

(Mis)perceptions of Broadband Services in Mendocino County & How They Inform Education

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1 Introduction

Broadband Internet services are not widely available in rural areas such as Mendocino County in California. Why not?

One answer is that, due to the sparse populations in these areas, it is expensive to deploy traditional network technologies such as fiber. As a result, there is often only a single incumbent Internet service provider serving these areas, stifling competition and driving up prices. Recently, however, organizations such as Further Reach have started to offer competitive Internet services, helping to lower prices for subscribers.

Another possibility might be that the people of Mendocino have concerns about the prospect of pervasive broadband services. It is this possibility that we seek to investigate. Do some residents harbor concerns about broadband, or even oppose it? Do some residents not believe that broadband would be beneficial for their lives? If so, what are their concerns, and how common are these concerns?

To answer these questions, in this project we conduct a qualitative research study on perceptions of broadband services in Mendocino county. The first and main part of this paper (sections §2, §3 & §4) summarizes our findings from nine interviews with Mendocino residents.

As technologists, we generally believe that access to broadband Internet is a valuable good. If some residents wish to know more about broadband Internet technologies, or harbor concerns that might be easily addressed through education, we would like to address them if possible. The second part of this paper (starting at §5) summarizes our efforts to develop educational materials with this goal in mind. We designed these materials based on an analysis of our interview materials: for each category of easily addressable concerns voiced about broadband Internet, we gathered factual information and presented them in an easy-to-understand format.

Throughout this process, we learned a great deal! We

end the paper (section §7) by summarizing these lessons.

2 Background

In our research we focused on residents in Mendocino County. Our research is also loosely affiliated with Further Reach.

2.1 Mendocino County

Mendocino is a small county located on the north coast of California. Due to the remoteness of its location and sparse population, high speed Internet has not pervasively penetrated this county, much to the frustration of its citizens. Most people rely on dial-up and satellite connections to access the internet, which proves to be time consuming and unfavorable.

2.2 Further Reach

The Further Reach/Celerate project is a De Novo Group [1] initiative to provide affordable broadband Internet access to rural communities around the world.

Many rural communities remain disconnected or are forced to rely upon slow, unreliable, or expensive Internet access. While many long-range networks have been developed in the past to connect such communities, the rollouts of such networks are fraught with complexities of both deployment and operation, leading to higher costs and lower reliability for users. Further Reach will leverage work from the burgeoning area of Software Defined Networking (SDN) to help redefine how such networks are built and managed.

The initial phase of Internet access rollout will begin with rural communities in Northern California within 250 miles of the San Francisco Bay Area. This initial rollout will enable De Novo Group and its affiliated researchers to provide real Internet access to users while

refining new approaches that improve performance, reliability, and affordability. Beyond this initial series of deployments, Celerate will expand to communities beyond California, and De Novo Group will seek to partner with interested technologists around the world.

3 Methods

Our main research goal is focused around understanding people's perceptions of broadband services in Mendocino county. Based on what we find from the research, our second goal is to act on our findings by creating educational materials designed to address some of the concerns or misconceptions that were raised.

3.1 Qualitative Research

We undertook this research project with the broad goal of understanding how people perceive Internet services, with a specific emphasis on high speed connection services such as broadband. We wish to analyze how people used the Internet, and if they had any concerns or misconceptions about Internet usage, installation, etc.

We conducted this research in several stages. In the initial stages, our goal was to hone in on a particular topic of inquiry. We then used the results from the initial stages to design our interview questions, and conduct the interviews themselves. The stages were as follows:

1. Analyze support tickets from Further Reach to understand what issues people commonly have with Internet services.
2. Interview Further Reach technicians (Yahel and Zean) to understand what topics we should focus on.
3. On-site in-person, and over-the-phone interviews with locals.

3.2 Educational Materials

In the second part of our project, our goal was to work towards analyzing and addressing these misconceptions through educational materials, that would aid residents in understanding the working and usage of the Internet in a better manner. In designing the materials, we strived to include inputs from interviewees as to what might be valuable to add and how we might best distribute these materials.

Initially we hoped to measure educational outcomes, i.e. conduct a survey among the people before distributing materials, then conduct a similar survey again after distributing the materials to measure how much they had learned. In the end we decided that this would not be the most valuable use of time.

4 Results

We first present the individual results from each method we discussed in [Section 3.1](#). Then we summarize and synthesize the final results.

4.1 Interviews with FR

In order to understand some of the common perceptions people have regarding broadband in the Mendocino County, we decided to have an interview session with Yahel and Zean due to their on site communication expertise and their valuable experience which they have collected over the years while setting up Further Reach. Our initial goal was to determine some of the common misconceptions of people regarding broadband, which they came across while promoting Further Reach. We also wanted to gain insight into some of the common topics people have expressed interest in learning more about.

A few important aspects that we touched upon during the interview process were as follows:

- Some of the common questions asked by the users and the mode of communication used by them to express their concerns
- Some of the common technical problems that have occurred in the network since it was set up
- The average education level of the local population regarding the notion of broadband and the usage of the Internet in general
- The techniques used by Further Reach in order to help people understand how the setup of the network works
- Types of technical problems encountered by the users in the past and the level of detail they used to describe them
- Queries of the users that have been difficult to solve or the users themselves had trouble understanding the explanation given to them for their concerns
- The specific components of the network that require regular maintenance by the local technicians

From the interviews, it became evident that there were indeed some concerns and misconceptions that the local population had. While interviewing Zean, he informed us that some users are confused with the term 'MB'. Specifically, they seem to conflate 'Bandwidth' with 'Bandwidth caps'. Some users also have very little knowledge about network latency and the amount of Internet bandwidth required for different types of services such as VOIP, video streaming, email etc. He also emphasized the need to explain to the people the difference between satellite and wireless Internet connections.

From the interview session with Yahel, we came to know that some people have concerns regarding the effects of radiation from wireless networks. These con-

cerns are one of the main reasons that prevent people from signing up for high-speed Internet services. He also told us that it has been a regular practice for them to need to explain people about Line of Sight (LOS) and what causes its obstruction.

An important observation that both of them made was that most of the people within the Further Reach network are quite aware of the importance of broadband and the various services and usages it comes with. Moreover, Zeen does a pretty thorough job of answering people's questions as he sets up their home network.

Thus the education material that we would prepare should aim towards the population who do not have access to high-speed Internet access nor any ways to gain information about it. As Zeen puts it, "we don't have a store front for people to go to get their questions answered".

4.2 Support Tickets Analysis

In order to reduce the scope of our research problem, we first decided to identify some of the common types of concerns and queries that people have when they have already been provided with high-speed Internet connection. For this, we used the ticketing system used by Further Reachs team for tracking its customers questions. We analyzed over 1425 tickets filed since August 2014, each depicting a particular customers query or concern. Based on our analysis, we identified 9 major categories of concern:

- **Payment.** This category included tickets filed by the people who had specific problems or general questions regarding paying online bills. Some common problems were error in billing transaction, autopay not correctly set up, inability to understand the online payment systems GUI etc.
- **Subscription Requests.** Many users asked for service. Others went further and offered to use their property as new relay sites or act as local tech volunteer, in areas like Albion and Gualala.
- **Quality of Service.** This category included concerns in which people expressed dissatisfaction with the service/plan they were paying for. The main concern given was that Further Reach seemed to have high costs but slow Internet speed or poor Internet connectivity. Many users attempted to run SpeedTests to make their point.
- **Troubleshooting.** Antenna not installed? System down? Many people call about the Internet being down. A large number of reasons ranging from extremely ambiguous to highly specific were given for system outages.
- **Questions about Equipment.** In this category, people asked help for assistance in set up/installation

and maintenance of equipment provided to them by Further Reach in order to help them gain access to the network

- **Interference with other Wireless.** There were a few tickets which claimed that they were receiving poor signal strength due to interference with other wireless networks within the area, e.g. AT&T towers.
- **Requests for unusual features.** Many tickets asked for availability of various types of Internet services that are available with the download/upload speed the users signed up for such VOIP features, streaming videos using Netflix, paying bills online etc.
- **Passwords.** Several tickets provided the SSID/password of their network and hoped that a technician could solve the connection issue.
- **Alternate Pricing.** Tickets in this category asked for details about Internet plans other than the one the corresponding user had, for example vacation prices and discounts, non-profits requesting free service, etc.

The above categories played a pivotal role in helping us formulate interview questions that mainly target the concerns of the population living outside the Further Reach network regarding high-speed Internet connection.

Essentially, when we analyzed the level of detail provided about the problem at hand in each ticket, it helped us understand the average level of knowledge the users had regarding broadband. We also learned about some of common difficulties users face while accessing various Internet services, one of them being trouble with paying online bills. Some tickets also helped us understand the main concerns people have with wireless Internet access. These included vulnerability to EMF from electronic devices and the health problems associated with it. Based on the locations of the users filling the tickets, we were also able to get an insight into their interest in high speed Internet access. This helped us decide on locations outside the Further Reach network where we could conduct on site interviews and try to understand what hold people back from signing up for high speed Internet access.

4.3 Interviews with Rural Residents

With the help of Mendocino Community Network (MCN), we recruited residents from Mendocino County using a flier that was put on public display and distributed by Shirley Freriks. Of the dozen or so residents who expressed interest in the survey, we were able to interview nine residents, 5 in person and 4 over the phone. The residents were selected among those who did not currently have access to Further Reach. All of the interviewees already had Internet access through another provider.

Based on our ticket analysis and interview sessions with Yahel and Zean, we consolidated a list of interview questions that touched upon the various categories identified in the trouble tickets section. While preparing the questions, we tried to avoid the assumptions that are our interviewees would have some considerable level of knowledge about broadband and the services it offers. We also tried to make sure that none of our questions make the interviewees feel uncomfortable while responding. Table 1 lists the questions we prepared.

We designed our questions to allow the interviewees to express their opinions as openly as possible with as little bias introduced by the phrasing of the question or our opinions. That said, we were biased toward the use of technology and may have introduced substantial biases, by priming their responses in the wording of our questions. In addition to the interviewee’s personal opinion, he or she was also asked about the opinions of her neighbors.

All of the residents that were interviewed expressed an interest in broadband and bringing it to the Mendocino County. Unfortunately, there were no residents who asked to be interviewed who were of the opinion that broadband should not be present in Mendocino. In addition, 44.4% of the interviews were considered technically knowledgeable by us.

Aside from the desire to have broadband made available to the homes, the opinions of the interviewees varied. Many did express some concern for the radiation emitted by antennas used for wireless Internet access. However, their concerns were not enough to prevent them from using WiFi at home or from using Further Reach if it were to be made available. Most interviewed residents were more concerned about the aesthetics of an antenna on his or her house more than the potential hazard of the RF radiation. There was a belief that there were those in the community who had major concerns about radiation from RF antennas. However, these individuals who had major concerns of radiation were described as being a small minority who had little effect on policy making in the community.

Although many of the residents interviewed described were technically knowledgeable, they felt that it would be valuable for their community to have technology education made available such as technology centers for this purpose. Some interviewees also felt that education at the school for children would be valuable. These same interviewees also described having broadband available as being most beneficial to the younger population for educational purposes.

There was a technical concern from many residents who felt that wireless broadband by use of line-of-sight would be infeasible given the terrain that surrounds the house. However, based on the addresses of these res-

1. What does broadband mean to you?
2. Do you have any concerns of high speed? Some part you dont understand?
3. Any concerns about health/safety?
4. In case we put a tower close to your house, what specific concerns u would have?
5. In case you are provided with high speed Internet connection, what would you mainly use it for?
6. What is a reasonable price range for high speed Internet in your opinion?
7. What degree of awareness do you have about the difference between various technology?
8. Your relatives usage of network and their concerns?
9. Is there something holding people from signing up for network?
10. Do you use any specific software to test speed of network?
11. How many people do you think would be interested in a better broadband service in a 10 mile radius?
12. How comfortable are you while paying bills online?
13. Have you considered Internet as substitute for TV ?
14. Have you contacted Further Reach to setup a network?
15. What was your reason to participate in the interview?
16. Do you participate in netbanking or shopping online?
17. Do you think Internet will be useful for kids
18. What would you think is most imp that should be included in our educational material? And how would we distribute them?
19. What is your present Internet provider and how much are you currently paying?
20. Any negative perception of broadband?
21. What is your current speed?
22. What would you think you can do with Internet but you dont know how to do?
23. Different peoples experience? Line of sight point of view?
24. Do you have a sense what the younger generation would do with broadband, which they cant do now?

Table 1: Interview Questions

idents and what the residents described, we felt that it would be technically possible to deliver wireless Internet. However, the cost of installation was not evaluated.

Cost of installation was a major factor for their choice of Internet access presently. Broadband through the use of fiber is available to the home. There is currently fiber deployed on many streets in the area. However, the cost of installation of the fiber has been quoted to be at least \$2000. Most residents felt this cost was too high if they must also pay for a very high regularly monthly bill, all estimates exceeding \$100. Residents are currently paying for Internet access between \$50–\$200 through technologies such as satellite or other line-of-sight providers.

Most residents seem to be knowledgeable as to the difference between broadband access and slower speed Internet. However, there were some confusions that were concerned with some of the details. One often confused topic was the difference between bandwidth in terms of throughput and a regular bandwidth cap. Another confusion was as to the bandwidth caps present in cellular services that have no perceived bandwidth cap and the fact that customers are rate-limited if too much data is used. Lastly, some residents were unclear as to the differences between the wireless implementations of satellite and terrestrial and its effect on quality of service.

We did a further analysis of the raw interview results, however, due to the small sample size of an area of a small number of people, we do publish the details here for privacy reasons.

5 Education Materials

From the interview material, we categorized potential misconceptions into five key topics. These five topics (below) became the focus of our educational materials.

- **Health.** For this topic we attempt to explain the physical properties of wireless. For example, we explain how much power is emitted from antennas as a function of how far away from the antenna you are, and we distinguish omnidirectional from directional antennas. We explicitly try to avoid health topics that are still debated within the scientific community, since it should be up to individuals to take their own stance on these issues, and we do not wish to impose our personal beliefs on them.
- **Line of sight.** Several of the interviewees understood that wireless requires line of sight, but most (including the interviewers themselves!) did not have a precise understanding of what is actually required in practice. We interviewed Yahel to get a better understanding of the exact requirements of line of sight, and incorporated his explanations into our educational materials.

- **Service quality.** Many interviewees had questions and potential misconceptions about how to think about and compare quality of Internet service. We start by explaining basic concepts (latency, metrics for measuring bandwidth, the difference between bandwidth caps and bandwidth speeds, etc.), and then try to help them build an intuition for how to weigh the pros and cons of different services, in terms of concrete examples such as loading websites of a certain size.
- **Cost.** On a related note, we put together a survey of the costs and service levels provided by competing Internet services in Mendocino.
- **Usage.** To address so-called ‘failures of imagination’, we surveyed different ways the Internet is used today. These uses include basic communication (email, chat, video conferencing, social networking), education (online courses, library materials), finance (online banking, online shopping), news dissemination, and entertainment.

5.1 Distribution

We found from our interview with Zeen that, because not everyone in Mendocino feels comfortable using the Internet, we should create our educational materials in a physical pamphlet form in addition to an online website. We will distribute the pamphlet through Mendocino Broadband Alliance. We also plan to make copies of our materials available to Further Reach technicians who may want to give them to potential subscribers as a reference.

Our online website can be found at <http://bit.ly/broadband-education>. The website contains the same material as the pamphlet, but has a few key advantages over the pamphlet. Most obviously, online materials might be consumed by a much broader audience. A second advantage is that we can use the website to indirectly measure how engaged users are; e.g. we can track how long users spend on the site, as some indication of whether the materials are pedagogically effective.

6 Related Work

Two strands of other works are related with our project: i) perceptions and concerns of Internet technologies; ii) existing education materials. We discuss each in turn below.

6.1 (Mis)perceptions and Concerns

The potential safety hazards of human exposure to radio-frequency (RF) waves have been a major concern, especially with the increasing ubiquity of Wi-Fi technology. FCC and Wi-Fi Alliance each has dedicated web pages

discussing the health issue [9, 13]. A range of scientific research has also been undertaken to understand the impacts and threats of wireless radio waves to human. A review paper by Foster *et. al* [10] states that “*unequivocally, the RF exposures from Wi-Fi and wireless networks are far below U.S. and international exposure limits for RF energy*” after summarizing the recent research work on Wi-Fi health (as of 2013).

Further Reach relies heavily on the RF technology in its deployment in Mendocino County. Different from typical approaches where RF technology is only used in the last mile of Internet within residents’ house, Further Reach also employed RF to construct the backbone network. Often, the directional antennas used by Further Reach are larger than typical Wi-Fi devices that have smaller omni-directional antennas. One health concern that locals have is directly related with the antenna size. Our project is also tasked to understand such concerns that are unique here and were not extensively studied before. Note that the directional antennas also bring up the line-of-sight issue.

Previous research has identified other concerns that limit the adoption of the Internet, especially in rural area. LaRose *et. al* suggested the resistance to constant self-renewal for adopting complex technology, a lack of relevant content and the affordability of broadband in rural communities [11].¹ Our work has taken these factors into consideration during our interview process and the construction of the education materials.

6.2 Existing Education Materials

Many existing education materials are available online, targeting at audience of different knowledge levels.

On one extreme, the materials from massive open online courses (MOOCs) [12] are quite selected and the instructions are well prepared. However, current MOOCs are typically targeted at knowledgeable audience such as college students, rather than the general public, especially the subject of our research—locals in rural area.

On the other extreme, there are many unorganized resources across the web. Even with the help of search engine, it will still be a time sink to find the “right” materials and understand them, especially for the non-technologists. Therefore, our work aims to summarize and synthesize these materials, together with some specific topic targeted at Mendocino County.

Below we offer some resources we have encountered; interested readers can follow the references or Google

¹The original paper also has discussions of other factors such as technical challenges in rural area. Further Reach has solved many such challenges so we focus on the remaining factors that local residents have in this paper.

more resources. Note that the list is not meant to be exhaustive.

- **General:** Organizations such as National Institutes of Health [4], University of South Florida [2] offer resources for the general public to learn science.
- **Health:** Many organizations have created pamphlets or fliers to provide health and safety advice regarding Wi-Fi. Examples are Wi-Fi Alliance [13], EMFacts Consultancy [7], EMFWise [8] and so on.
- **Service Quality:** Speedmatters explained what is high speed Internet and why it is necessary [5]. Fiber to the Home Council explained Fiber as well as the benefit of a high speed.
- **Usage:** Regarding how Internet can be used, all types of reports and tutorials are available. One report from Massachusetts Broadband Institute highlights the many ways Internet can help local governance, education, digital literacy, health and emergency [3]. Department of Communications at Australia has a tutorial about what the Internet can do [6].

7 Lessons Learned

As computer scientists who have never been trained in how to conduct qualitative research, this project was an excellent learning experience for us. Here are a few lessons we learned along the way:

- Broadly speaking, qualitative research is really difficult! It is time consuming and challenging to come up with interview questions that really focus on the key issues without biasing the responses. Moreover, conducting interviews is challenging itself, and thoroughly synthesizing the results of the interviews more-so.
- It is highly challenging (if not impossible!) to conduct interviews in a non-biased way. We often walked away from interviews wishing that we could do them over again, because we felt that the way we had phrased the questions in a way that primed the interviewee to respond in a particular way. A general takeaway from this is that we should strive to ask questions in a way that gets interviewees to do most of the talking, where they can frame issues in their own words.
- Snowball sampling seems like a great idea. Sampling bias was pervasive in our interviews; most of our interviewees were pro-broadband, and we did not manage to find many anti-broadband viewpoints, or people who could not afford broadband. This was largely an artifact of the way that we distributed our request for interviews: having Shirley (MCBA) email a mailing list of people who are likely actively tuned in to broadband issues.

- It's hard to draw strong conclusions from our interviews, largely because of our small sample size. Qualitative research takes a long time! It's both conceptually difficult and work intensive to come up with strong results in this area.
- We have come to believe that our educational materials will be more useful as a *reference* for anyone who comes to Further Reach with questions, rather than as an vector for convincing many to sign up. From what we heard in the interviews, there are numerous reasons why a pamphlet alone is unlikely to succeed in convincing anyone to sign up: from what we understand, some families in Mendocino struggle to pay rent, nonetheless pay for Internet services; some apparently do not want to learn about broadband and choose to continue living their normal lifestyle (which is of course a valid choice); and many more are likely to be indifferent to a simple pamphlet. If we wanted to more effectively educate the public about broadband services, we would instead (i) hold in-person information sessions rather than simply handing out a pamphlet, and (ii) target younger populations who are more likely to be amenable to learning about technology.

7.1 Future Work / Loose Ends

Our work currently leaves open several loose ends and directions for future work. We briefly describe them here.

- In the next few days, we plan to distribute our educational materials through the Mendocino Broadband Alliance and through Further Reach's technicians.
- As mentioned previously, it would be interesting to analyze how users engage with the online educational materials. For example, we might add a quiz at the end to measure educational outcomes, or we might analyze which sections of the materials receive the most attention from users.
- To gain a better understanding of the kinds of issues experienced by wireless Internet service providers, it might be fruitful to apply a frequency analysis to the different categories of Further Reach's trouble tickets.

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Appendix

Request for Interviewees Flyer.

Interviewees Needed For UC Berkeley Research

Curious about broadband Internet services but hold back from subscribing?

Do you think you would not use it well enough or often enough to justify the cost?

Is it even available where you are?

Maybe you just use a data phone and do not need a home service?

Do you have other concerns like health or safety that keep you from signing up?

Broadband Interview Survey Calling

Interested? Help us!

- Volunteer to be interviewed.
- Take our surveys.

Interested? Contact us!

Contact Shirley Freriks
sfreriks@mcn.org
(707)937-1677

The students will get in touch to discuss your availability and details of the project.

A group of UC Berkeley graduate students wants to understand people's perceptions of broadband Internet services in Mendocino County. They are particularly interested in hearing from people who do not yet have affordable access to broadband Internet, or who may have concerns about existing services. Hearing from the "people on the ground" about what you think of these services is central to the research project.

Interview

Length: approximately 30 minutes.
Type: in-person or by phone.

Example Questions:

- How do you think broadband Internet would affect you or your family? Positively or negatively?
- Do you have any concerns about the health/safety impact of broadband?
- Do you feel that the cost of broadband is not worth it for what you would use it for?

Disclaimer

Participation in the interviews and surveys is completely **voluntary** and unrelated to Further Reach's service. You are welcome to email Prof. Jenna Burrell (jburrell@berkeley.edu) with any questions about the project.

Thank you!

Thank you for considering taking a few minutes to help this research team understand the needs and concerns about broadband connectivity to the Internet. This will help the service to become more robust on the Coast where there is little.

Survey

The questionnaire will be sent over the next 4-6 weeks, including online and offline access.

Shirley Freriks
President, Mendocino Coast Broadband Alliance
And the UC Berkeley research team