High Peaks Education Foundation

Keene New York Town-Wide Broadband Internet Project

Final Report

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Project Co-Directors

November 2010

Project Summary

This report documents a project to bring universal broadband Internet service to a small (about 1000 homes and businesses) rural town in upstate New York. Through a public-private partnership with the locally owned cable company, network infrastructure has been extended to 90% of the homes and businesses. Pulling together funding from a variety of sources, including donations from local seasonal and full-time residents, we were able to refurbish the aging existing coax network and build out into major new areas of Town using fiber-to-the-home technology. The project was organized by the High Peaks Education Foundation (HPEF), a group of local volunteers dedicated to preserving our small public school. A major goal of the project was to put every home with a student, teacher or school staff member on the network and this was achieved. The report explains the history of the project, how it unfolded, and the results that have been accomplished. A detailed project timeline can be found at the back.

Key Facts:

- 90% of all homes and businesses can now get broadband Internet access (97% for year-round residences and businesses); every home with a student or school staff person is connected
- 61% of those now subscribe to some broadband Internet service (75% for full-time residents)
- The local Internet Service Provider (ISP) is financially viable and has sufficient income to fund market grade salaries and future upgrades/maintenance; revenue has grown 84% while costs have grown only 77%
- Service speeds and reliability have increased significantly
- The average cost per mile of installed coax or fiber was $11,500; the average cost per new potential subscriber reached as $1700.
- 42% of the funds needed by this project were raised from private donations

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Goals and Accomplishments

This project began with the vision of universal broadband Internet access. We wanted to make it possible for anyone that wanted to connect to the Internet using a modern, high-speed (i.e. broadband) connection to be able to do so. As the project progressed, we set a specific goal of reaching at least 90% of the homes and businesses in the Town, as some homes at the extreme edges of Town, often off-grid, would be prohibitively expensive to reach. We started with 59% of the Town reached and ended with just over 90%.

Another major goal was to make the ISP, Keene Valley Video and Internet, a sustainable business that the town can rely on in the future. This meant the business had to generate enough money to (1) pay market-rate salaries to the people who work there and (2) pay for ongoing maintenance and upgrades to continue enhancing the speed of the service. When we started the project, the ISP was in serious financial trouble. The network physical plant was deteriorating and KVVI did not have reserves to use to do the necessary refurbishment much less expand the network. They were contemplating shutting down the business and, in fact, had decommissioned a major section of the network. This was one of the things that spurred us to create this project. In the end these two objectives for the business were accomplished by increasing the scale and operating margin of the business.

Our broader goals were:

- Provide a new source of remote network-based employment (telework) for the citizens of the Town. Today, there are a growing number of people who work primarily in their homes. Some new residents have moved to Town, bringing their net-based jobs with them. Even working at home part-time helps reduce the use of fossil fuels and saves people time and money.
- Get every home with a student or a staff member of the Keene Central School (KCS) on the network so that the Internet can be used more broadly in education. It was our view that a student today must have ready access to good Internet from home if they are to master the skills necessary to succeed in college and/or the working world. By fall 2009 we had connected all KCS homes. Today, we see teachers, especially in the higher grades, making much greater use of the Internet.
- We also hoped that the ability to work remotely would enable new families with children to live in Keene and send their children to KCS. One of the oft-cited reasons for the decline in your families living in Town, and hence the decline in enrollment at KCS, is the lack of employment.
- Lastly, we expected the availability of high-speed Internet for people with seasonal homes would allow them to spend more time here (e.g., make four day weekends), thus providing more business for local merchants and restaurants. There is some evidence that this is occurring. In particular, part-time homes are purchasing full-year service, which we take to mean that with Internet service here they apparently expect to visit more frequently and throughout the year.

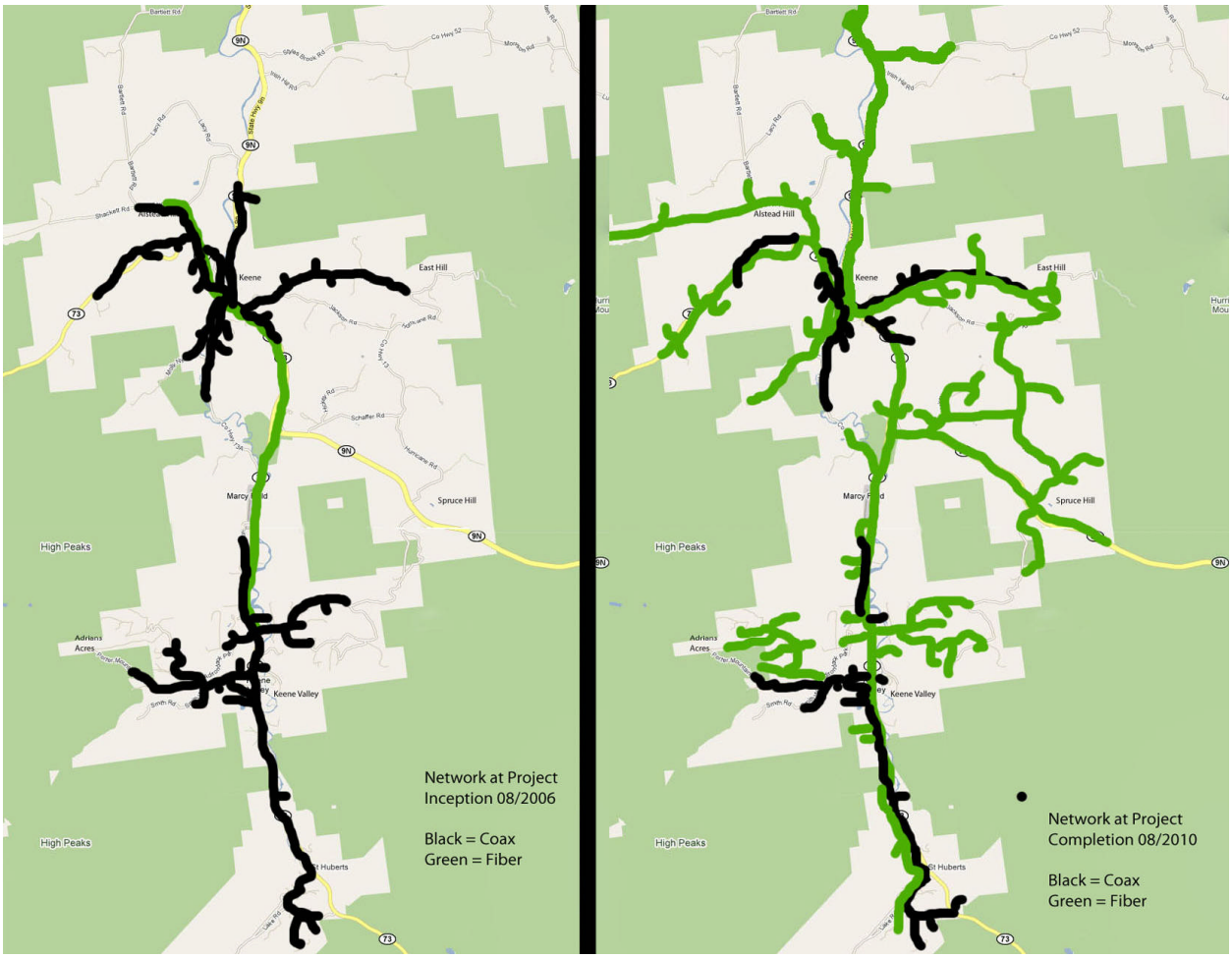
The high levels of adoption by the residents of Keene now that good Internet service is available is proof that the Internet provides great value to people living in a rural environment. This value should increase as people learn more about what they can do over a modern broadband connection.

Situation upon Project Completion

Physical Plant

The network has been expanded by 60% in terms of the number of homes and businesses that can now get high-speed Internet service compared to the number that could 4 years ago. This breaks down into a 26% increase in full-time homes and businesses now reached by the network and a whopping 167% increase in part-time ones. Today, 97% of the full-time homes and businesses in Town can get service and 80% of the part-time ones; overall this means 90% of all potential subscribers can get service. In round numbers, there are a little over 1000 potential subscribers and a little over 900 can be reached now that we have reached an additional 350 homes or businesses. This was our goal and we are pleased that we achieved it.

We did this with a combination of some new coax connections in the parts of town already wired with coax (primarily the hamlets) and new fiber-to-the-home connections for the major parts of the build out to new areas. Today, about 40% of the potential subscribers in town are reached via fiber. But more than 90% of new potential subscribers reached by the build out were reached with fiber connections. The before and after maps below tell the story well.



Who Isn't Served?

At the beginning of the project we ruled out trying to reach any off-grid premises. Our cable plant has to be strung on poles because of our limited funds. Also, by definition, off-grid premises are far away from other potential subscribers.

We generally excluded an area that required a large investment for a very few potential subscribers, unless that area contained a house with a KCS student or staff member. So, for example, we excluded Irish Hill, where there is a very long run, some of it underground, before you get to the five potential seasonal home subscribers. However, we did run fiber all the way to the end of Alstead Hill Lane to reach a business and house with KCS students.

During the project we surveyed potential subscribers to try to ascertain their level of interest and there were areas into which we did not build because there was no interest at the time. Also, if on a street there was a large stretch without houses and then a single house way at the end, we often did not build out to the end. We had to use our funds to connect as many houses as possible. Our usual cutoff was more than 4 poles of cable to a single subscriber.

However, it has been the general trend that more and more people want service, even if they are seasonal. Even people who were adamant in their lack of interest four years ago are now indignant that they cannot get service without personal investment for installation. However, the funds we had are largely spent now and were used primarily to build out to reach the KCS homes.

Still, even those still not connected benefited. Every home in town can be connected to the network using this fiber-optic technology. But the owner(s) will have to invest to extend the network to their doorstep. Without this project, there would not be any chance of them getting broadband service.

Finally, it is important to note that some of the unserved remote homes use satellite or cell-tower based services. In fact, one pocket of seasonal homes was specifically left unserved by fiber because it will soon be reached by service from a new cell tower, which should be sufficient. These homes are in an area without winter access and will never be homes of KCS students.

We do anticipate that some short new extensions will be added from time-to-time but there really is not much left to build.

Connecting to the Rest of the Internet

When we started the project, the entire Town was connected to the rest of the Internet by a 3 Mbs (megabit per second) link and a bank of telephone dial-up lines. These connections were expensive and slow to upgrade when more capacity was needed. The 3 Mbs link was provisioned on standard telco T1 (1.544 Mbs) trunks from Verizon that came in over Cascade Pass from Lake Placid. There was no direct cable telecommunications link to either Elizabethtown in the east or down south out of Keene Valley via Route 73.

It was obvious that if we were going to transition all the dial-up users to broadband and also add a couple hundred new subscribers, then we were going to need more capacity on the link to the Internet.

Also, it was clear that people's use of the Internet was changing: moving from text email to sending lots of photos, using social networking sites like Facebook, and, most recently, downloading movies and TV shows.

An important milestone in the project came when KVVI negotiated a contract with Charter Communications (www.charter.com), the cable company in the next town north, Upper Jay. The deal was that KVVI and Charter would each construct a fiber link to the border between the two towns and it would be used to deliver as much capacity as KVVI was willing to pay for. The price per Mbs was much lower than the previous arrangement and it has continued to go down as the contract has been renewed. With this arrangement KVVI has been able to quickly add more capacity as new users come on and they monitor network traffic levels and add capacity when usage patterns trend upward. In this way they have been able to stay ahead of user demand and yet not buy before the capacity is needed. But the most tangible result of this beneficial arrangement has been that KVVI has been able to keep increasing the speeds delivered to its customers without increasing prices.

During the course of the project, KVVI did succeed in migrating all the dial-up users to other services and was able to completely decommission its phone lines, resulting in significant cost savings.

Internet Services Adoption by Potential Subscribers

Of the full-time homes and businesses that KVVI can reach, about 75% buy cable modem service today. Part-time residents have an adoption rate of about 40% today. The overall adoption rate by homes and businesses that the network now reaches is 61%. Interestingly, more part-time subscribers buy year-round service than buy the seasonal (6 month) offering of KVVI.

Here is the detail on changes in subscriptions from 2006 to 2010.

	# of Subs 2006	# of Subs 2010	% increase
Dial-up	103	0	n/a
Internet-only FT	118	185	57%
Internet-only PT	7	34	386%
TV only FT	183	68	-63%
TV only PT	0	14	n/a
Package FT	75	245	227%
Package PT	15	23	53%
Total subs	506	569	12%
Total subs w/o dialup	398	569	43%

The number of installed cable modems jumped 227% during the course of the project. The total number of customers, including those that only buy TV or that used to buy dial-up service, went up only 12% but if you exclude the old dial-up users, then subscriber counts went up from 398 to 569, a gain of 43%. The total number of subscribers to any kind of Internet service (excluding dial-up) grew from 215

to 487, an increase of 126%. It is this increase in the number of subscribers buying broadband Internet service that makes the business financially stable now.

This adoption rate by residents is well beyond what other projects assessing local access in the Adirondack Park expect – most studies suggest expectations should be in the 30-40% range and work will be needed to push it higher. Our Town's experience has dramatically exceeded this, buy why? We believe three things worked in our favor:

(1) Our project was a grassroots effort, organized and largely paid for by residents,

(2) We worked with a motivated locally-owned ISP that only serves the town, and

(3) The project was centered on our school – specifically connecting (not just reaching) all homes with students or staff of Keene Central School (KCS) to enable KCS to innovate using the net as a tool.

Like most small towns, Keene has strong social networks. Rather than hold training classes, what happened was someone would buy a VoIP phone service, for example, and word would quickly get around that it was great or terrible. Anything that saved money was soon popular and talked about as justification for buying net access. Centering the effort on the school meant the students needed it, and they were often able to demonstrate different uses and value to parents.

Service Upgrades with Stable Pricing

Service price points at the beginning of the project were $60, $80 and $100 per month and these have been maintained.

There was also dial-up service for $19.95 per month – this is no longer offered but former customers were given an opportunity to move to 64kbs cable modem service for $25 per month. This service level, which has been upgraded to 384Kbs, is not available to new subscribers.

The following table shows how the core services have evolved.

	2006 Down link	2006 Up link	2010 Down link	2010 Up link
$25/ month	64kbps	64kbps	384kbps	128kbps
$60/ month	384kbps	256kbps	1meg	256kbps
$80/ month	512kbps	256kbps	2meg	512kbps
$100/ month	n/a	n/a	3meg	1meg

The most common service, priced at $60 per month, has seen the downstream speed increase 2.6x. The middle tier service has seen the downstream speed increase by 3.9x and the upstream by 2x. The price point of the top tier service did not exist in 2006.

While these price points remain expensive relative to an urban service provider, the project has enabled these speed increases while keeping prices stable. We expect service speeds will continue to increase as

low cost bandwidth becomes available to KVVI and head end equipment is upgraded to bring new bandwidth to customers.

Making the ISP/CATV Business Sustainable

One reason the broadband project in Keene was successful is that the ISP is a small locally owned business that only serves the town. It was built (see the project timeline at the end of this document) by a seasonal resident who was in the cable TV business. Most people in town could only get one over-the-air broadcast TV station, at best, so he took it upon himself to build a small CATV system in the town in the 1970s. (CATV stands for Community Antenna TeleVision).

By 2006, the community demands on the business had grown to include internet access which was moving from dial-up to cable modem technology that it only had operating on a small scale. To broadly deploy broadband required investments that were so badly mismatched with the finances of the business that it was ready to close. This would have left the town with no internet access at all. As organizers of the broadband project, we were willing to raise money to rebuild and extend the network, but we also had to be sure that, at the end of the work, the business would become financially viable once again. We define "viable" by these two points:

> The business had to generate enough revenue to pay employees current market-based incomes (historically KVVI's employees were paid substantially below market because the business didn't generate sufficient revenue to pay more).
>
> The business had to generate enough revenue to pay for continuing maintenance and upgrades to the network so it would not find itself in need of being rescued and re-built by the community again in the future.

These two points meant the business had to get larger. Revenues have, in fact, grown by 84%. Costs have grown by 77%. The difference shows up as an operating margin increase from 7 cents/dollar of revenue to 11 cents per dollar of revenue.

The table shows how this has worked out in cents per dollar format comparing 2006 with pro-forma 2010/11 expectations based on the current number of subscribers.

	2006 Cents/Dollar of Revenue	Pro Forma 2010/11 Cents/Dollar of Revenue
Revenue	$1.00	$1.00
Costs		
TV subscriber fees	0.13	0.15
Internet access fees	0.13	0.07
Pole Rent	0.03	0.03
Salaries	0.31	0.32
Utilities (phone/power)	0.03	0.02
Depreciation	0.09	0.12
Operating Margin	0.07	0.11

So how have we done in terms of our two big issues? Salaries to staff can now grow by 88% while increasing it by only one cent per dollar of revenue. The revenue boost from expanding the network to include hundreds of new subscribers has made it possible to pay market rate salaries. Depreciation, which reflects re-investment in the network, can grow by 154% by increasing it to 12 cents per dollar of revenue, up from 9 cents. This will avoid having the business get into a situation where it needs to be rescued again in the future; instead it will be able to upgrade services as internet technology advances.

The single biggest improvement in lowering costs came from internet access fees paid by KVVI that went down from 13 cents/dollar to 7 cents per dollar. In 2006, the business had very high telephone bills supporting banks of modems for the dial-up business and 2 T1's provisioned by Verizon. The dial-up business was a major loser and the service was shut down. The T1's were replaced by a new fiber link constructed to connect to Charter Communications in Upper Jay. These two changes meant KVVI had 10x the bandwidth to support the growth in subscribers and increase speeds of everyone's connections while paying basically what it did for all the phone lines and T1's of 2006. This was the single most important change in the cost structure.

So the business is healthy enough to support itself and maintain the network but it is not so healthy as to afford cheaper prices to subscribers. The operating margin remains a slim 11%. So, for example, a 10% price cut, making a monthly rate go from $60 to $54 would wipe out nearly all the profits.

Physical Characteristics of the Town of Keene

Keene is a town in the heart of the Adirondack Mountains. It is almost 80% protected wilderness. There are three hamlets where there are dense collections of homes and businesses. The rest of the town is a spidery collection of roads that go up the mountain sides in the north-south and east-west axes primarily. There are about 73 miles of roads in total and 80 miles of utility cables. This results in large areas with relatively low density of potential subscribers, which is why the old network was only built in the hamlets.

Because the Town is so hilly, it presents problems for use of wireless technologies, which do not penetrate mountains. The Town is also largely forested and the wireless technologies available at the time did not penetrate leaves and needles well. Even though a cellphone tower has recently been installed in the hamlet of Keene, only a portion of the surrounding area up the hillsides can receive a signal. The same is true for reception of broadcast TV. There are many homes in Town that cannot use satellite TV or satellite-based Internet access because a mountain or hill or forest is in the way of pointing at the satellite. Someday, the new 4G wireless technology that is just beginning to be deployed in large cities may perform better in terms of penetrating tree cover but it still won't go through mountains, so many towers would be required to reach relatively few people.

The long distances involved in the Town's road system also meant that the old coax technology was severely limited in its applicability. Radio signals can be transmitted over only about 1300 feet of coax

before they need to be reamplified. After going through more than 4 amplifiers, the signal is too degraded to be able to transmit data or TV. This means that a coax branch of the network can only run about a mile. One of the great beauties of the fiber-to-the-home (FTTH) technology is that it can run up to 12 miles without any reamplification. There is no home that is further than 12 miles from the network head-end so this technology allows us to reach any home.

Technology Selection

At project inception the existing network was a hybrid fiber-coax (HFC) plant with only a single fiber trunk connecting KVVI's TV receiving antenna farm on Alstead Hill and the coax plant in the hamlet of Keene with the main coax network in the hamlets of Keene Valley and St. Huberts. As mentioned above we concluded that we could not reach as far as we wanted with the coax endpoint technology. In addition, significant portions of the coax plant had degraded and had to be replaced. For the first part of the project, we devoted our effort to rebuilding the existing coax plant, thus improving service quality, increasing network speed, and connecting new subscribers in areas where the network already reached. But to expand the network we knew we needed a different technology.

We looked at various wireless approaches (point-to-point, mesh Wi-Fi and satellite) and concluded that none of them could work with our physical geography. The inherent latency in a satellite service also disqualified it as our main approach. We also made inquiries with Verizon, the local telco, but they were entirely unresponsive. The FTTH technology offered the potential for much higher speed connections than telco DSL systems could offer over the existing copper wire plant in town.

During the spring of 2008, after rebuilding degraded sections of the existing coax plant, we settled on Fiber-to-the-Home (FTTH) from a company called Alloptics (www.alloptic.com) which can work in conjunction with an existing CATV DOCSIS plant. We did our first pilots in early summer of 2008 and they were totally successful. Our timing was excellent as FTTH technology is just reaching mainstream adoption and costs for the components have been falling dramatically in the course of our project. Today, many elements are 10% of the cost they were 2 years ago. The splicing technology is also much simplified and easy for a small operator to handle.

Financing the Project

One role of the High Peaks Education Foundation was to use its 501(c)3 status to raise capital to fund the project. Our starting proposition was that the construction of the extensions was not viable from a business perspective. Specifically, the net income generated by the new subscribers on the extensions would not be sufficient to pay back the cost of their construction. Most cable TV companies will not bring service into areas with a density lower than 20 homes per mile; some will go as low as 15 homes per mile. However the KVVI network has 13 potential subs per mile – clearly not enough to be a viable business according to industry norms.

Our solution to this was to find outside funds to provide the capital to build the extensions, and, with the additional revenue from subscribers in new areas, make KVVI a sustainable business once again.

Sources of Funds

We raised $586,000 from four sources shown in the table below. These sources all brought different benefits and needs to the project.

NY State Economic Development Grant	17%
Private Donations	42%
Private Construction Fees	23%
Keene Valley Video and Internet	19%

The NY State Economic Development Grant was 17% of the funds, the smallest percentage, but nonetheless, a key portion of the money. HPEF applied for the grant with assistance from the office of our NY State Senator, Betty Little. We laid out our plan to raise matching funds and to spend the money at KVVI and via payments to vendors of materials and construction labor. There were people in Keene who did not understand that such grants are routinely given to private business so an official "stamp of approval" by the State clarified the legitimacy of our plan. The State, from its perspective, was encouraged to make the grant because it was already matched by private funds. A public-private partnership is just what the Sate looks for when reviewing economic development grant applications.

Knowing there was "public money" made raising private money easier. Private donations, 42% of the total, came from 116 donors in contributions ranging from $20 to $27,000. About 80% of the total private donations came from 20% of the donors, a common percentage in our community. More importantly, the process of public fundraising sent notice to the community that the issue of broadband was being actively worked. We sent fundraising letters to every single landowner in Keene – the list of taxpayers is available to anyone via our County offices. We wanted everyone to have a way to contribute, no matter how small, and we sought to build some public enthusiasm and buy-in to the project so, when the cable came to your street, people would be ready to hook up to it. The fact that the fund raising was run by HPEF made it tax deductible, which was a benefit expected by major donors.

Private construction fees were paid to KVVI in a couple of situations. One large customer needed to bring fiber several miles to its location and was willing to pay for it. But its tax status meant there no benefit to donating the money to HPEF so it simply paid KVVI for the construction. In another case, the Town was involved in moving a number of telephone poles in the heart of the Keene Valley hamlet and it was paying all the utilities, electric, phone and KVVI to do the work. All new subscribers were charged $300 to install the service and this amount paid for the cable modem and for the Network Interface that is on the outside of each customer's house. Finally, customers with especially long private installations and all customer underground work was done on a fee-for-service basis. The project paid for all the fiber, but subscriber premises underground burial costs and installation of very long runs needed to be paid by customers.

KVVI directly contributed 19% of the capital costs. There were several major cable runs the company built early on with their own hands-on labor. There were also some clear project elements that were

not about building extensions that KVVI paid for, like a back-up power generator, a new head-end equipment room and racks. They also did all the design engineering work along with materials purchasing to keep costs down.

How the Money was Spent

The spending is shown split up by type in the table below. The total spent was $586,000. The whole project split 53% labor and 47% materials.

Mapping Labor	4%
Construction Labor	49%
Outdoor Materials	33%
Head End Equipment	14%
Total	100%

Mapping Labor, 4% of total

The very first thing we spent money on was a set of current, accurate, maps showing all of the existing power, telephone and CATV lines on the entire town. The work was all labor and it came to 4% of the total project. The contractor was Precision Valley Communications of Springfield, VT (www.PVC2.com)

The town has some 73 miles of roads and about 80 miles of utility lines, mostly on poles. We needed to know where every single pole and building was located and the distance between each one. This gave us real engineering level data to work with for the first time so we really knew what we were up against. With this data we could do the design engineering work for a neighborhood, pull together a bill of materials to order and get it on the schedule of construction crews. So, while it looks like a minor amount of money, you can't do anything without such maps. And, no, the power and phone companies will not just give you their maps. This is considered proprietary information by these companies and, these days, there are security issues related to making such maps freely available.

Construction Labor, 49% of total

Construction labor had two equal components.

Half went to work by KVVI to do all the design engineering, ordering and staging of materials as well and indoor work on the head-end equipment room. Splicing and testing was done by KVVI as well.

The other half was paid to a contractor, Eustis Cable (www.eustiscable.com) of Brookfield, VT, a women-owned business. It brought in crews, trucks and equipment to hang cable on poles, which is the bulk of the network. Another contractor was used for underground runs.

Outdoor Materials – 33% of total

In addition to the actual cable, putting it up requires pole hardware, strand wire to attach the cable to, lashing wire and various outdoor enclosures where fibers are spliced together. The prices of all these

components declined dramatically during the project. Outdoor enclosures that used to be made of metal are now made of less expensive plastic. At the time, anything made of metal was getting more expensive, making coaxial cable increasingly unattractive. The Passive Optical Network (PON) system we were building simply did not require some outdoor components like power supplies that are needed in coaxial networks. Some specific components, like splitters, for example, dropped from $90 each to $15 during the project. We benefited from the classic adoption cost curves of a new generation of fiber optics.

Head End Equipment - 14% of total

The main components in the head end are servers, lasers, and the DOCSIS units (Digital Over Cable Service Interface Specification) which are the core electronics employed by cable television operators to provide internet access over their mixed Hybrid Fiber Coax (HFC) cable infrastructure. The first DOCSIS specification (1.0) was released in 1997, version 2.0 in 2001, and version 3.0 in 2006. Version 3 is just now being widely deployed (it takes time for a new specification to be turned into a commonly available product). The fastest deployment of version 3 at the end of 2010 offers 120mbps downstream and 30 megabits upstream to customers in Quebec City. So there is a long path to growing the speed of KVVI's service by changing the head end equipment.

KVVI had been operating entirely with DOCSIS 1.0, typically buying used equipment. KVVI is now moving to DOCSIS 2.0, buying used equipment again as large city networks upgrade to 3.0. This approach, staying one step behind the large city networks, gives KVVI two important advantages. First, used equipment in fine condition costs a fraction of the price of leading edge equipment. Second, KVVI benefits from the fact that more people with technical experience are available to help and the bugs have been worked out of the older electronics. This path forward assures KVVI that it will be able to offer increasing speeds to its customers for a long time by changing head end equipment.

Other head end investments including a new climate controlled equipment room. A generator has been added to keep the head end (and the whole fiber network) operational during power failures.

Spending Metrics

The most common metrics used to evaluate networks like KVVI's are costs per mile of cable/fiber or cost per customer reached. On the cost per mile metric, we did a great job. Even with this, the cost per new potential subscriber reached and the cost per actual new subscriber were expensive, which is why the capital costs had to be funded with grants.

> We spent about $11,500 per mile, on average, to rebuild some old sections and build new extensions. This is far below common estimates of $36,000 per mile. We believe that this was largely the result of extremely cost conscious purchasing, including used head-end equipment, and use of non-union labor. So, on this measure the project was a great success.
>
> We spent about $1700 per new potential subscriber reached. This is where the rural nature of our town shows to be a problem. Anything over $1500 per potential subscriber is high. In an

urban area, a cost per new potential subscriber is typically half of this amount, about $850, and the continuing operating costs will be lower in an urban area.

We spent almost $2150 per actual new subscriber, which is a perfect illustration why no normal commercial venture would build what we have built here in Keene.

We are, of course, pleased how this all worked out. If the cost per mile had been something closer to normal, we probably would not have been able to complete the project.

Building Support for the Project

The original idea for the effort came out of a strategic planning effort for the public school. Through the publication of the School Enhancement Task Force Final Report the idea got good initial exposure. We then solicited explicit resolutions of support from the Board of Education and the Town Board of Supervisors. This all happened in the summer of 2006.

A small group worked through the fall to develop a plan and to estimate costs, etc. We were ready to present our initial findings, conclusions and recommendations to the community by the end of the year and we scheduled the first of what would be three public information sessions during the 2006 break between Christmas and New Years in the hope of catching some part-time residents. We used posters on the wall to summarize the key points and we took small groups of people through them with 15 minutes presentations. These public sessions were very important in building support for the project, communicating the facts and setting expectations.

When the fundraising campaign was in full-swing we sent the proposal and request for donations to every land owner in Town. Although we knew beforehand that in a project of this nature we would receive something close to 80% of our donations from a handful of philanthropists, we felt that getting a broad base of small contributions would help to build a sense of town-wide ownership for the effort and we believe that this has turned out to be true and may partially explain the high adoption rates we have seen.

We also communicated back to donors after each round of fund raising to tell them what we had accomplished so far, how close we had come to our fund raising goals, and what we expected to accomplish going forward. This level of communication allowed us to get a significant number of repeat donations in subsequent rounds.

Good communication to the community and with your donor base is a critical success factor.

Critical Success Factors and Advice for Other Towns

Advice to Other Towns

This project took four years from inception to completion. This is, of course, a very long time with respect to internet technologies. We learned quite a lot as we worked through this, and technologies have changed. With this in mind, we offer the following points to other towns in the Adirondack Park and other rural areas.

- Building community support and good on-going communication is key. This is a slow process. Unless you have a lot of money, this will take a while and you need to keep people informed of the progress being made, even if they cannot see it.
- Get your School Board and Town Board to formally endorse your effort with resolutions of support. You should get pointers from these people to find sources of grants from various agencies and programs. These kinds of resolutions count in the grant process. Pulling together public and private resources will give your grant application a leg up.
- Make the local ISP your partner. You are helping build extensions that will add revenue and scale to their existing operation. Don't get angry with them or think that building something to compete with them is your answer. They already have a lot of what you need to succeed.
- Make the goal of connecting school student homes an anchor cause and draw for funding. Broadband only really works in schools where all students have net access at home. Not including some handful of remote students is not acceptable. Including the needs of other anchor institutions like health care facilities and emergency services locations will also garner support and grant funding.
- New online maps in most states (for New York see http://www.broadbandmap.ny.gov/) now let you enter an address and it will tell you what broadband services are available there. This will help you get a handle on the scope of your challenge. However, soon you will need actual maps of every pole location, distance between them, etc. that provide you with the design engineering data.
- Size the grant to your ISP to pay for the excess cost of construction needed. For example, let's assume your ISP says they will build into a density of 20 homes per mile and it costs $Y per mile for this construction. You should select an extension to build, do the engineering to determine it will cost $Y + an extra $X, then fund the $X amount with a grant. You end up funding the incremental cost of building into low density areas, not the full cost.

Government Support for Rural Broadband Needs to Change

Today, local network traffic pops up right after school when students arrive home. But the network they use at home, the public ISP, is different from the network they used when they were in school. We have built two separate networks with redundant capacity, in parallel. Traffic on the school network, a separate network built and run by the State, drops to nothing leaving all that capacity and investment idle, while the public network is suddenly jammed.

When the net first appeared, it was obvious that rural areas needed access too and the government acted to provide it. Since it could not provide home access, the approach was, for example, for the State to build a dedicated network to connect the school. Then they did this for health care and even in some cases, libraries. A lot of government funded broadband is still done this way and it actually hurts the effort to connect rural homes because the often large amounts of capacity cannot be shared with residential users.

If, instead, the state had required the school to buy its internet access from the local public ISP, then, when school was closed, all that bandwidth could be used by the rest of the town. The ISP would not notice any change in the overall traffic, but the origin of it would switch from the school to homes. The same bandwidth would serve double duty, instead of having to buy it twice.

This government practice remains largely the same today, building dedicated, isolated networks for major community institutions. Our message to government broadband policy people is this:

- Your approach of building private networks for rural schools, for example, made sense years ago but now, it actually materially hurts efforts to build out access to everyone in rural areas.
- It forces over-buying of bandwidth, making the overall system more costly than it needs to be. The core idea of the internet is that it is a shared service, a party line so-to-speak. Pushing large government users into private-line versions of the net, makes it more costly for everyone and pushes down the quality and speed of the services that can be made available today.
- The practice of building dedicated government program funded networks takes some of the best customers away from private rural ISPs who need every cent of revenue and every efficiency they can find to keep pace with rapidly increasing demand.

To truly support rural broadband to homes, the government should stop this practice and move toward an approach that requires government entities to buy service via local ISPs, especially in rural areas. Without a single dollar of increased spending, the bandwidth available to homes will increase dramatically with such a change.

Rural Broadband Needs to be a Near-Monopoly to be Viable

Here in Keene, the cable TV company, owned by a local family, became the local ISP. There is alternative decent service available via the cell phone companies and this will continue to get better. Satellite service is often an option unless your home is in the forest. So there is some level of healthy competition.

However, let say, for example, that the telephone company suddenly decided to rebuild the old phone network in town and offer DSL service, but only in the dense hamlet areas, not out in the more rural zones. The result might be that 1/3 of the customers would move to DSL but, financially, this would be devastating to the local ISP, which would see its revenue drop by 33% but its costs stay the same. In a fairly short time, it would be forced to shut down, once again leaving the customers outside the core village without service. Keene would be right back where we started from – the village dwellers would

be able to lower their monthly Internet service bill a little, but the rural homes would be left with nothing.

While we are aware that monopolies are not popular these days, in this case, they are the only thing that will work. Pure market competition will be a rural broadband killer, unless it is between two large players who have very low incremental costs for new customers. But a large player will not build out to low density areas without very large outside funding.

Future Expectations

The project to extend the network is finished but further improvements to it will continue and new uses and applications will grow to take advantage of it. Here are our thoughts on what is reasonable to expect.

Short Term Expectations – 0-3 years

The network power supplies around town, which are needed for the coax plant, will be optimized, both to save on electric costs and to make more of the network "always on", which is true for all fiber customers now. Today, if you are on a fiber connection and have some way to power your router and modem during a power failure, you will have internet access.

More people will switch to IP phones (from companies such as Vonage or Ooma) and drop Verizon land lines because of the cost savings that KVVI's broadband Internet service makes possible.

Cell service from Verizon Wireless in both villages means we will have smart phones everywhere – these work on the cell network and on Wi-Fi in your house. People will attach so-called "femtocell" antennas to their home broadband connection. These enable you to receive cell service in the immediate vicinity of your home even if there is no cell tower available. This allows, for example, part-time subscribers who use AT&T or T-Mobile cell services to use their smart phones while here. It also allows people who are in an area where the signal from the Verizon towers is blocked out by a mountain or hill to use their Verizon smartphones at home.

As large numbers of homes have been connected, use of local Wi-Fi hot-spot service has fallen off. New cell towers and smart phones will be the main way travelers and tourists get net access, not local Wi-Fi hot spots, even if they are inexpensive or free.

More and more fiber will be added. Replacement of coax will be easiest in areas where both fiber and coax already run along the street.

Seasonal home adoption rates will grow to around 2/3, more like a normal city, for the benefits of IP phone service, home security and femtocells. It's just starting to catch on now.

There will be more 'special situations' like addressing the needs of the health center, the school, and hopefully new businesses that get set up in Keene.

The project called DANC/ION, funded by the Federal stimulus program, will bring a second supplier of bandwidth to Town. This will greatly increase the reliability of the network because Keene will then have 3 trunk fiber routes in/out of town (now it only has one). It will again allow KVVI to significantly increase everyone's connection speeds without raising prices.

Medium Term Expectations – 4-6 Years

The user experience of television may not feel different, but in this timeframe most of KVVI's television programming will come into town over the fiber network, replacing the satellite dishes and antennas used today. More television viewing will be delivered via the internet, but the viewer probably will not notice. Current estimates are that today about 2 million TVs connect directly to the Internet for some of their programming. The same estimates predict that there will be 45 million Internet-connected TVs within 5 years.

WI-FI will appear on the school bus (actually powered by the Verizon cell services) where students currently spend a lot of time. "Bus time" will turn into "school work time".

Many new applications will appear and more home devices will get connected. Home entertainment, smart electric meters and home appliances, home security and monitoring (esp. for part-time homes), and more will become widely used.

The last coax segments of the network will be converted to fiber.

Longer Term – 7-10 Years

The underlying CATV system, the way TV gets to your home, will have been shut down as virtually all TV transmission is via the internet. The old CATV system will be viewed much like dial-up is now, an antique and expensive service that just gets rolled into internet. Customers will pay directly (meaning they will pay the content producer, not the CATV company) for channels they want. The CATV "channel line-up" will be a thing of the past.

Cell service in town will be upgraded to 4G which, for those who can get a signal, will be a solid alternative to KVVI's fiber-based network.

Key People that Made This Happen

- The Board of Trustees of the High Peaks Education Foundation was key to this project. HPEF, through its support for the KCS School Enhancement Task Force, got the idea started. Two board members, David Mason and Jim Herman, due to their prior backgrounds in networking and high-tech in the 1990's, drove the project, providing both technical and management leadership. They managed the fund raising and awareness building efforts as well. Vice President Charity Marlatt played a key role in approaching the State for the grant and shepherding the grant application through the State's approval and payment process.

- The KCS Superintendent, Cynthia Ford-Johnston, was supportive throughout the project and also played a key role in getting the State grant approved.
- The Board of Education also supported us, in particular its president, Teresa Palen. The Board of Education passed a resolution of support that was needed to get the NY State grant.
- Our State Senator, Betty Little, is the one responsible for us receiving the grant and has shown great appreciation of the importance of broadband Internet service to the future economic development of the region.
- The Town Board passed a resolution of support that was needed for the NY State grant. Supervisor Bill Ferebee has also been supportive, participated in the effort to obtain the NYS grant, and has helped when permits or rights-of-way over Town land were needed and in many other small ways.
- The key people who did the actual work to make this project possible are the employees of KVVI: Tim Whitney, Mike Whitney and John LaFountaine. This project would have been impossible if we had had to work with a large cable company or telco. Their dedication to the community, their sensible and frugal purchasing and engineering decisions, and their willingness to invest their own sweat equity and real capital in the project were absolutely essential to success. John LaFountaine found the PON fiber technology that ultimately made this all possible and built the early connections that proved we could do this.
- Our electric utility, NYSEG, was cooperative and helpful throughout the project.
- Our major subcontractor, Eustis Cable, a minority owned business in Vermont strung fiber all around town and were very generous in making their services available at the lowest cost possible because of the grass-roots nature of our effort.
- Last but not least, the 116 donors to the project who allowed us to move forward on our own with the sense that we can make the needed investment in the future of our Town. Donations to the project were made through HPEF and had to be explicitly earmarked for the project. No unrestricted donations were used for the project. Following is a full alphabetical listing of the donors. If you feel that your name is missing, it may be because you did not earmark your funds for the project. Or there may be an error. Please contact David Mason if you feel there is an error.

Donors to the Project

Samuel & Mary Allen
Cynthia & Woody Andrews
Anonymous(2)
Donna & Dick Austin
Charlotte & David Ball
Russell Banks
Beatrice & Wayne Bardin
Baxter Mountain Tavern
Alice and Bill Boardman
Joseph & Linda Bogardus
Tom and Alana Both
Brad and Monica Bradbury
Jane Haugh & Christian Brammer
John Brodok
Neal & Deborah Brown
John & Elsie Butterworth
Merrill Ware Carrington
Sylvia Colt de Almeida
Michel De Muszka
Elizabeth & Andy Derr

Dom & Melissa Eisinger
Brian Fallon
Gregory & Catherine Farrell
Sam Fisk and Linda Coe
Esty & Barbara Foster
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Ben Kernan
Milton Dudley & Kathy Kernan
Patrick Kirmer
Conrad Knapp
Whitman E. Knapp
James & Carol Kobak
Joan & Miles Kulukundis
Anne Laumont
Nancy and Day Lee
Tony & Elena Lucas
Dan and Carol Luthringshauser
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Matthew & Jennifer Mauer
Tracy and Scott McClelland
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Mr. and Mrs. Charles K. Nason
Sandra Nowicki
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Anitra Pell
Steven Pounian & Jay Haws
Mrs. Alexandra Preston
Seymour & Suzanne Preston
Mr. & Mrs. Edward Prince
Alfred & Kathleen Putnam
Warren and Pat Radcliffe
William Redpath
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Timothy and Janet Smith
Mason Snyder & Jim Sams
Kathryn & Dr. Harold Speert
Mark & Phyllis Stern
William & Elizabeth Stewart
Stewart's Stores
Lanse Stover
Dan and Ellen Strickler
Mark Gallogly & Lise Strickler
Barbara Strowger
T. Dennis & Susan Sullivan
Carol Rupprecht & Pete Suttmeier
Phoebe Thorne
Chase Twichell
Charles & Denny Uffelman
William and Katrina Wagner
Julia & Carter Walker
Anthony Walton & Jennifer Gao
Jeanne Warner
Mr. and Mrs. E. Gray Watkins
Susan & Bob Wei
Burns Weston

Monique Weston
D. Bruce & Elizabeth Whitman
Jeff & Kathy Wiegand
Philip and Tricia Winterer
Fred S. Wonham
Sally Woodin & David Wethey
Robert Worth
Robert & Blakie Worth
Cecil & Gilda Wray
Tad and Martha Anne Zelski

Major Vendors and Contractors that We Used

The various vendors that supplied us equipment or services obviously played an important role in making this project a success. In many cases they offered us discounts given the community nature of the project. In other cases, they were extremely generous with their technical support. Here are the major vendors for the project and their contact information.

CTDI | Products Division (formerly Alloptics)
1373 Enterprise Drive | West Chester , PA 19380
Direct: (610) 793-8256 | Main: 610.436.5203
www.ctdi.com
jpanichelli@ctdi.com
(DOCSIS compatible FTTH equipment)

Eustis Cable Enterprises
355 East Street
P.O. Box 500
Brookfield, Vermont 05036
www.eustiscable.com
Sue Kay sue@eustiscable.com
(Plant Construction)

Power&Tel (formerly Clifford of Vermont)
Box 1000
Dept. 841
Memphis, TN 38148-0841
www.ptsupply.com
(Company deals in fiber and strand.)

Fiber Instrument Sales Inc.
161 Clear Road
Oriskany, NY 13424
www.fiberinstrumentsales.com
(Optical splitters, fiber jumpers, Wdms)

National Cable TV Coop
PO Box 414826
Kansas City MO 64141
www.nctconline.org
(Purchasing cooperative for CATV providers)

CommScope
PO Box 1729
Hickory, NC 28602
www.commscope.com
(Fiber in Conduit - fiber)

Precision Valley Communications
333 River Street
Springfield, Vermont 05156
www.pvc2.com
(Mapping)

Keene Town-Wide Broadband Project Timeline

1979 George Bright builds original CATV network in portions of Keene and Keene Valley and it goes operational in time for the 1980 Winter Olympics in Lake Placid.

1992 Tim Whitney acquires the network from George Bright having been the principal engineer for its entire operation.

1997 Summer: KVVI offers dial-up modem services (maximum speed of 26kbs) using a 56Kbs link to the Internet.

1998 Fall: KVVI begins limited broadband Internet service over the cable plant with top speed of 384Kbs.

2004 Fall: KVVI installs a fiber link from Keene Valley shed to its Alstead Hill remote antenna site, creating initial fiber backbone for its coax cable network at a cost of $100K.

2005 Spring: KCS SETF is launched to develop a strategic plan for the school.

2005 Fall: KVVI decommissions cable plant south of Beers Bridge due to poor service quality and lack of funds for capital investment. Serious and frequent service outages plague much of existing KVVI network due to degradation of the cables.

2006 Spring: KCS SETF concludes that broadband development in Keene would be important to the school's future quality of education and student preparedness for college/business, and could help in drawing new families to town that have Internet-based jobs. KCS SETF recommends creation of town-wide broadband task force.

2006 Summer: Jim Herman and Dave Mason (HPEF Board members) initiate a task force to investigate town-wide broadband as a follow-up to the KCS SEFT; they seek participation from members of the community.

2006 August: Board of Education and Town Board of Supervisors pass resolutions in support of the Town-Wide Broadband Project. HPEF Board of Trustees agrees to support a private fund-raising effort for the project. Small group meets to discuss goals for the project and brainstorm benefits to the Town and School.

2006 Fall: Project sub-teams reach many key conclusions. Detailed model of all streets, houses and businesses in town is created to evaluate different pricing, coverage and profitability options. Wide coverage and high adoption rates will be critical to generating sufficient customer base for a sustainable ISP business. Use of Wi-Fi hotspots to generate additional coverage and revenue is proposed. Primary goals of project: as close to universal service as possible (95%) and a sustainable ISP business. Interim goal is to reach every house with a student at KCS. Technology options narrowed to extension of hybrid fiber-coax system of KVVI and deployment of Wi-Fi hotspots in the hamlets. Mike Whitney becomes project manager for KVVI.

2006 December 29: First public information meeting is held to explain the project to town citizens, build support and prepare for fund-raising. Mixture of loans and grants to KVVI is proposed. Project phases proposed. First phase, to refurbish the existing fiber/coax plant, is agreed as initial goal of fund-raising. Estimate of $120K for capital equipment to complete phase 1 is developed.

2007 Winter: Round 1 of fund raising nets $60K. Charity Marlatt (HPEF VP) along with Town Supervisor and KCS Superintendent meet with State Senator Betty Little to discuss NYS Economic Development grant for the project. Loan agreement signed between HPEF and KVVI for $60K to initiate phase 1 refurbishing of existing network. KVVI agrees to provide all labor for the project at no cost. Discussions begun with Ausable Club and Putnam Camp about funding network rebuild in St. Huberts. KVVI hires second lineman, John LaFountaine.

2007 Spring: Led by Charity Marlatt, HPEF submits application to NYS for $100K grant. Network refurbishing gets underway, resulting in 90% decline in service outages. Town uses existing grant monies to fund $10K of refurbishing effort. KVVI finds that capital costs are declining and revises total phase 1 estimate to $100K. KVVI introduces 512Kbs service. New subscribers are added, improving KVVI sustainability.

2007 Summer: Refurbishing of network continues. Grant application to NYS is revised and resubmitted. Contract signed between KVVI and Charter Communications to provide new source Internet connectivity at much lower cost and increased capacity that involves building a fiber trunk to the town line with Upper Jay. Second public information meeting held on August 29 to build wider support for project and keep everyone informed of progress.

2007 Fall: Ausable Club and KVVI agree on $55K contract to rebuild the network to and around club property and provide a dedicated 1.5Mbs link to the Club House. Round 2 of fund raising nets additional $60K.

2008 Winter: HPEF contracts with Precision Valley Engineering to do complete mapping of all poles and buildings in the town and work is substantially completed.

Spring: Link with Charter is implemented and network capacity doubled. New connection to Ausable Club implemented and Club houses previously on the network reconnected. More subscribers added to network in areas covered by old network. Research on FTTH technology begins.

2008 Summer: Three public for-fee Wi-Fi hotspots implemented in Keene Valley by KVVI. KVVI implements fiber link to KCS as subcontract to Charter Comm. Network refurbishing is largely complete with 59% of town covered by hybrid fiber/coax network. First FTTH pilot project implemented successfully. Decision made to implement expansion of network using FTTH due to lower cost, higher capacity, long-distance runs and better reliability.

2008 Fall: Surveys are sent to homes in unserved areas to determine potential interest by new subscribers. KVVI doubles speed of most connections for same monthly fee, with top speed of 1Mbs. On October 9 the third public information meeting was held to launch network expansion using FTTH to reach 90% of town. HPEF annual fund-raising appeal includes broadband funding requests and decision is made to send appeal to all town residents. Explicit decisions are made concerning where network expansion will

reach and where it will not, and how to fund connections from the road to a subscriber's house. Round 3 of fund raising nets an additional $60K, which was somewhat amazing given it was during the financial crisis of fall 2008.

2009 Winter: HPEF receives $100K NYS Economic Development Grant funds. KVVI installs backup generator to increase system reliability.

2009 Spring and summer: Press conference held May 21 with Senator Little to describe the success of the project. Network expansion proceeds using FTTH. HPEF raises additional $55K for the project. Costs for FTTH materials drop significantly lowering overall cost for the project. KVVI continues to contribute significantly to capital costs from their improved cash flow. Network speeds are increased again with top service offering of 3Mbs with no increase in monthly fees.

2009 Fall: All homes with KCS students are connected to the network by October. Steady activation of new subscribers continues. HPEF raises additional $13K for the project. Verizon cell tower is activated in hamlet of Keene providing alternative source of broadband.

2010 Winter and spring: KVVI decommissions dial-up service. DANC/ION awarded Federal Stimulus grant to build middle-mile broadband infrastructure that will include Keene and offer future opportunity for much higher capacity connection for KVVI to the Internet (estimated operational in late 2011). Last few fiber spurs added to the network and subscriber activations continue.

2010 Summer and fall: KVVI continues to connect new subscribers. Project co-directors gather and analyze before and after data and write this final report.