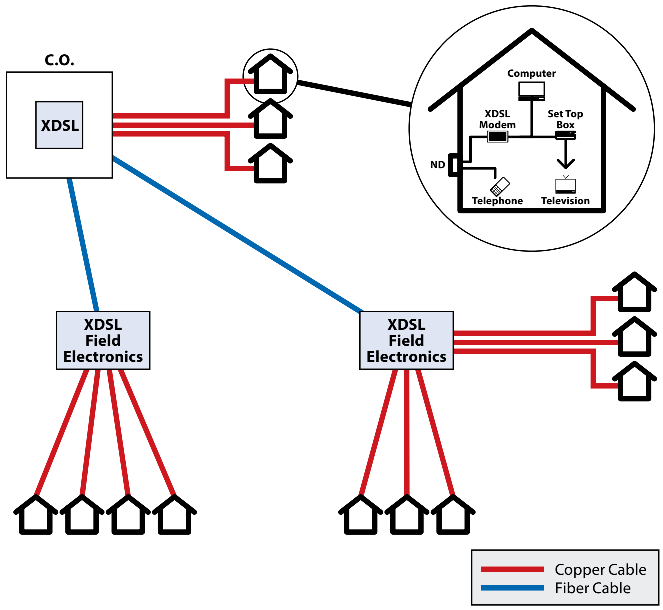


FIGURE 2: DSL NETWORK TOPOLOGY

The most common DSL technologies are Asymmetrical Digital Subscriber Line (ADSL) and Very-high-bit-rate Digital Subscriber Line (VDSL). The latest variants of these

TABLE 4: DSL OVER TWISTED PAIR BROADBAND PERFORMANCE SUMMARY

Broadband Capability	• Typically 10 to 20 Mbps for customers close to the connection point, usually more urban; could be 1 Mbps or lower for customers far from the connection point, usually more rural. • Realistic maximum: 50 Mbps over very short loops (up to 3,000 feet).
Latency/Delay	• Low latency
Other Considerations	• Attainable data rates dependent on age and quality of plant • Mature technology; few further advancements expected • Can leverage existing telco twisted pair plant • Susceptible to electrical interference
Overall Assessment	• Bandwidth capacity insufficient to meet long term customer needs

technologies are ADSL2+ and VDSL2. These technologies have been defined and standardized by the ITU-T.[6]

The latest advances in DSL have improved broadband speeds at very short copper cable lengths (less than one mile). Many rural networks are designed to have copper lengths of up to 18,000 feet. On average at these lengths, only 1 to 2 Mbps per customer is usually possible over good quality copper cable. A comparison of the data rates of the various DSL technologies is shown in **Figure 3**.

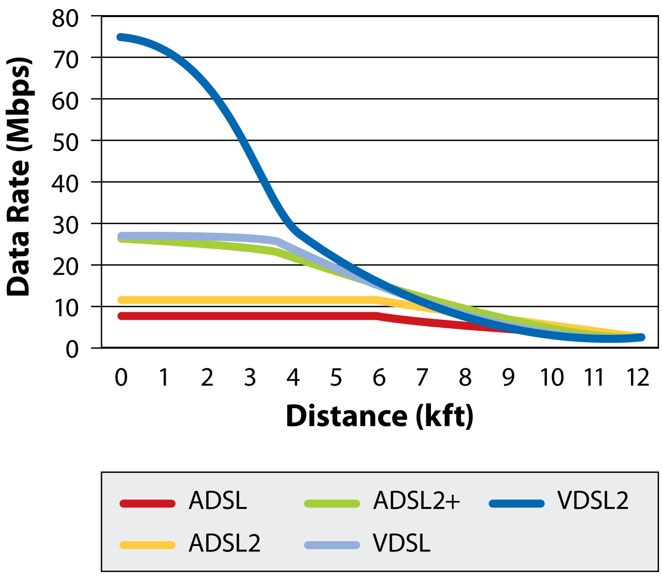


FIGURE 3: DATA RATES VS. DISTANCE

Over the past 15 years, DSL has been an effective technology for deploying broadband over existing twisted pair cable, but has been hampered by several significant limitations, such as distance, compatibility issues, the need for many field electronics, electrical interference problems, and a relatively modest broadband capability. Most service providers have realized that DSL has not been a long-term solution for broadband delivery, but it has allowed providers to deploy fiber optic cable closer to the customer and prepare for a more broadband capable network.

B. DOCSIS VIA COAX CABLE

(TABLE 5) A cable television (CATV) company's core service has historically been broadcast video. Coaxial (coax) cable was used to deliver video to their customers. The CATV industry has implemented standards called Data Over Cable Service Interface Specification (DOCSIS), which define how the coax network can be used to deliver broadband services

TABLE 5: DOCSIS OVER COAX BROADBAND PERFORMANCE SUMMARY

Broadband Capability	• Up to 160 Mbps downstream (shared among group of subscribers) with DOCSIS 3.0 • Up to 120 Mbps upstream (shared among group of subscribers) with DOCSIS 3.0
Latency/Delay	• Low latency
Other Considerations	• Increasing bandwidth requires the deployment of many fiber-fed electronics • Many systems require substantial upgrades to meet delivery requirements
Overall Assessment	• Upstream bandwidth limitations will be significant as bandwidth demands become more symmetric • Broadband capacity shared, so speeds reduce as more customers are added to the network

[6] International Telecommunication Union (ITU) – Telecommunication Standardization Sector

to customers. The capacity available on the coax cable must be allocated between video and broadband and shared by hundreds of customers that share this cable. This architecture worked well for broadcast video services, since it was a "one-to-many" service, but has limitations when delivering other services such as broadband where each customer requires a own unique connection.

DOCSIS provides the capability to give customers their own "virtual" connection across the shared coax cable by putting data on the cable at frequencies that are normally used by video channels. There are three basic methods a CATV provider can use to increase bandwidth to their customers on a coax network: 1) reduce the coax cable length to increase the available bandwidth, 2) reduce the number of customers sharing the bandwidth on each cable, and 3) implement the bonding of multiple channels together.

Figure 4 shows a modern coaxial cable system that can deliver video, high-speed data and voice services. These systems are two-way capable (downstream and upstream), and utilize fiber nodes with coax distribution to the subscriber. When used for broadcast video deployment, a fiber node can serve hundreds, or even thousands, of customers. As broadband demands increase, additional fiber nodes must be deployed closer to the customer and often serve less than 200 customers each.

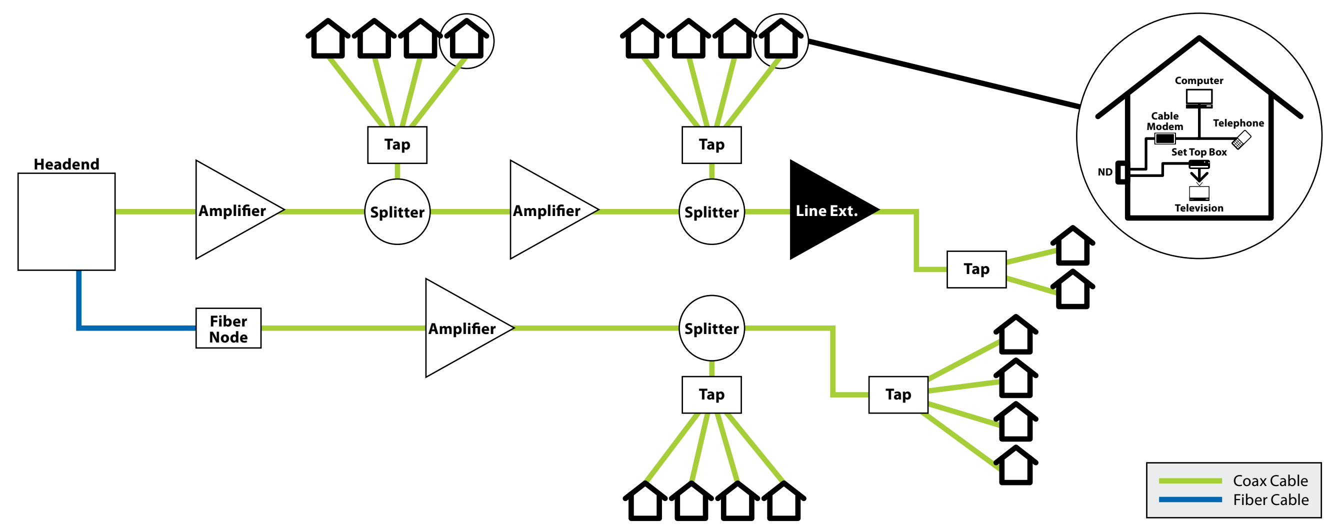
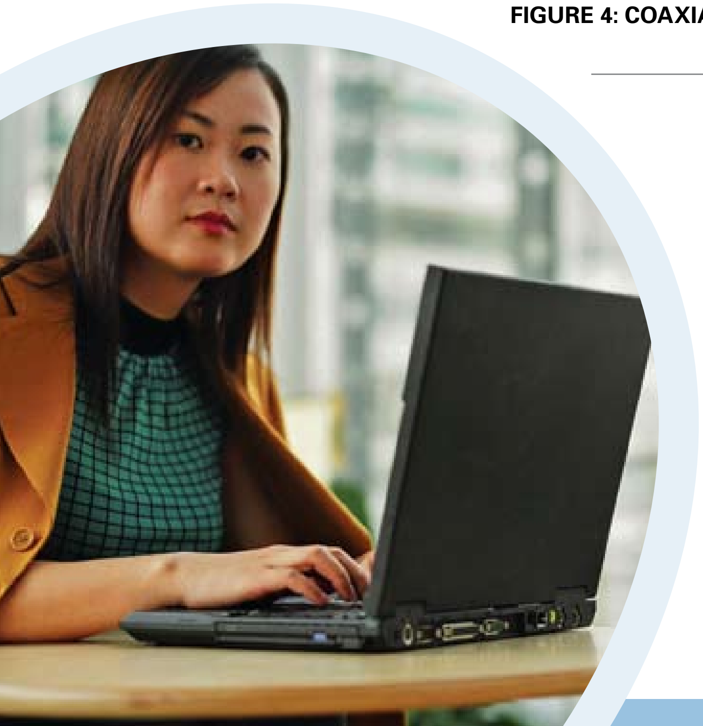


FIGURE 4: COAXIAL CABLE ACCESS NETWORK



"Building world-class broadband that connects all Americans is our generation's great infrastructure challenge."

FCC Chairman Julius Genachowski
NARUC Conference, Washington, DC
February 16, 2009

Figure 5 is a depiction of a typical coaxial cable system's channel usage. As shown, this signal on the coax cable is divided into 6 MHz segments. Analog video channels each take 6 MHz of bandwidth. As illustrated in Figure 5, a number of digital video channels can also be placed within the same bandwidth as one analog channel. The bandwidth from 0 to 54 MHz is normally reserved for upstream data (from the subscriber to the provider) and above 54 MHz is shared by video and downstream data (from the provider to the customer). It is important to note that CATV networks share bandwidth among many customers in the access network and have significant limitations in their upstream bandwidth.

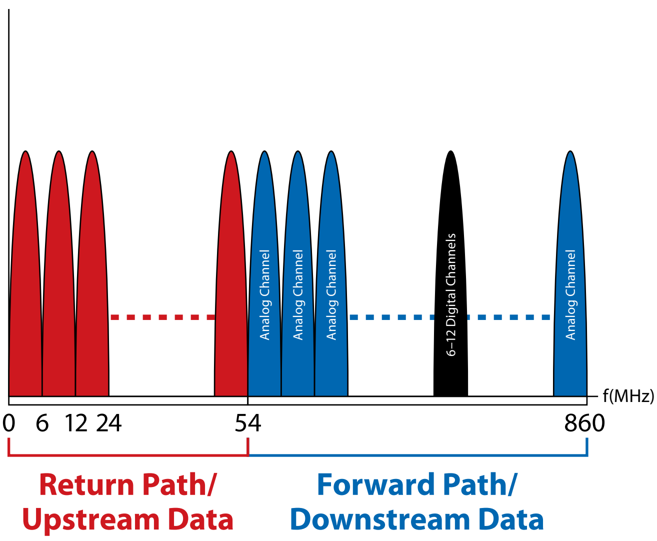


FIGURE 5: CATV SPECTRUM

In a DOCSIS configuration, several hundred users share the downstream and upstream data channels. The latest version of the DOCSIS specification is version 3.0. With DOCSIS 3.0, the 6 MHz channels can be bonded together (called a bonding group) to provide up to 160Mbps downstream and 120 Mbps upstream per bonding group. All the subscribers that are assigned to that particular bonding group share this bandwidth.

C. FIBER OPTIC CABLE TO THE PREMISES

(TABLE 6) Fiber optic cable has been used by service providers for more than 30 years to build high bandwidth (high throughput) networks, primarily for long-haul transport routes. In the last decade, fiber optic cables have been used to increase bandwidth in the customer access network as well. No other technology can deliver as much bandwidth to the customer as fiber-to-the-premises (FTTP) technologies. FTTP is sometimes referred to as fiber-to-the-home (FTTH). Fiber optics has the ability to deliver greater bandwidth over a much larger distance than other technologies. In addition, the bandwidth does not decrease as the cable length increases. Each new generation of FTTP electronics allows the service provider to offer significantly more bandwidth over greater distances. There is no end in sight as to the amount of bandwidth that is possible over fiber cables. Today, there are two main competing FTTP technologies: Gigabit-capable Passive Optical Network (GPON) and Active Ethernet. Vendors are now making Wavelength Division Multiplexing Passive Optical Network (WDM-PON), which promises even greater bandwidth to the customer. Each FTTP technology will be discussed briefly below.

Most GPON implementations use optical splitters to serve up to 32 subscribers using a single fiber from the central office. GPON technology is defined by ITU standards and currently allows for 2.4 Gbps downstream and 1.2 Gbps upstream, which is shared by the 16 or 32 customers on the same PON. Under a "worst-case" scenario where all customers are

TABLE 6: FIBER BROADBAND PERFORMANCE SUMMARY

Broadband Capability	• GPON: 75 Mbps or more; 300 Mbps planned • Active Ethernet: 1 Gbps symmetrical; 10 Gbps symmetrical planned
Latency/Delay	• Low latency
Other Considerations	• Bandwidth is not limited by distance from central office • Not susceptible to electrical interference • Dramatic increases in bandwidth are possible by changing the relatively inexpensive electronics without any outside plant cable changes.
Overall Assessment	• Provides more bandwidth than other technologies; significant bandwidth increases planned

demanding maximum bandwidth, each customer could be limited to 75 Mbps downstream and 37.5 Mbps upstream—still a respectable amount of bandwidth by today's standards. Future advancements of GPON are expected to provide a four-fold increase in bandwidth (10 Gbps downstream) and be called 10GPON. A typical PON system is shown in **Figure 6**.

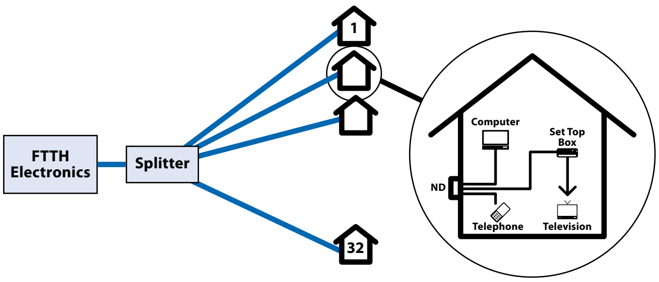


FIGURE 6: PON SYSTEM

Active Ethernet systems use a dedicated fiber between the central office and the customer, so the bandwidth consumption of one customer does not affect the amount of bandwidth available for other customers. In addition, Active Ethernet systems are symmetrical in that the downstream and upstream rates are the same. Today, most Active Ethernet systems can provide up to 1 Gbps to each subscriber—more than 10 times the bandwidth available on a GPON system. Active Ethernet has not been as widely deployed as GPON systems in the United States, since it is typically more expensive to deploy. As subscriber bandwidth demands continue to increase, Active Ethernet systems are becoming more common. A diagram showing an Active Ethernet system is shown in **Figure 7**.

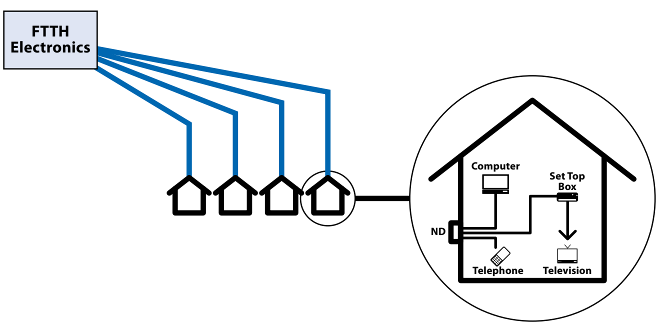


FIGURE 7: ACTIVE ETHERNET

Wavelength Division Multiplexing Passive Optical Network (WDM-PON) technologies have similarities with both GPON and Active Ethernet. Like GPON, a single fiber cable can serve multiple customers, and like Active Ethernet, each customer can have their own dedicated wavelength on the fiber. In some implementations, a small number of customers on a PON share a wavelength. Adding wavelengths on a PON network has the effect of multiplying the effective bandwidth to the customer. A WDM-PON system is depicted in **Figure 8**.

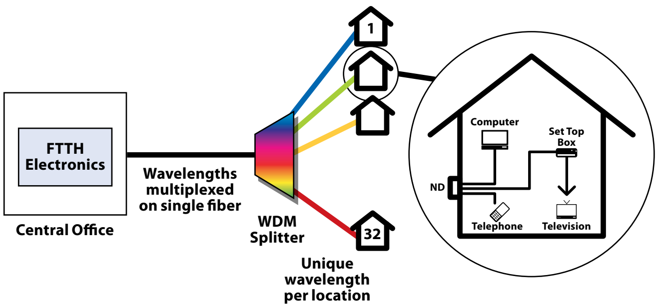


FIGURE 8: WDM-PON SYSTEM

There are currently no standards for WDM-PON. Because of the lack of standards, most vendors have not spent much time and effort in product development. Once WDM-PON is standardized and user demands increase, it may become a more popular technology for broadband deployment. WDM-PON is an example of how advancements in electronics technology can leverage an existing fiber network to provide almost limitless bandwidth potential.

V. BROADBAND DEPLOYMENT COSTS

The investment required to deploy broadband is driven by many factors. Although some of these factors are similar when comparing wireless and wireline technologies, some are very different. There are two basic measures of broadband economics:

- Broadband deployment cost per customer for a given broadband speed—This measure is useful when comparing the costs associated with different types of broadband technologies. The broadband speed assumed for the comparison is normally selected based on an established minimum broadband speed.

- Broadband deployment cost per megabit per second (Mbps) delivered to the customer—This measure is useful when determining which broadband technology is the most cost-effective to deploy. If the broadband network can easily be upgraded for more bandwidth as customer demands continue to increase, less future investment will be required.

The cost to deploy broadband can vary dramatically from one location to another. It is difficult to detail the cost of deploying broadband technology, since there are many complex factors to consider when determining the cost. We attempt to generalize the costs in the following paragraphs.

A. WIRELESS COST DRIVERS

A large portion of a wireless broadband network is the tower, tower electronics, and backhaul. Wireless broadband can be more cost effectively deployed in areas where each tower can serve a large number of customers, such as the more populated urban areas. Some of the more significant cost drivers for wireless deployments which result in increased cost include:

- Customer density
  - Low customer density—In rural areas, there are very few customers over which to spread the infrastructure costs. This results in a higher cost per customer.
  - High density—A high number of customers can overload wireless capacity and degrade service. This can be corrected through sectorization or the addition of more towers to reduce the size of the cell sites.
- Uneven terrain or obstacles—Wireless radio frequency (RF) signals used for broadband access are "line of sight." Mountains, hills, valleys, buildings, and trees interfere with the propagation of the wireless signal. These terrain issues and obstacles can mean that some customers cannot receive the broadband signal or that additional towers (and investment) are required.
- Atmospheric conditions—Temperature, time of day, humidity, and precipitation can all affect radio propagation characteristics.
- Land and right of way issues—New tower construction becomes more difficult and costly where land prices are high and where rights of way (ROW) is expensive. ROW costs increase with strict local environmental regulations, local zoning issues, protected plants or animals, or areas of historical significance.
- Frequency spectrum—Generally, more towers are required to cover an area when higher frequency bands are used. 700 MHz has a greater reach than PCS and AWS, which are located around 1,700 to 2,100 MHz. Also, the cost for spectrum acquisition can be a significant factor in the costs.

Typical material and labor costs for rural construction of a wireless infrastructure, excluding the core switching and data network, include:

- Tower (300 foot): $180K–$200K
- Land costs: $10K–$35K
- Tower electronics and antenna: $25K–$40K
- Customer premises equipment (fixed): $200–$600 per customer location

In a wireless broadband network, it is not uncommon for a tower with electronics to cost $230K to $240K. At first glance, it appears the electronics costs are small in comparison to the tower costs. However, the electronics will likely need to be replaced four or five times over a 30-year period, so with time, the electronics costs can equal or exceed the cost of the tower. In addition there are spectrum acquisition costs, backhaul costs,[7] core network costs, and interconnection costs with other carriers. Under very good conditions, a wireless broadband system may provide service up to 12 miles from the tower when using 700 MHz

[7] It should be noted that a landline fiber network will be required to provide the broadband backhaul capacity needed by the wireless network.

and normally six to eight miles when using AWS or PCS spectrum. A tower could provide service to several thousand customers in a more densely populated area, but less than 100 customers in some of the more remote rural areas.

B. WIRELINE COST DRIVERS

The largest portion of a wireline broadband network is the cable infrastructure. Wireline broadband can be more cost effectively deployed in areas where a short section of installed cable can serve a large number of customers, such as more populated urban areas. Some of the more significant cost drivers for wireline deployments, resulting in increased cost, include:

- Lower customer density—In rural areas, there are very few customers over which to spread the infrastructure costs, translating to a higher cost per customer.
- Difficult construction corridors—For buried plant, unfavorable soil conditions, such as rocks, lava flows, as well as lakes, rivers, forested areas, railroad crossings, and other challenging corridors, make construction difficult.
- Land and right of way issues—Cable construction becomes more difficult and costly where land prices are high and where ROW is expensive. ROW costs increase with strict local environmental regulations, protected plants or animals, or areas of historical significance.

- Labor and fuel costs—Cable construction is labor intensive and relies on the use and transportation of large equipment. Typically, 60%-80% of the construction costs are labor-related rather than the cable material costs.

Typical material and labor costs for rural construction of a FTTP infrastructure, excluding core network costs, include:

- Typical fiber cable construction (rural): $7k–$50k per mile or $5k–$25k per customer location
- Typical fiber cable construction (town): $10–$30 per foot or $2.5k per customer location[8]
- Central office and customer premises electronics: $500–$750 per customer location

In addition there are transport costs, switching costs, and interconnection costs with other carriers. A FTTP network is typically designed to reach customers that are up to 12 miles from the electronics, but technology exists to allow reaching customers 20 or more miles from the electronics location.

C. WIRELESS VS. WIRELINE COST OBSERVATIONS

Often, the initial capital expenditure for a wireless network is less than the capital expenditure for a FTTP network. However, it is important to note the following:

- A lion's share of the FTTP investment is the cable, which with a 30-year life, compared to the wireless infrastructure, has a greater portion of the investment associated with faster depreciating infrastructure. When replacement costs are included over a 30-year life, the cost savings for a wireless network is significantly reduced or eliminated.
- The amount of bandwidth per customer is significantly greater for a FTTP network when compared to a wireless network. Using the technologies available today, the bandwidth delivered to a customer can be more than 100 times greater than what is possible over a wireless network under similar conditions. The bandwidth advantage for FTTP will increase significantly in the coming years due to technology advances with the electronics.

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8 Town construction is normally much more expensive per foot than rural construction due to the additional expenses associated with easement and rights of way, increased labor due to placing the cable under streets and driveways, constructing around existing utilities, and the additional splicing required. Also, access to the cable is more frequent, resulting in more handholes, manholes, and pedestals.

When the costs are calculated for a 30-year period, the investment required for FTTP and a 4G wireless network are not significantly different. It should be remembered, however, that wireless and wireline broadband technologies should not be considered competing technologies as most customers will require both.

VI. CONCLUSION

(TABLE 7) World-class broadband is essential for the United States to effectively compete in the global economy. Consumers will require a landline broadband service to satisfy their high bandwidth needs, such as entertainment video, graphic intensive gaming, and cloud computing. They will also require a mobile broadband service for limited video and mobile communications including e-mail, messaging, and social networking. Because of fundamental limitations in the radio spectrum, wireless broadband has practical capacity limits and will not be able to provide enough throughput to serve the broadband needs of all consumers.

Over the next few years, the major wireless carriers will migrate their networks to 4G, at least in the more densely populated areas. One factor in determining the bandwidth available over these 4G networks is the broadband capacity of the landline carrier providing the backhaul. The 4G wireless towers require high capacity connections, typically using Ethernet delivered over a landline carrier's fiber network.

Most consumers will require both a fixed and mobile broadband connection for the unique benefits each can provide. To meet the ultra-high-speed broadband needs of their customers, landline carriers must continue to deploy fiber closer to their customers—with the ultimate goal of eliminating the copper cables from their network entirely in favor of fiber. To meet the mobile broadband needs of their customers, the wireless carriers must continue to upgrade their networks to 4G technologies. The investment on the part of the wireless and wireline carriers to achieve this will be large, but the cost of failing will be even larger.

TABLE 7: BROADBAND PERFORMANCE SUMMARY

Average Broadband Speeds (Per User)	Applications	Wireline			Wireless		
		Twisted-Pair Copper	Coax	Fiber	4G Fixed	4G Mobile (Cellular)	Satellite
Low Speed Broadband (<1Mbps)	VoIP, basic email and simple web browsing	Excellent	Excellent	Excellent	Excellent	Excellent	Poor (latency)
Medium Speed Broadband (1Mbps to 10Mbps)	Basic telecommuting, file sharing, SD IPTV, basic interactive video, basic remote education	Very Good	Excellent	Excellent	Very Good	Good	Poor (latency and bandwidth)
High Speed Broadband (10Mbps to 100Mbps)	Telemedicine, complex remote education, high quality telecommuting, HD IPTV, advanced interactive video	Good	Good	Excellent	Poor	Poor	N/A
Ultra High Speed Broadband (> 100Mbps)	Research application, HD telepresence, virtual realities, remote supercomputing	Poor	Poor	Excellent	N/A	N/A	N/A

Foundation for Rural Service

The Foundation for Rural Service, in cooperation with the National Telecommunications Cooperative Association, seeks to sustain and enhance the quality of life throughout Rural America by advancing an understanding of rural telecommunications issues.

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RURAL EDUCATION

AND THE ROLE OF BROADBAND

Rural Telecom Educational Series

RURAL EDUCATION
AND THE ROLE OF BROADBAND

"Education is all a matter of building bridges."

– Ralph Ellison

HISTORY TEACHERS WOULD AGREE that to understand our present, we must look to the past. A brief timeline of the nation's education system reveals that early Americans home-schooled their children, with wealthier families hiring private tutors. By the 1600s, the first public schools opened. These were primarily located in cities, and although attendance was not mandatory, the schools were only open to boys. The 1700s saw the proliferation of free schools that welcomed poor boys and orphans. By the 1800s, girls were allowed in the classroom, and there were one-room schoolhouses dotting the rural landscape. By 1918, laws were on the books making elementary school compulsory for all American children. In 1954, the Supreme Court ruled that public schools must be open to children of all races.

This paper was produced by the Foundation for Rural Service, sponsored by the Rural Telephone Finance Cooperative, and written by Rachel Brown. Rachel Brown is a freelance writer/researcher/copy editor with more than 20 years of experience working in the telecommunications industry.

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IN EACH CENTURY, the American people saw the value and need for education; and at each turn, they sought to make it as inclusive and as accessible as possible. Fast forward to the 21st century and there would seemingly be no more hurdles to overcome. The U.S. National Center for Education Statistics reports that there are nearly 99,000 public schools serving 55.5 million boys and girls. But education experts point to an inequity faced by rural schools—the lack of broadband technology to deliver high-speed Internet access.

According to a survey conducted by the Federal Communications Commission (FCC), 20% of rural schools report that broadband is not available in their area; only 38% of rural schools have fiber optic connections (versus 46% of urban schools); 37% of rural respondents say installation costs are a barrier, while only 27% of urban districts cited cost of installation as a barrier; and less than a third of all of rural schools have average speeds greater than 10 megabytes per second (Mbps) (compared to 41% of urban schools).

"There is an inequity there—there is a digital divide," said Aimee Howley, senior associate dean in the College of Education at Ohio University. "All schools are enhanced with broadband. It ought to be a tool that is available to rural schools just as it is a tool that is available to urban schools."

Rural schools often focus on oral history lessons, Howley noted. "They send students out into the community with digital voice recorders to interview older people; they then take this audio tape back so they can transcribe it and write their reports," she explained, adding that technology also allows rural students to do in-the-field projects. "They might visit a watershed and take water samples, evaluate them and plug that data into handhelds. That goes back to a central database for analysis."

Despite these two rural-specific examples, Howley said that, for the most part, rural schools use their broadband connections to do the same sorts of things as suburban and urban schools: expand their curriculum through online classes and incorporate online components with traditional classroom teaching; offer teacher collaboration and training; and conduct online testing for student progress and analysis.

Noelle Ellerson—assistant director of policy analysis and advocacy for the American Association of School Administrators (AASA), a professional organization for education leaders and an advocacy group for public education—did not disagree that most schools use their broadband connections in the same ways, but she pointed out that broadband has a greater impact on rural schools and students. "If an urban school is offering an advancement placement [AP] course in trigonometry, that's likely one option among many AP math classes for an urban student," she cited as an example. "In a rural school, that may be the first AP course that's ever been offered. Rural schools often lack the enrollment or don't have the teachers to make it worth offering these types of courses. Broadband represents a more unique opportunity to a rural student."

Alex Morrison—vice president of business partnerships for Discovery Education, a digital content provider for grades K-12 and community colleges—agreed that students who attend small, rural schools often do not have the same academic opportunities as students who go to suburban or urban schools. "Broadband allows rural schools to offer supplemental courses—maybe even learn Mandarin from a professor in China, or advanced science courses from a university professor hundreds or thousands of miles away" he said. "Sometimes community colleges offer these types of courses, but the nearest one may be 400 miles away."

Defining "Rural"

ru*ral (roor'el), adjective [from the Latin *ruris* the country]
1. of or characteristic of the country (as distinguished from cities or towns), country life or country people; rustic: opposed to urban. **2.** living in the country. **3.** having to do with farming: agricultural.

Say the word "rural" and it's easy to imagine various scenes that people envision. Some may picture a sleepy hamlet with a steepled church; some may conjure up rugged mountains and meandering streams; others might think of fields of corn or wheat as far as the eye can see.

Whatever the vision may be, rural policy experts note that rural areas are different across the country, and this translates into different solutions and methods when it comes to broadband delivery and policy. "Rural schools struggle for various reasons," explained John White, deputy assistant secretary for rural outreach for the Department of Education. "In some cases, it's because they're in sparsely populated areas or they're in mountainous areas. In Vermont, there are hilly terrain issues. Out in places like Wyoming, Montana and South Dakota, you're dealing with vast distances. In Alaska, the ground is frozen for most of the year, so it's not possible to bury fiber."

Tim Marema—vice president of the Center for Rural Strategies, a nonprofit organization—noted that there are pockets of the country where geography and poverty conspire to make broadband access more difficult. "Any area of the country that combines rural and poor will have trouble," he said, citing central Appalachia, Indian country and frontier counties (very sparsely populated counties) as three particularly hard hit areas. "The reaction among Washington lawmakers is often: 'Well, these people need to move. What are you doing living out there? You need to move to the big city.' That cannot be the mindset."

Noelle Ellerson—assistant director of policy analysis and advocacy for the American Association of School Administrators (AASA), a professional organization for education leaders and an advocacy group for public education—agreed. "Rural doesn't have to mean remote when it comes to education," she said, arguing that a child in a rural school should have the same connectivity as a child in an urban school. "Rural can be modern. It doesn't have to mean that everyone there is 5 to 10 years behind the rest of the country."

Bob Wise—former governor of West Virginia and president of the Alliance for Excellent Education, a national policy and advocacy organization—noted that the country's education policy should be to offer rural students the same level of connectivity and coursework as urban and suburban students. "Broadband will preserve our rural schools more than any other initiative," he said. "Broadband solves equality issues when it comes to geography."

Another area of inequity that comes to mind for AASA's Ellerson is the Obama administration's goal to have online standardized testing at every public school. "We are nowhere near meeting that requirement because in some areas, basic connectivity is lacking; and that means that schools will be precluded from online assessments," she said, explaining that rural schools can resort to paper and pencil testing, but they won't get the benefit of immediate comparisons and assessments. "It comes down to rural students being a little bit behind and not having the same access that urban and suburban schools have."

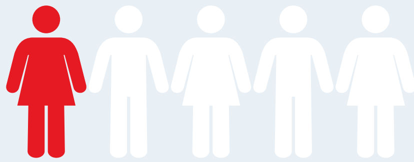
Tim Marema—vice president of the Center for Rural Strategies, a nonprofit organization—noted that inequities in education hurt rural students and the nation as a whole. "Americans believe that opportunity and hard work are the essential ingredients to building a better life," he said. "Rural students are among that group of Americans who face obstacles and can be left out of these opportunities. It perpetuates itself generationally and within regions, and it holds everyone back."

UNDERSTANDING THE DEMOGRAPHIC

A snapshot of the rural student population confirms Marema's assertions. According to the Rural School and Community Trust, a nonprofit advocacy organization, students who attend rural schools make up one-fifth of all public school children. "That's 11 million K–12 children," said Robert Mahaffey, director of communications and marketing for the Rural Trust, adding that while the adult rural population is declining, the number of rural children is growing." One in four rural students is a child of color, and 40% of rural kids live at or below the poverty line."

Mahaffey agreed with the other education experts that all schools use broadband for distance learning, AP offerings and whiteboards in classrooms. "But in high-poverty, low-populated areas, the schools are much more reliant on these technologies to enrich the curriculum," he said, pointing out that wireless technology is not the solution. "Even with wireless, we still need towers; we still need fiber.

1 IN 5



SCHOOL CHILDREN ARE IN RURAL AMERICA

Building that infrastructure is more costly in rural areas because the cost per customer is so much higher. That's why rural telecommunications companies are so crucial."

John White, deputy assistant secretary for rural outreach for the Department of Education, noted that he's seen many successful partnerships between rural schools and small telephone companies and co-operatives. "Some of the larger telecommunications companies won't even go into a region because of the lack of the customer base," he said. "For that reason alone, small utilities play an important role."

White also pointed out that while many rural schools have some form of Internet access, it's often outdated and insufficient. "A lot of schools of have DSL or T1 lines, but fiber is more robust and allows for higher speed and greater bandwidth," he said, explaining that education applications are typically rich in video and audio. "These require enormous bandwidth."

The demand for bandwidth will only increase in time, White added. "The challenge going forward is making sure that schools have fiber connections because this allows for high-speed Internet access," he said.

FUNDING FACTS

While the nation does face a challenge in this area, White said he's optimistic that the country is moving in the right direction, adding that the United States Department of Agriculture is making a great deal of progress in terms of getting funding and resources to bring Internet connections to rural schools.

Education and rural policy experts don't discredit these federal agencies' efforts, but they point out that the federal government only spends 8 to 10% of its budget on education. "The rest comes from state and local taxes, and many rural areas don't have the population or property values to bring in the taxes needed to adequately support the schools," said Mahaffey.

Adding to this disparity is the nature of public funding formulas. Under the Title 1 (of the Education and Secondary Education Act), the Department of Education allocates funding for low-income school districts, but these federal dollars are concentrated around larger population centers. "The way education funding works is that poor rural students receive less funding than poor urban pupils," Mahaffey explained. "The reality is that low concentrations of poverty are just in as much need as high poverty areas."

Flipping the Classroom

Perhaps one of the most innovative educational developments to spring from the availability of broadband is a new method of teaching termed "flipping the classroom." The "flip" is that instead of a teacher introducing a lesson or new concept and then assigning students homework, students are introduced to the concept at home via video or another interactive technology and then they use their classroom time to do their homework with instructor supervision.

Educational experts peg the origins of this new model of teaching to around 2007 because that's when it became possible to add audio and video files to PowerPoint presentations and share them online; it was also the beginning of YouTube.

This style of teaching is beneficial to teachers and students, said Matt Monjan, vice president of educational partnerships with Discovery Education, a digital content provider for grades K–12 and community colleges. "Rather than the teacher standing in front of the class and giving a lecture, now he or she can walk around and facilitate and mentor and work with students to make sure they are getting the concept," he said. "It's a much more efficient use of their time."

From the students' perspective, it allows them to have a more interactive, interesting learning experience, Monjan said. "Modern-day kids are wired differently," he said. "They are born ready to multitask. They like interacting with technology and different media; they like collaborating with their peers and working one-on-one with the teacher; they want to create their own stuff. The flipped model allows for all of that."

The flipped classroom model also helps prepare students for their future jobs, whatever those may be, Monjan said. "Looking ahead, we have no idea what type of new jobs may be out there," he said, adding that Facebook wasn't around 10 years ago. "How do you teach a workforce when you don't even know what those jobs might be?"

The answer to that riddle is to teach the skills, Monjan said. "You teach them how to use technology; you teach collaboration so students learn how to connect with others," he said. "Very likely in future jobs, they'll have to connect with others outside their home states and even outside the country."

"What I most like about having Internet in my school is being able to study and do research reports on the computers in the library. Many of my classes use the Internet on a regular basis to teach or review. It's allowed us to learn without having to carry around so many heavy textbooks."

—Krysten Ayers, junior at Moorefield High School
Hardy County, W.Va.

Wise pointed out that a one-time infusion of federal dollars is not the answer. "That capital investment is important, but with technology, you must constantly upgrade it," he said. "Rural schools that got Internet connectivity 5 or 10 years ago are now running at speeds that the average home gets. Even a school running on 100 Mbps right now, in three to four years, that likely won't suffice. There's an insatiable demand for broadband."

AASA's Ellerson agreed that it's necessary to do regular, ongoing upgrades, adding that there's often a disconnect on this at the state and local levels. "Most people have a cell phone plan or pay for their Internet or TV on a monthly basis, but they don't think about the fact that schools also have to pay those bills every month," she said. "It's an important expense to consider and build around."

Another key funding issue to consider is flexibility. "Many state and local budgets are hard pressed, but when they do allocate funding, it should be as flexible as possible to meet the common goals," Ellerson said. "In urban schools, they might use those funds to have better interconnectivity within the school itself. In rural districts, they might need those funds to pay for the final mile."

THREE STRAIGHT-A EXAMPLES

Despite the steep logistical and economical hurdles involved in bringing broadband to rural schools, many of the nation's small telephone companies and cooperatives are stepping up to that challenge.

In Lost River, W.Va., Hardy Telecommunications Inc., a telecommunications cooperative, first began bringing area schools online in 1999. "By 2008, we were providing Internet service to six schools; by 2011, all of them were on fiber networks," explained Derek Barr, marketing and human resources director, adding that the co-op also was able to deliver a fiber network to a local community college in 2010. "This has allowed the students access to courses they'd never get. It has given them whiteboards in the classrooms."

More than that, broadband has opened up doors to the students, Barr said. "In a city, students might study a historical event and then pop down to a museum or go visit a landmark," he said. "Rural students never get that opportunity, but they can take a video tour."

Barr pointed out that most of the co-op's employees have children in the local school system. "This is part of our mission," he said. "We are involved and want to help the schools."

Talk to other telco and co-op executives and they express the same sentiment. Tom Maroney—chief executive officer of Halstad Telephone Co. in Halstad, Minn.—said his two children (now both in college) came up through the local schools. "When they were in high school, they both took college courses online," he said, pointing out that small schools cannot afford specialized teachers. "You can't have a teacher for two kids. It just doesn't work that way."

The schools in his part of rural Minnesota are indeed small. "In some cases, we're talking about 150 kids in a K–12 school," Maroney said, adding that Halstad started building fiber networks to the area schools six years ago, and also connected the University of Minnesota. "We've got fiber to all six school buildings and made it possible for them to have inter-building communications also."

Maroney noted that Halstad is part of the Northwest Minnesota Special Access, a network formed in 1997 composed of 18 local exchange carriers in the state. Together, they provide the transport network for Internet and video services to participating schools and libraries, serving a customer base of approximately 90,000 users. "It's important to be able to work with neighboring companies because it's a joint effort to get this accomplished," he said. "The big boys don't have these relationships, but we're looking toward the future."

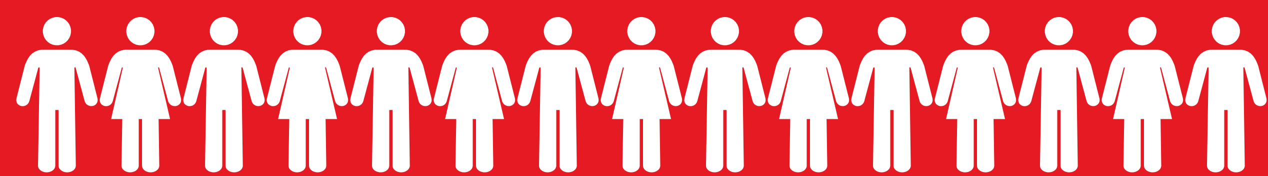
Hardy's Barr agreed that rural providers have a different mindset. "The big players don't even want to come here," he said. "We have such a small population; and with them, everything is dollars and cents. Why build a network out here, when you could make more money by just offering another service to the urban customers?"

Michael Burrow—vice president and general counsel at NineStar Connect (Greenfield, Ind.), which is a merged company between a telecommunications co-op and an electric co-op—said his motto and one that his company shares is: A rising tide lifts all ships. "We are a community-based company," he said, noting that the telephone side of NineStar has served Hancock County for more than 100 years. "We believe that the more we do to raise the quality of life in our community, the more we will prosper as a company. This is not AT&T's business model. They are looking at customer density and maximum profit for shareholders, so there's no investment in the community."

NineStar's investment in its community is extensive. The co-op started building new fiber networks in 2001; by 2006, it started converting its copper lines to fiber. Eventually, this led to NineStar building fiber networks to cover all four school districts and delivering broadband services to more than 25 school buildings, with all of them interconnected.

THE POPULATION OF RURAL CHILDREN IS **ON THE RISE**

Overall, public school enrollment on a national level has increased by 1% in the past few years



but enrollment in rural public schools has **risen by 15%.**

While these school districts experienced the same sort of educational benefits as the other rural schools with broadband, Burrow said he was most surprised by how the schools were able to use their fiber networks to save money on their day-to-day operational expenses. “When the schools first wanted Internet access, they had to use T1s,” he said. “This only provided 1.5 Mbps, and each one cost $600 to $700 a month. A high school alone needed three or four T1s, so it wasn’t uncommon for a school district to be paying as much as $10,000 to $20,000 a month just for Internet service.”

Now, with a fiber network and a centralized Ethernet connection, the schools are able to purchase more bandwidth at a lower price; and they can parcel it out to the different school buildings on an as-needed basis, Burrow explained. “They’re now paying $1,000 to $1,200 a month, and the rate is 20 to 25 Mbps,” he said. “That’s a real cost savings.”

The Indiana schools have also saved money on their regular landline telephone systems. “Each district needed 70 to 80 phone lines for administrators, secretaries, athletic directors; but now the Ethernet connection can provide phone service, so the total cost has gone down,” Burrow said, adding that the schools’ IT and maintenance personnel have also benefitted from broadband. “They use the fiber network for security monitoring, and they’ve got sensors on heating and cooling systems. That means no one’s driving out to each school to check on boilers. Instead, there can be alarms sent to a monitor on someone’s desk.”

In addition, the teachers in Hancock County no longer have to make the 30- to 40-minute drive to Indianapolis to take their continuing education courses necessary to maintain their teaching licenses, Burrow noted. “Before, they had to be reimbursed for mileage. It was disruptive and costly,” he said. “Now, they can take these courses online thanks to broadband.”

HOMEWORK MEANS BROADBAND AT HOME

As critical as it is to have broadband at school, rural education and policy experts note that it’s just as important to have it at home. “The lack of connectivity at home prevents learning,” Marema asserted. “It’s almost the same as denying student textbooks—it’s that essential now.”

The Trust’s Mahaffey agreed that rural students need broadband services not just at schools and libraries but at home as well. “Department of Education Secretary Arne Duncan said that students need their online learning environment to be available to them 24/7,” he said, adding that it allows greater collaboration amongst students. “Kids can meet in groups at a park and sit around a laptop and study together.”

Going Digital

In the very near future, nearly one of out every five textbooks sold will be digital, according to Edudemic, an education technology site to connect teachers, administrators, and students. Not only do these literally take the burden off students’ backpacks, digital textbooks are also an appealing offering because they typically cost 53 percent less than new print books. Going forward, e-texts will focus less on the printed word and instead build multimedia experiences around particular concepts. Features will include interactive quizzes, animated content, educational games, and online study groups.

Students who have broadband at home can do research and even read digital textbooks, explained Discovery Education’s Morrison.

Those students who don’t have broadband at home often have to stay after school to complete their homework because some of it may have an online component to it or there may be online participation or testing, Marema said. “It’s an extra hurdle for kids who already have enough hurdles,” he said, adding that lack of home connectivity is a problem for teachers as well. “A community college professor had to record all of her grades online. She struggled for hours with her dial-up connection at home, and then it timed out, and she lost all of her work.”

Talk to the local telco and co-op executives about the importance of broadband at home and they echo the sentiments of the education experts. “Internet connection at home is important because learning is not just from 8 to 3,” Halstad’s Maroney said, adding that 70% of his company’s customers have broadband service. “But it’s available to all of them.”

Burrow added that Ninestar is working hard to build fiber to the home in all of its school districts. “The demand is there and so much of it is student driven,” he said. “We hope to soon have broadband to 85% of our students and in the next few years, make it virtually 100%.”

Hardy Telecommunications has similar goals for broadband delivery to the home. “For students, they can hear about something at school and expand on it at home,” Barr said. “It’s possible to find anything on the Internet.”

While these are all impressive endeavors, the local telecommunications executives are quick to give credit and thanks for a host of funding mechanisms—everything from the FCC’s Universal Service Fund (USF: a program that makes telecommunications services more affordable to residential and commercial users in rural and remote areas) and E-Rate program (the public school and libraries arm of USF) to the federal stimulus funds, and to grants from private charitable foundations.

“The high-speed Internet has provided me with what I call a better toolbar. By that, I mean can have several websites going at once without the fear of it freezing up or loading super slow. That helps me compare many sources of information to see if it’s applicable to my assignment or to find the most correct answer to my questions.”

—Josh Ograbisz, freshman at Moorefield High School, Hardy County, W.Va.

Broadband Delivers Music Lessons

Robert Lacey—a young music teacher at Valley High School [student population: 121 in grades 7–12] in Orderville, Utah—is helping to bring after-school music lessons to all 18 of his orchestra students. Typically, students who play classical string instruments—such as the violin, viola, cello, and/or bass—take private lessons to supplement their music class instruction.

"Because this is such a rural area, the nearest private instructors are an hour and a half drive away," Lacey explained, adding that the three-hour round trip did not include the cost of the lesson (anywhere from $50 to $100).

Solving this problem of time and money and travel came to Lacey when he was working to complete his own master's degree. "My music professor had to discontinue our lessons because he was moving to Maine," he explained. They decided to continue their lessons online via Skype. "Granted, you don't have the hands-on element, but it's still an effective lesson."

As technology improved in terms of latency and lag times, Lacey said he soon realized that this could be a solution for his own students. "We paired the high school students with college music students from Brigham Young University, so the college students deliver half-hour to 45-minute music lessons online," he said, explaining that a grant from the Foundation for Rural Service helped to get the program started by providing a small income to the college students. "This helps the college kids, but it also means there's no cost to the high school students."

The high school students can take their lessons at home if they have broadband at home, Lacey said. "Or they can find a Wi-Fi connection nearby or use their smartphone if they have a 4G connection or stay after school and use the connection here," he said. "This allows our students to have the same level of instruction; the technology makes it possible."

In rural areas, the schools are the heartbeat of the community, Mahaffey with the Rural Trust said. "By connecting to the schools, you are connecting to the community."

The Rural Trust's Mahaffey doesn't dispute that funding is important, but he said that money alone is not the answer. "The real investment is in terms of community involvement, building relationships and human capital," he said, adding that small telco execs sit on school boards and join their local Parent-Teacher Associations. "In that light, the small telcos and co-ops are indispensable. It's not possible to put a value on their role."

Discovery Education's Morrison agreed that rural telcos support their schools. "They know everybody, and everybody knows them," he said. "They are tied into their communities in a way that the big broadband providers can never be. Half the battle is building the network; the other half is helping the community use it."

Historically, the practice of giving low-interest loans to cooperatives and locally owned small business has worked well, explained Marema with the Center for Rural Strategies, adding that this is just a start. "The government could do more—not just through investments but through policy and regulation changes. Let rural regions try something new. Open it up to innovation."

Rural markets work differently, Marema stated. "If you want rural in the game, you have to accommodate that," he said, adding that the nation needs rural in the game. "To succeed as a country, we can't write off more than a fifth of our young people. When rural America succeeds, the nation as a whole does better."

Former Gov. Wise concurred that it's in our national interests to promote and preserve rural America. "When you flip on a light switch, thank a natural gas provider or a coal miner," he said. "When you go to the grocery store, thank a farmer."

In rural areas, the schools are the heartbeat of the community, Mahaffey with the Rural Trust said. "By connecting to the schools, you are connecting to the community," he said.

BUILDING THE BRIDGE TO OUR FUTURE

To successfully map out our future, we must look to the past, Mahaffey suggested. "Historically, our country has made the commitment and the investment in other infrastructure projects," he said, citing examples like the interstate highway system, rural electrification and the nationwide landline network. "We need that same level of commitment for high-speed Internet—in the schools, in the libraries and at home too."As the country moves further into this century, let's embrace the belief that education is a matter of building bridges—necessary infrastructure that leads all of us into a more successful future.

Foundation for Rural Service

The Foundation for Rural Service is a 501(c)(3) nonprofit organization based in Arlington, Va., that serves rural communities across the United States. Established in 1994 by the National Telecommunications Cooperative Association, their mission is to sustain and enhance the quality of life throughout rural America by advancing an understanding of rural telecommunications issues. FRS educates the public about the benefits of a nationwide telecommunications network and promotes rural connectivity as an essential link in this network. FRS believes that rural communities—regardless of their size or location—deserve the same connection to the world as do residents of urban areas. FRS provides a variety of programs, ranging from youth-based initiatives and educational materials to consumer awareness and rural economic development.

For more information on FRS, go to www.frs.org

RTFC Rural Telephone Finance Cooperative

The Rural Telecom Educational Series is funded by the Rural Telephone Finance Cooperative.

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