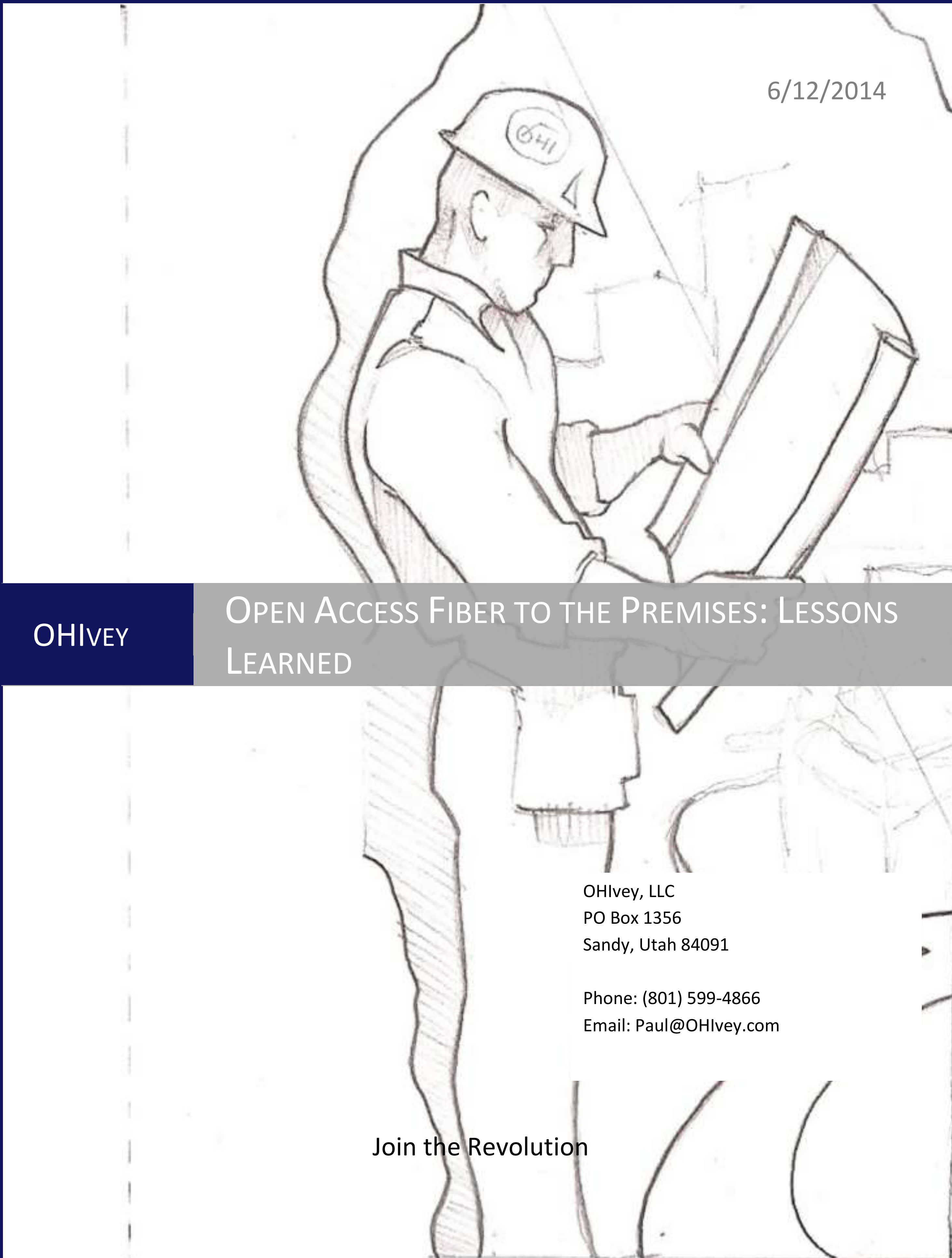

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OHIvey

Open Access Fiber to the Premises: Lessons Learned

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Join the Revolution

1 Introduction

The largest open access fiber to the premises project in the nation is the **U**tah **T**elecommunication **Op**en **I**nfrastructure **A**gency, or UTOPIA, network. UTOPIA is a consortium of 16 Utah cities, created to provide construct and operate a wholesale fiber optic advanced broadband infrastructure. Eleven of the cities (Brigham City, Centerville, Layton, Lindon, Midvale, Murray, Orem, Payson, Perry, Tremonton, West Valley) have pledged sales tax revenue to support bond payments and have some network construction completed. Five cities (Cedar City, Cedar Hills, Riverton, Vineyard, and Washington) are non-pledging members and have no network construction complete[1].

UTOPIA was started in 2002 and implemented its first production services in 2004. Unfortunately, UTOPIA has struggled since its inception. When the project was conceived, the intent was to pass 141,000 addresses in three years and to secure over 49,000 subscribers across those addresses. At its three year anniversary – its projected break-even point – UTOPIA had only completed 26% of its target construction and captured only 12.5% of its target subscribers. Even as late as 2012, UTOPIA had only achieved 41% of its original construction goal for 2007 and only 19% of subscribers originally projected for 2007[2].

	2003 Goal for Sep. 2007	Actual June 2007	June 2009	June 2011	June 2013
Addresses Passed	**141,000**	37,160	48,646	56,000	65,000
Subscribers	**49,350**	6,161	8,009	8,572	11,120
Subscription Rate	**35%**	16.6%	16.5%	15.3%	17.1%

Table 1: UTOPIA Goals and Results

More to the point, UTOPIA has failed to meet its financial goals. "Figure 1: UTOPIA Revenues and Expenses" demonstrates revenues have not kept pace with operating expenses and that debt service has been a continuing burden.

[1] The Interlocal Cooperative Agreement governing the Agency can be found at ftp://ftrftp.slcgov.com/attachments/06-10-04A3.pdf.

[2] In 2012, the Office of the Legislative Auditor General for the State of Utah audited UTOPIA's performance. The results of that audit can be found at http://le.utah.gov/audit/12_08rpt.pdf.

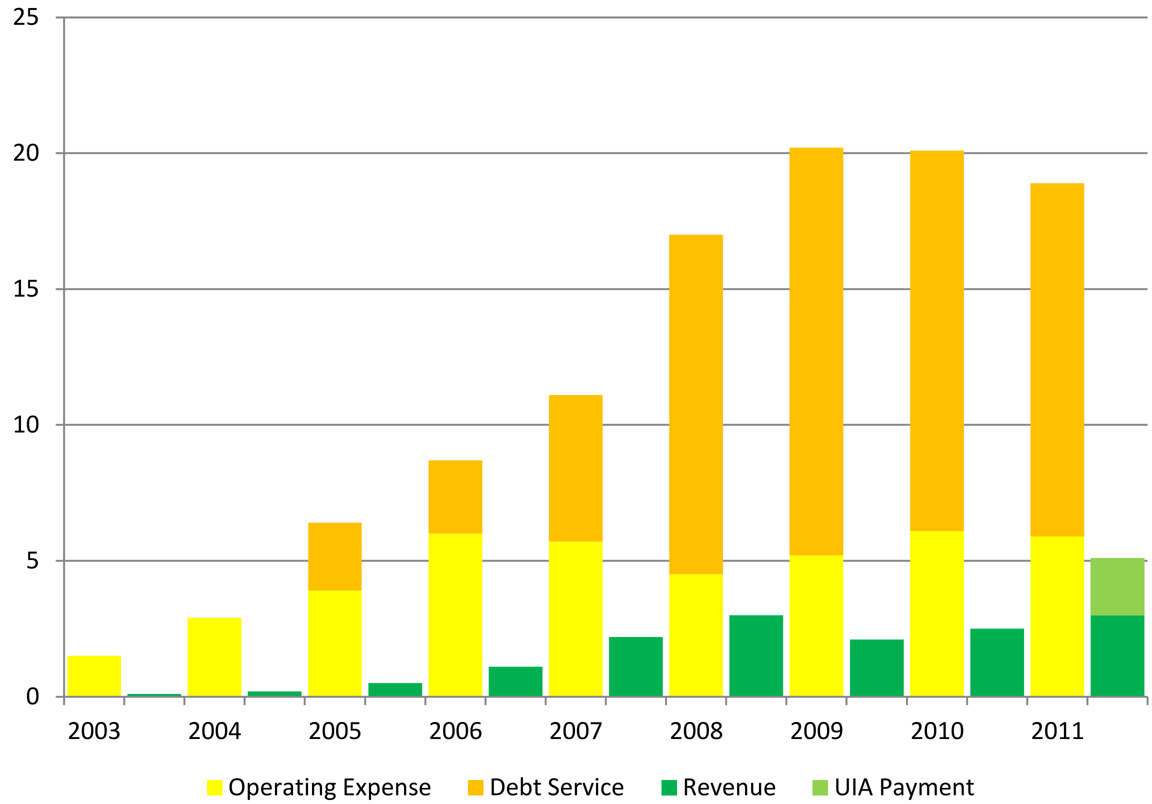


Figure 1: UTOPIA Revenues and Expenses

UTOPIA has had to continue to borrow from its member cities and through its bonding capacity in order to sustain operations and service its debt. As of the end of UTOPIA's 2012 fiscal year (June 2013) UTOPIA had a negative net asset value of $146,528,970[3].

UTOPIA's sister project, iProvo (in Provo, Utah) also struggled. Maryland State Senator Catherine Pugh wrote in the Baltimore Sun opinion section[4], "Taxpayers in Provo, Utah, for instance, spent $40 million to build a relatively small and modest network only to sell it for $1 a few years later because they underestimated the massive costs of operating, upgrading and maintaining it. …[A]s Provo residents learned, even their recently build network – barely a decade old – requires $20 million in upgrades before its new owner – Google – deems it fully operational."

UTOPIA and iProvo serve as warnings for cities considering a municipal broadband project. Quoting again from Senator Pugh's Baltimore Sun op-ed, "For the most part, municipally-built broadband networks have the economic chips stacked against them and, where tried, have saddled local taxpayers with a mountain of debt and half-built networks that are then sold at fire-sale prices to vulture

[3] Represents combined "Total Net Position, End of Year" from UTOPIA and UIA Financial Statements from June 2013.

[4] Pugh, Catherine (15 August 2013). "The False Promise of Municipal Broadband: Local Governments Keep Building Expensive Networks that Fail to Attract Customers." The Baltimore Sun. http://www.baltimoresun.com/news/opinion/oped/bs-ed-broadband-20130815,0,2185759.story.

investors." Given such a poor track record, how can one suggest the story will play out differently if any other city chooses to invest in an open access fiber to the premises network?

We believe Senator Pugh's warning is a little off the mark. Municipally-built broadband networks do have the economic chips stacked against them. Municipal projects are not designed to be profit centers; rather, they are built to meet public policy objectives. Therefore, where tried, network owners and operators must carefully consider similar projects and glean what lessons they can to help balance the equation. We have identified many factors critical to the success of open access fiber to the premises. The lessons learned from UTOPIA and iProvo help define four of them: scope, execution, financial planning, and network design.

2 Tipping Points

Malcolm Gladwell's 2000 book The Tipping Point: How Little Things Can Make a Big Difference[5] describes three factors critical to tipping an "epidemic":

1) The "Law of the Few" or as Gladwell states, "The success of any kind of social epidemic is heavily dependent on the involvement of people with a particular and rare set of social gifts." Gladwell defines the required social gifts as:
   a) "Connectors" or people who "link us up with the world… people with a special gift for binding the world together." These people span multiple social and professional worlds and are able to connect people from these various worlds with each other.
   b) "Mavens" or people who collect information – especially about the marketplace – almost as if it were a hobby. "Mavens" are critical to the diffusion theory as they are the trusted sources or opinion leaders to whom the early majority turns. The unbiased recommendation of a maven is the greatest influencer to overcome (or reinforce) the early majority's resistance to their knee jerk reaction to buy a new service.
   c) "Salesmen" who persuade people with their charisma and negotiation skills.
2) The "Stickiness Factor" or the specific content of a message that renders its impact memorable and actionable.
3) The "Power of Context" which suggests human behavior is driven by current environment as much or more than personality traits or other characteristics.

Perhaps as pertinent to public open access fiber to the premises as anything in Gladwell's work is the analogy he provides of a tipping point in the endnotes to the introduction:

> *The best way to understand the Tipping Point is to imagine a hypothetical outbreak of the flu. Suppose, for example, that one summer 1,000 tourists come to Manhattan from Canada carrying an untreatable strain of twenty-four-hour virus. This strain of flu has a 2 percent infection rate, which is to say that one of every 50 people who come into close contact with someone carrying it catches the bug himself. Let's say that 50 is also exactly the number of people the average Manhattanite – in the course of riding the subways and mingling with colleagues at work – comes into contact with every day. What we have, then, is a disease in equilibrium. Those 1,000 Canadian tourists pass on the virus to 1,000 new people on the day they arrive. And the next day those 1,000 newly infected people pass on the virus to another 1,000 people, just as the original 1,000 tourists who started the epidemic are returning to health. With those getting sick and those getting well so perfectly in balance, the flu chugs along at a steady but unspectacular clip through the rest of the summer and the fall.*

[5] Gladwell, Malcolm (29 February 2000). The Tipping Point: How Little Things Can Make a Big Difference. Little Brown and Company.

> *Bu then comes the Christmas season. The subways and buses get more crowded with tourists and shoppers, and instead of running into an even 50 people a day, the average Manhattanite now has close contact with, say, 55 people a day. All of a sudden, the equilibrium is disrupted. The 1,000 flu carriers now run into 55,000 people a day, and at a 2 percent infection rate, that translates into 1,100 cases the following day. Those 1,100, in turn, are now passing on their virus to 55,000 people as well, so that by day three there are 1,210 Manhattanites with the flue and by day four 1,331 and by the end of the week there are nearly 2,000, and so on up, in an exponential spiral, until Manhattan has a full-blown flu epidemic on its hands by Christmas Day.*

While not specifically describing them the analogy suggests three concepts critical to the successful adoption of open access fiber to the premises in a community or region and across the nation. Gladwell does not clearly define them in his book so we will call them the relevant variables, the fulcrum, and the population.

Relevant variables are those factors that, given an adjustment, make a real difference in the system. If, for example, we want to freeze a cup of water, the amount of contaminates in the water and, especially, the temperature are relevant variables. The cup's color or the style of its handle have no impact on whether or not the water will freeze. In Gladwell's Canadian Flu analogy, the number of people encountered by each sick person and the infection rate of the flu are relevant variables. The infected person's job or the shoes they are wearing are not.

The impact of the relevant variables depends on the fulcrum – or the constellation of relevant variables that exists around the tipping point to maintain equilibrium. Very minor changes to relevant variables around the fulcrum make significant changes. Our cup of water will never freeze if the temperature is kept at a constant 33 degrees. However, a very small 2 degree change in temperature will turn the water to ice. At 35 degrees or at 29 degrees a 2 degree change will have no effect. At 60 degrees, even a 20 degree temperature change will fail to achieve the desired effect – ice. While physics does not allow it to happen while freezing water, it may sometimes be easier to change the fulcrum point than to adjust the relevant variables. That is, if you have 60 degree water and you are trying to have ice, you may need to move the freezing point of water instead of trying to cool the water.

Finally, the total possible population has a significant impact on the spread of a desired effect. In Gladwell's Canadian Flu analogy, the exponential epidemic spiral will end when everyone who can get sick is sick and a new saturation point – a new fulcrum – is reached. With our water, we will never get a quart of ice if we are starting with a cup of water.

When proliferating open access fiber to the premises in a community or region it is important to identify the relevant factors and to implement and measure actions designed to affect them or to adjust the fulcrum point. Further, it is critical – from the feasibility stage and throughout the life of the project – to know the constraints of the population.

3 Relevant Factors

Experience with multiple municipal projects has demonstrated a myriad of variables effecting potential success. Construction costs, competition, services, demographics, and more can all have a significant impact on the proposed project. Even the definition of success itself plays a role in determining success or failure. We will discuss four critical relevant factors sitting near the fulcrum of project success: scope, market execution, financial planning, and network design. It should be understood that scope, market execution, financial planning, and network design are inextricably tied together; nonetheless, we will do our best to address each of them in turn.

Scope

The size, or scope, of a municipal open access fiber to the premises network makes a difference. Scope

- Defines economy of scale opportunities,
- Is a prerequisite to attracting name brand service providers, and
- Enables or restricts network effects.

Economies of Scale

There are certain fixed costs when deploying a network of any size. Minimum staff is required to support the network, a head-end must be provided for video services, a network operations center (NOC) must be built, and so on. Most of these core functions require significant initial capital investment and very little incremental investment as new subscribers or addresses passed are added. The greater the scope of the project, the more efficiently it capitalizes on economies of scale.

Both UTOPIA and iProvo have significant excess capacity in their network core and their NOC:

- UTOPIA's core network was built early in the project process when project decision makers believed they would be passing 140,000 addresses in three years. When the project failed to achieve the number of homes passed, its 60,000 passed addresses were "stuck" with a robust core network designed to support more than twice its size.
- Looking at iProvo, at various times, UTOPIA has made arrangements to use the iProvo video head-end. The fact that the UTOPIA project could add its demand to the iProvo head-end and the capacity existed to absorb UTOPIA's demand suggests significant excess capacity.
- In order to achieve economy of scale discounts on set top boxes, UTOPIA purchased a very large number of them. When construction failed to pass goal numbers of addresses and take rates were lower than anticipated, UTOPIA was left with significant stock of set top boxes the project could not use and eventually sold them at a significant loss.

Lessons Learned from UTOPIA and iProvo

Economies of scale are important to maximize fixed cost capital investments and to achieve bulk discounts on equipment and other materials. Nonetheless, it is important to carefully plan and coordinate needs so as not to over-purchase to secure bulk purchase discounts.

Attracting Service Providers

When SBC acquired AT&T, SBC elected to retain the highly recognizable and trusted AT&T brand. Brand recognition matters to telecommunications and broadband consumers. Attracting a recognizable name as a service provider can contribute significantly to the success of a public open access fiber to the premises network. Attracting a recognizable name requires offering a sufficiently large potential market to attract the name brand company's attention.

There is no hard and fast rule defining the scope a project must represent before it can attract name brand service providers. UTOPIA initially indicated it would pass 140,000 addresses and that was sufficient to bring AT&T onto the network as a service provider. However, AT&T first abandoned its triple play intent by dropping its video product and later, when it became evident UTOPIA was not going to achieve its 140,000 addresses in three years goal, abandoned the network altogether. Another name brand service provider indicated that if the project were larger than 180,000 addresses they might be interested in participating.

A name brand service provider offers a municipal project three critical benefits:

- First, many consumers purchase telecommunications and broadband services based on brand recognition. Providing consumers with a name they know and trust will increase take rates.
- Second, a name brand service provider's decision to participate on the network represents a vote of confidence in the project from the service provider. That vote of confidence can be useful when persuading businesses and residents to subscribe to the network.
- Finally, a name brand service provider is more likely to have the resources to innovate on the fiber network than smaller providers. Innovative applications that truly differentiate the fiber network from the incumbent copper networks are very valuable to the network and magnify the value of network effects.

iProvo was initially only able to attract little known and now defunct HomeNet as a service provider. HomeNet failed at about the time AT&T abandoned its UTOPIA triple play intentions. UTOPIA had AT&T on the network for over a year but AT&T maintained a "wait and see" posture, did not use its name brand to advance UTOPIA's success, and eventually abandoned the project. This left both UTOPIA and iProvo scrambling to find a triple play provider. Both projects started with little known service providers as the anchor tenants.

In another tale of scope affecting service providers, MStar, a largely specialized DSL provider indicated they could develop triple play services and became the anchor tenant on both iProvo and UTOPIA. MStar built its triple play capabilities around a planned scope of more than 140,000 addresses passed. The failure to achieve this market scope is one of the many factors leading to the demise of MStar.

Lessons Learned from UTOPIA and iProvo

Neither iProvo nor UTOPIA achieved the scope required to attract and retain a nationally known name brand service provider. This failure may have contributed to the soft take rates experienced by both projects.

Network Effects

A product displays positive network effects when more usage of the product by any user increases the product's value for other users. Real study of network effects did not begin until the early 1970s. However, in AT&T's 1908 annual report Theodore Vail, after describing the economies of scale, innovation, and legal benefits of the Bell System's integrated vertical cooperation with its affiliated companies, explains[6] :

> *There is now a decided tendency on the part of the public to favor consolidation wherever there are two exchanges. A great difficulty in the way is that, as a rule, much of the duplication of plant cannot be utilized for many years, if ever.*
>
> *Gradually the public is becoming convinced that – quoting from last year's report –*
>
> *'Two exchange systems in the same community, each serving the same members, cannot be conceived of as a permanency, nor can the service in either be furnished at any material reduction because of the competition, if return on investment and proper maintenance are taken into account. Duplication of plant is a waste to the investor. Duplication of charges is a waste to the user.' (pp. 20-21)*

He then writes:

> *A telephone – without a connection at the other end of the line – is not even a toy or a scientific instrument. It is one of the most useless things in the world. Its value depends on the connection with the other telephone – and increases with the number of connections.*
>
> *The Bell system under an intelligent control and broad policy has developed until it has assimilated itself into and in fact become the nervous system of the business and social organization of the country.*
>
> *…*
>
> *Cheapness is relative to value, not to price. Value in telephone service depends on development, extent of system, certainty and promptness. (pp. 21-23)*

To paraphrase Vail, a gigabit network connection without a gigabit on the other end of the line (and throughout the line) is one of the most useless things in the world. That is, if the only places a network user wants to go focus their attention on only require 5 Mbps download speeds, the user doesn't need more than 5 Mbps.

It is no exaggeration to say that the Internet has changed the way many Americans work, communicate, and live their lives. E-mail alone would bear that same distinction, and "Google" has become a verb

[6] Vail, Theodore (1909). "Annual Report of the Directors of American Telephone & Telegraph Company to the Stockholders for the Year Ending December 31, 1908." AT&T. http://www.porticus.org/bell/pdf/1908ATTar_Complete.pdf.

because of its ubiquitous place in the lives of many Internet users. Well-known examples of other game-changing Internet offerings run the gamut of experience:

- Amazon.com and other successful online retailers changed the way Americans buy everything from books to groceries. Consumers often get better deals than in the past, too; easy comparison shopping means online and bricks-and-mortar stores face real price competition every day.
- eBay and other auction sites didn't just give people an alternative to setting up a yard sale in July – they gave entrepreneurs a platform for creating viable businesses out of their homes.
- Monster.com and similar sites gave job seekers instant access to employment listings, worldwide and at every level. Looking for work no longer means waiting for the Sunday newspaper to hit the doorstep.
- Craigslist has further eroded the importance of that local newspaper by offering free "classified ads" for any item or service you wish to sell – or give away.
- YouTube has given everyone with a video enabled cell phone the ability to post and play videos, instantly, from anywhere.
- Netflix and Hulu have had a dramatic impact on the way people watch movies and television.

In fact, look at any consumer or business relationship – banking, trading stocks, watching video of the latest news, interacting with your local government – and the Internet has changed it. During a time when most users had dial-up or relatively slow cable or DSL broadband connections, the Internet enabled the creation of applications and services that, as recently as ten years ago, were impossible for most people to imagine – and that was with application developers limiting their imagination to the bandwidth the incumbent transport networks could offer. Fortunately, they did not have to limit their imagination when it came to scope. Almost anyone could get dial-up Internet service.

Now imagine the innovation and possibilities presented by truly competitive and truly high-speed fiber connectivity. Fiber to the premises networks hold the promise of expanding on those previous innovations and acting as a springboard for innovations that most people can't yet imagine. In education and healthcare – in commerce and entertainment – the potential advances enabled by fiber's huge bandwidth are of the type that could lift the entire population. A fiber network offers enough bandwidth, for example, to support an interactive, high-definition video link between a teacher and a sick child in a hospital – enabling the child to stay connected to the classroom.

Is it possible to envision what educational opportunities, businesses, or social connections might be on the horizon? Perhaps we can dream of some but certainly there is a gigabit enabled Facebook or Google out there we simply cannot conceive until the bandwidth is available – and available with sufficient scope to make developing applications that depend on the bandwidth appealing. With open access fiber to the premises, the network owner does not have to try to create all of the potential applications. The network owner simply needs to build an environment that does not constrain the imagination of applications developers; an environment that offers bandwidth abundance on a large enough scale so that the value of developing applications that take advantage of the capacity of fiber becomes enticing.

As applications are deployed, their value is typically enhanced by more potential and actual users. New applications will bring new subscribers and new subscribers will inspire new applications.

Sufficient scope fuels network effects. Insufficient scope strangles continuing growth.

Lessons Learned from UTOPIA and iProvo

As of 2012, UTOPIA had passed 60,000 addresses with limited construction continuing in 2013 and beyond. iProvo has passed 35,000 addresses and has reached the limits of its growth. Neither of the projects on their own – or even combined – represent a sufficient market size to inspire development of new fiber dependent network effect applications.

To truly succeed, markets for fiber projects around the nation need to aggregate their scope for application developers. Cities should not only build their metropolitan areas but should also put in place support structures that help application developers tie into the markets in Kansas City, UTOPIA, iProvo, Chattanooga, and other very high speed networks.

Market Execution

In the wholesale/retail split model, network owner revenues primarily come from participating service providers. However, revenues are ultimately generated from sales made to subscribers. The network owner, asset manager, and service providers must be ready to support service provider direct sales, reseller opportunities, neighborhood fiber advocacy, and other sales models.

Typical feasibility surveys place likely market penetration for fiber to the premises overbuild projects between 55% and 70% with the potential market arcing close to 80%. "Table 2: Composite Market Survey Results" combines results from several market surveys in a variety of markets. The data is based on interviewees receiving some background describing fiber to the premises, how an open access network functions, and what the costs and benefits to subscribers would be. They are then asked some form of the question, "How likely would you be to switch to the fiber to the premises network?" Response options are given in some form of: Very Likely, Somewhat Likely, Neutral, Somewhat Unlikely, and Very Unlikely.

Residential			Business/Commercial	
100% of Very Likely & Somewhat Likely	76%	Potential Market	79%	100% of Very Likely & Somewhat Likely
100% of Very Likely plus 50 to 70% of Somewhat Likely	59% to 66%	Likely Market	61% to 68%	100% of Very Likely plus 50 to 70% of Somewhat Likely
100% of Very Likely	42%	Minimum Market	43%	100% of Very Likely

Table 2: Composite Market Survey Results

In spite of survey results, many municipal projects struggle to achieve projected take rates. "Figure 2: UTOPIA Take Rates through Time" shows the UTOPIA project has languished at between 15% and 17% take rates for more most of its history.

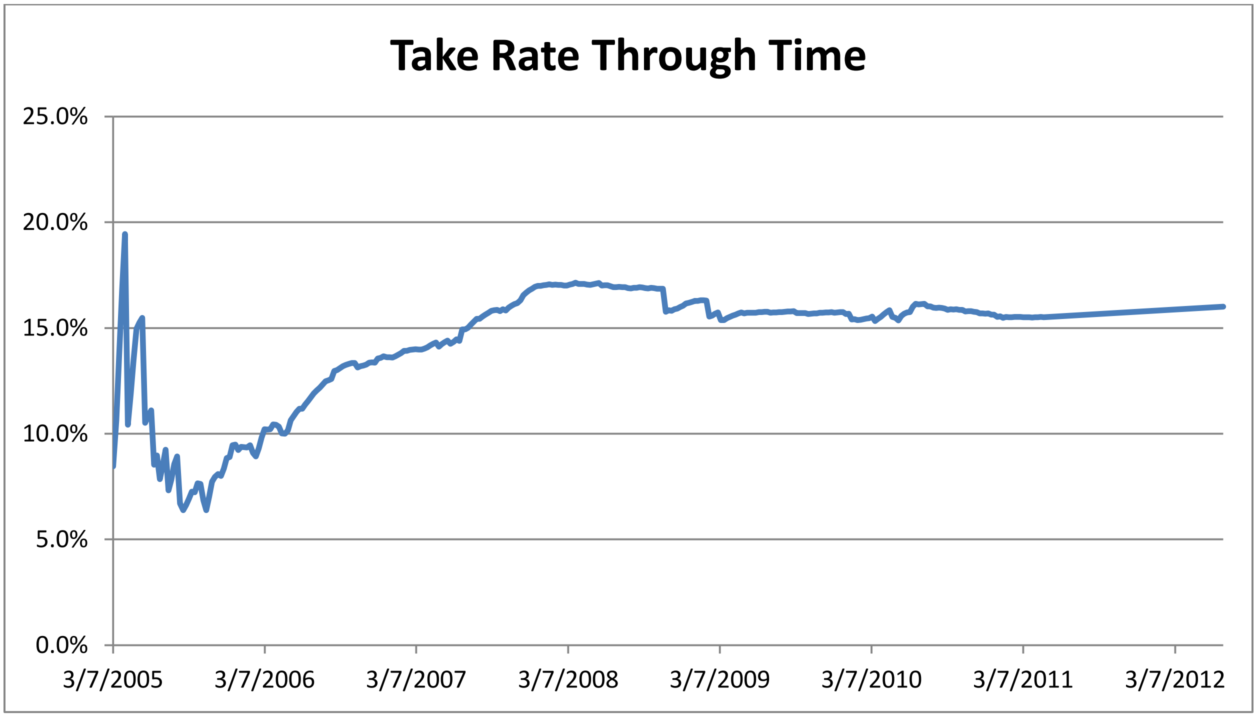


Figure 2: UTOPIA Take Rates through Time

The iProvo project has experienced very similar results to that of UTOPIA.

Unfortunately, as depicted in "Figure 3: Fiber Project Monthly Revenue and Expense" generic feasibility modeling suggests a fiber to the premises project needs to reach about a 30% take rate to meet financial obligations.

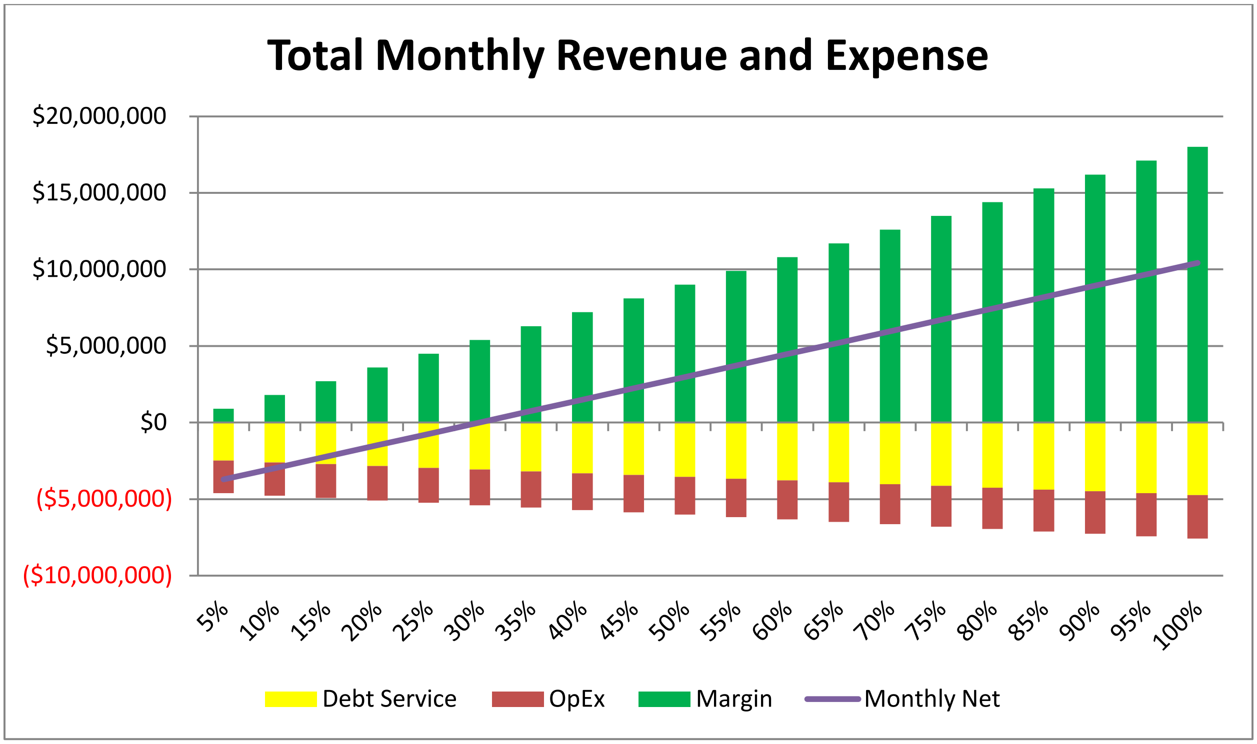


Figure 3: Fiber Project Monthly Revenue and Expense

The question must be asked, "What about these projects' market execution keeps them from passing take rate thresholds required to make them financially successful?"

In 2003, UTOPIA contracted Dean & Company to conduct a feasibility study. Dean & Company concluded their study with three recommendations intended to create a strategic focus on several factors that were key to maximizing the economic value created by the project. These recommendations included:

- Capitalize fully on perceived Local/Community advantage in marketing UTOPIA-based services
- Recruit providers of unique FTTH-intensive applications to differentiate UTOPIA from Comcast and Qwest broadband capabilities, e.g. telecommuting, entertainment-on-demand, gaming, home networking . . .
- Strong focus on serving the business community to capture the productivity benefits of fiber broadband. UTOPIA's sponsors should develop an integrated economic development plan around the benefits of a fiber infrastructure

In a 2002 feasibility study conducted by the Strategic Research Institute (SRI), SRI provided a discussion on the diffusion theory and identified what Geoffrey Moore calls the "chasm theory" in the diffusion theory of new innovations. The Dean & Company recommendation could have helped the UTOPIA project (and iProvo, for that matter) overcome soft take rates and cross the chasm. Before we look at the Dean & Company recommendations in more detail, let's review Moore's "chasm theory" in diffusion theory.

Diffusion Theory

While market surveys suggest probable take rates above 60%, municipal overbuild telecommunications projects seem to stagnate at a 15% to 20% take rate. Diffusion theory suggests that based on typical marketing efforts executed by these projects, about 17% take rates are to be expected.

While 17% take rates are short of the typical penetration required for success and far short of potential market shares nearing 80% it is in keeping with the results that could be expected from the marketing efforts typically executed in municipal projects. In 2002 Strategic Research Institute (SRI) produced a market survey titled "Closing the Chasm… Introducing New Products/Services into the Marketplace by Integrating Diffusion of Innovations with Product Life Cycle" by G. Gary Manross and Everett M. Rogers[7]. To quote from this report:

> *Diffusion theory says that the diffusion of an innovation is the process by which that innovation "…is communicated through certain channels over time among members of a social system."[8] The main focus of diffusion theory is on communication channels, both mass media and interpersonal, which transmit information about an innovation.*
>
> *Rogers' diffusion model suggests that there are five categories of people involved in the adoption process ([Figure 4: Diffusion Model]):*
>
> *Innovators (2.5% of the target population)*
>
> *Early Adopters (13.5%)*
>
> *Early majority (34%)*
>
> *Late majority (34%), and…*
>
> *Laggards (16%)*
>
> *These five categories of individuals have distinct characteristics that define their roles in the diffusion process.*

[7] Manross, G. Gary and Everett M. Rogers (2002). "Closing the Chasm… Introducing New Products/Services into the Marketplace by Integrating Diffusion of Innovations with Product Life Cycle." Strategic Research Institute.
[8] Rogers, Everett M. (1983). *Diffusion of Innovations* (3rd edition). New York, NY: The Free Press.

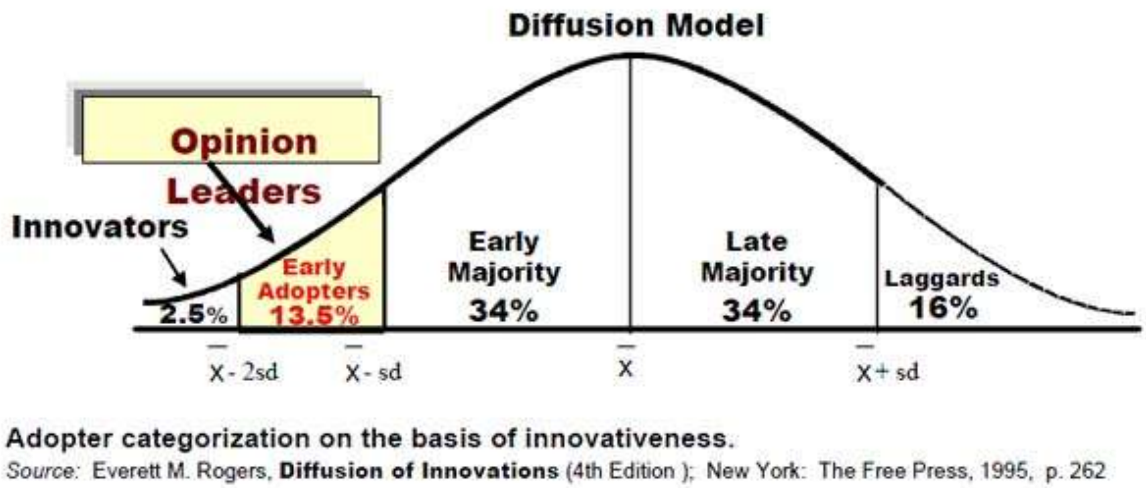


Figure 4: Diffusion Model

When an innovation (e.g., new product or service) is introduced in a marketplace, those in the category of innovators are the first to "try" the new product; and, in many cases, subsequently adopt it. This takes place in a relatively short period of time. Innovators, by nature, are likely to be risk takers who are willing to try new ideas because they want to be the first ones to do so. As a result, those in the other four categories seldom pay much attention to these individuals.

But if a given innovation being introduced in the marketplace is, indeed, a viable product or idea, then it is likely to begin gaining wider acceptance fairly rapidly. This process, of course, is influenced by advertising and price[9]. According to Kalish, "…The rate of adoption is determined by awareness (of the innovation), which is (heavily impacted) by advertising, and the rate of growth of (the) potential adopter population, which is controlled (to a large degree) by price."

Those in the second category – Early Adopters – are seen by both the early majority and late majority (categories three and four, respectively) as being opinion leaders. As a result, they are often thought of as the most important category of adopters, especially from a marketing perspective. Early Adopters are information seekers. While willing to take some amount of risk (certainly more than those in the three subsequent categories), these people want to make INFORMED DECISIONS. In terms of attributes, Early Adopters are often upwardly mobile and among the higher SES (socio-economic status), compared to other adopter categories.

[9] Kalish, Shlomo (1985). "A New Product Adoption Model with Price, Advertising and Uncertainty," Management Science, Vol. 32, No. 12, December, pp. 1569-1585.

> *The third category – early majority – pay attention to Early Adopters. Those in the late majority are inclined to follow those in the early majority. Laggards may never adopt a given innovation; at least not during the initial product life cycle.*
>
> *…*
>
> *Marketing researchers who have studied diffusion…paid particular attention to the Innovators and the Early Adopters, since they help define consumer behavior patterns.*
>
> *Opinion leaders…are those from whom others seek leadership and advice. Since these individuals influence the opinions of others, it is believed that attention must be given to them while developing a marketing plan. The assumption is that IF opinion leaders can be convinced to try a product, and subsequently develop a favorable attitude toward that product, they will communicate this attitude to others in the social system (the target market), thus, encouraging broader adoption.*
>
> *If Early Adopters are to influence the opinions of others, then these individuals MUST be effectively communicated with relatively early in the product life cycle. Additionally, it is important to identify the media habits of opinion leaders, so that we know the optimum methods of communicating with them.*

Typical municipal overbuild marketing efforts focus primarily on door-to-door campaigns. Door-to-door marketing is very good for capturing innovators and early adopters. However, the early majority is inclined to wait for a recommendation from a trusted opinion leader before adopting a new product. No matter how good they are at their jobs, door-to-door sales staff are seldom considered trusted opinion leaders. Thus, door-to-door efforts should expect to see adoption by innovators and early adopters – or, about a 16% take rate.

The Manross and Rogers report goes on to define the existence of a gap or "chasm" between early adopters and the early majority. Continuing with the report:

> *The adoption process begins with the notion that when prospective adopters (e.g., buyers) become aware of a new product, service and/or idea that is appealing to them, the KNEE JERK reaction is, in fact, a desire to adopt (purchase), or at the very least, give the innovation a try. In the short term, the knee jerk reaction leads to a decision to purchase.*
>
> *What is different between those individuals in the Early Market (visionaries) and those n the Mainstream Market (pragmatists) is that the former (visionaries) are far more likely to act on their knee jerk desire to adopt (purchase the product); while the latter (pragmatists) are inherently not risk takers. As a result, before adopting (making a decision to purchase), those in the Mainstream Market feel compelled to first "check it out" with someone they trust (an opinion leader); then make the decision to purchase or not to purchase. The higher the level of risk (e.g., the higher the price), the more likely*

pragmatists are to seek advice from someone they trust before making a decision to purchase.

Thus, what is likely to happen if:

The visionary to whom the pragmatist turns to for advice isn't aware of the product/service for which the inquiry is being mad?, or worse…

The visionary is, indeed, aware of the product/service, but does NOT perceive it as having sufficient value to purchase?, or equally problematic…

The visionary likes the product/service for which the inquiry is being made, but the visionary's reasons for adopting the innovation have nothing to do with the pragmatist's reasons for being interested in the innovation?...

Clearly, the likelihood is high that each of the above scenarios will result in a decision on the part of the pragmatist NOT TO BUY…

Without executing specific efforts to overcome the pragmatist inclination not to buy, the municipal project should expect take rates that include innovators and early adopters – or about 17% of the available market.

Lessons Learned from UTOPIA and iProvo

Neither iProvo nor UTOPIA created marketing efforts that would encourage early adopters to share positive experiences and recommend the network to the early majority. In fact, UTOPIA was greatly hampered by the fact that service availability has languished in a quilt like pattern due to lack of capital funds. This quilt like availability makes it so that even if an early adopter makes a recommendation, the potential subscriber may not be able to get service. The dampening effect of this quilt like availability on take rates is dramatically represented in a comparison between two UTOPIA cities: Payson and Lindon. In both Payson and Lindon, some construction was finished in Phase I of the UTOPIA project in 2004-2005. Both projects then languished until 2007 when Lindon was largely completed and Payson was not.

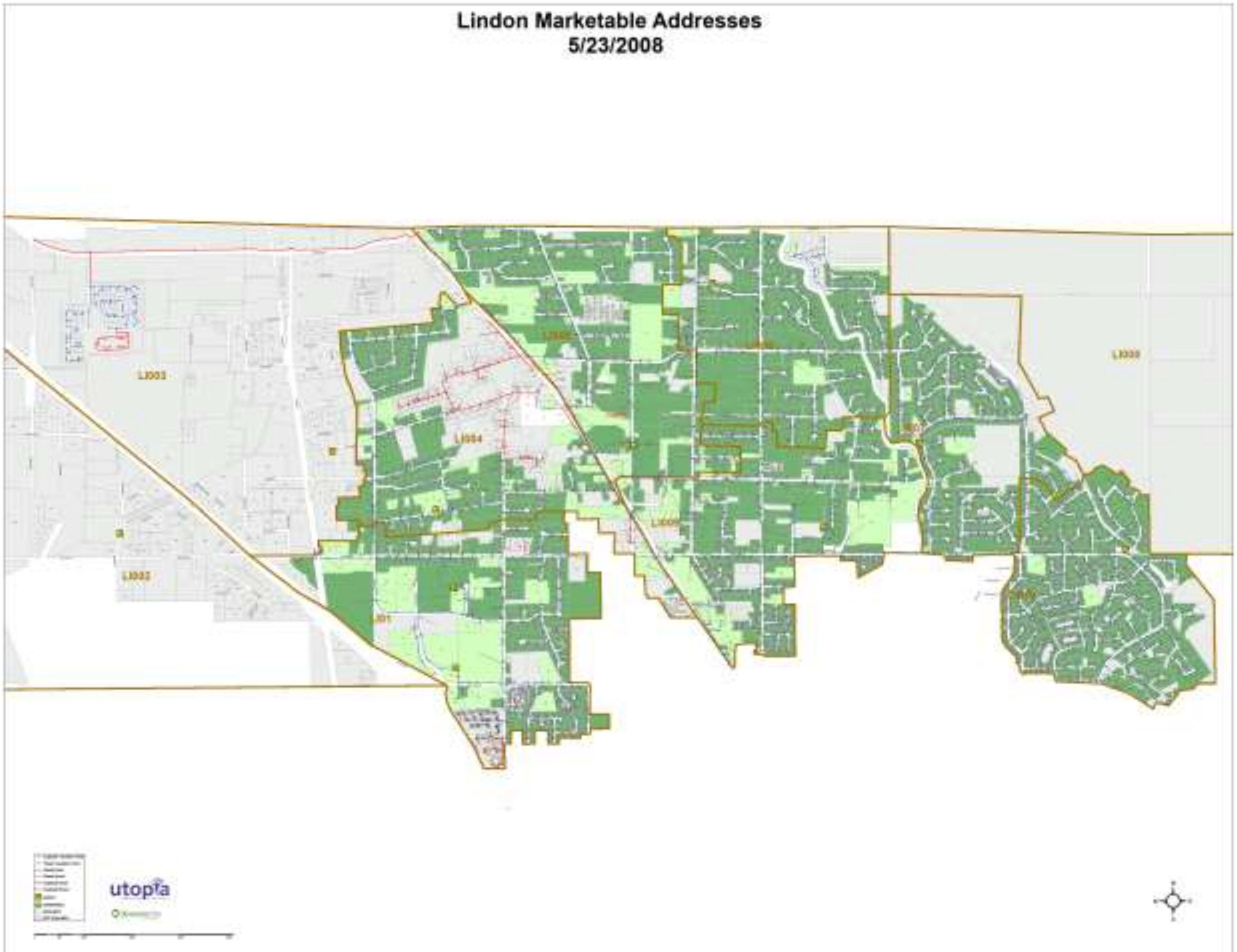


Figure 5: Lindon Available Addresses (in green)

"Figure 5: Lindon Available Addresses (in green)" shows available addresses in Lindon after 2007 construction was complete. The unavailable areas (in gray to the west and east of the bulk of the town) are largely undeveloped.

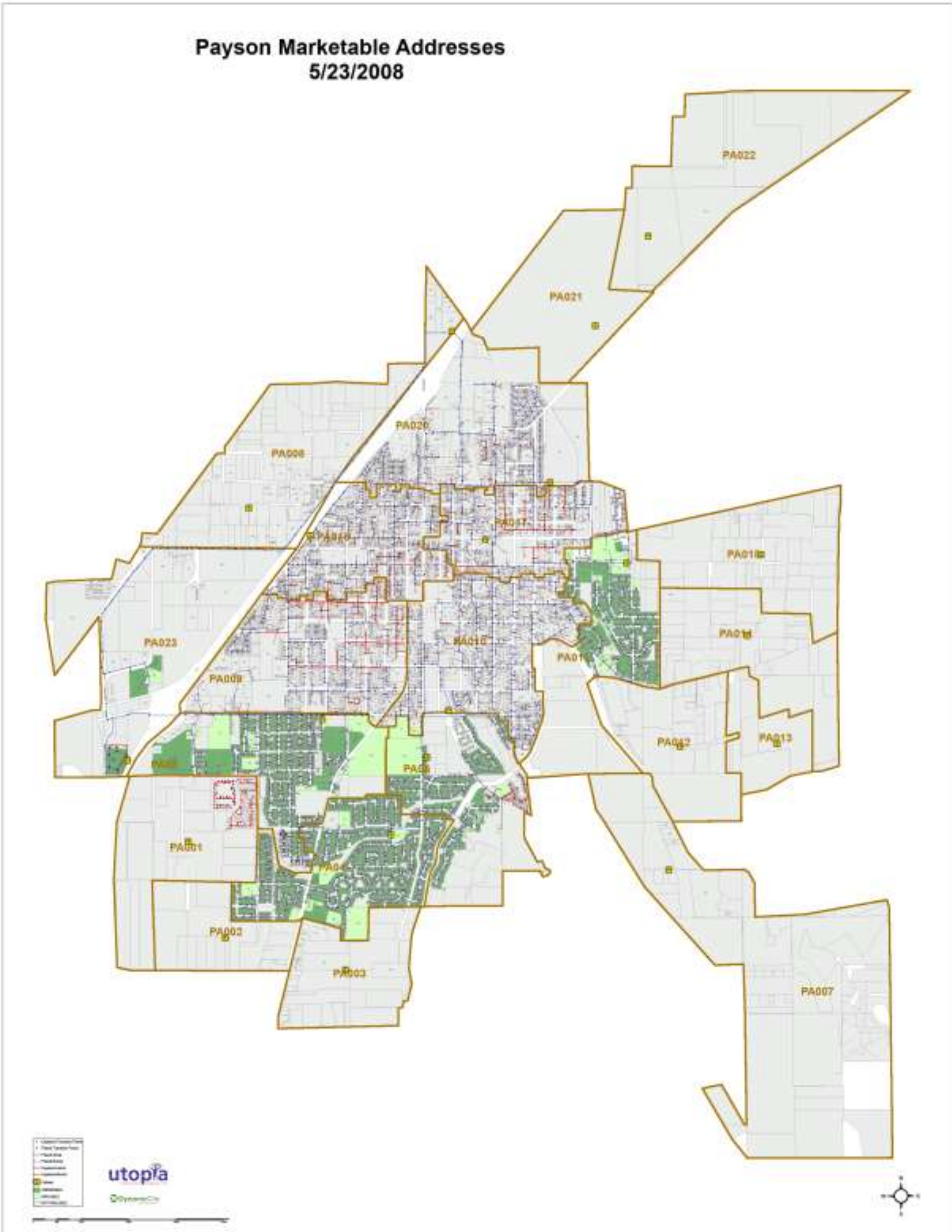


Figure 6: Payson Available Addresses (in green)

"Figure 6: Payson Available Addresses (in green)" shows available addresses in Payson after Phase II construction (2007). While much of the outlying areas of Payson are undeveloped, the unavailable area in the center of the map represents the majority of addresses in Payson.

So, as we compare the largely complete Lindon with the quilt like network availability in Payson, what was the take rate impact of availability and the power of word of mouth marketing as early adopters made recommendations to other potential customers?

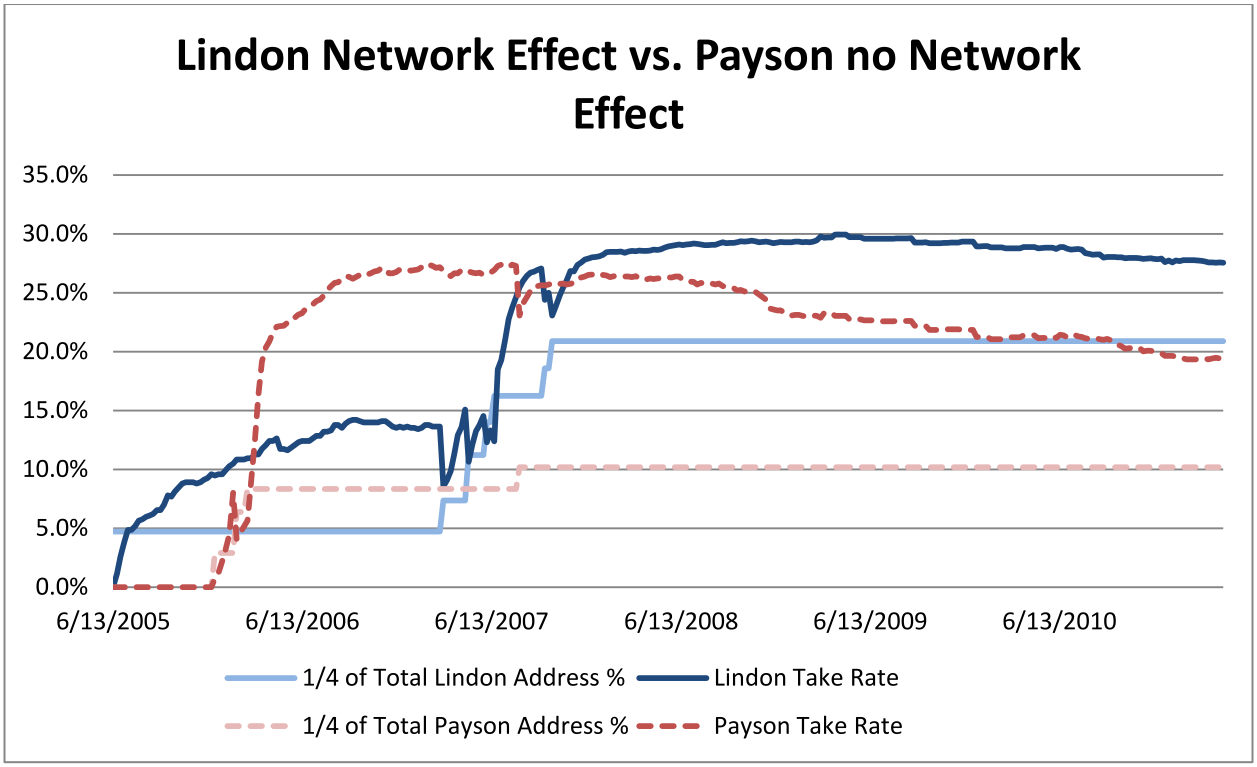


Figure 7: Lindon vs. Payson Available Addresses and Take Rates

"Figure 7: Lindon vs. Payson Available Addresses and Take Rates" shows Lindon enjoyed a significant increase in take rate (that is percentage of subscribers versus available homes) after the 2007 Phase II construction and Payson did not.

Of course some of the boost may have been from network effects or other factors. Nonetheless, one of the lessons learned is to ensure mechanisms are in place to close the diffusion chasm between the early adopters and the early majority to get beyond 17% take rates.

Near ubiquitous deployment enabling functional visionary and early adopter recommendation market effects is one of the things needed to close the diffusion gap. The elements recommended in the Dean & Company report also play a significant role.

Community Benefits

A municipal fiber to the premises network can provide community benefit without the stigma of generating profits for a behemoth out of town provider. These benefits can include economic development, education opportunities, health care advantages, civic engagement opportunities and others. All of the potential benefits of a municipal fiber network exist to one extent or another in the iProvo and UTOPIA networks. However, neither community has done an effective job of highlighting these community benefits and setting the network effort apart from the large multi-state incumbents. A quick search for either project will reveal a long list of articles about them – most of them dealing with the projects' financial struggles and the projects' teams' responses to criticisms about their financial struggles.

The interlocal agreement that chartered UTOPIA states, "WHEREAS, this joint effort in creating a wholesale telecommunication utility makes the most efficient use of the Members' powers in a mutually advantageous way, including the benefit of economy of scale, which will facilitate superior services to residences and businesses; enhance government administration; provide more functional buildings and grounds; support better educational opportunities, health care, and police and fire protection; and spur economic development." This chartering statement indicates the network will:

- Facilitate superior services to residences and businesses,
- Enhance government administration,
- Provide more functional buildings and grounds,
- Support better educational opportunity, health care, and police and fire protection, and
- Spur economic development

However, when we look at UTOPIA's web site (http://www.utopianet.org), we can learn about residential and business services but we cannot find anything celebrating how the project meets the other chartering objectives. It is almost as if UTOPIA has abdicated its chartered responsibility and abandoned the community benefits message Dean & Company suggested the project focus on.

Lessons Learned from UTOPIA and iProvo

Community benefits are an important reason municipalities undertake to build broadband networks. If the network owners and operators fail to highlight the community benefits, they are reduced to competing with incumbent providers on the incumbent providers' terms.

In both the iProvo and UTOPIA projects, early project leaders focused on the financial benefits the projects would bring the cities. Project leaders suggested the networks would become not only self sufficient enterprise funds but that they would generate profits that could be used for other community enhancing projects. When the projects failed to produce the revenues to do so, the perceived community benefit was also lost. Public projects should focus on the community benefits intrinsic in the community network, not those that can come as a secondary benefit as revenues are (or are not) generated from the network.

Differentiation

Dean & Company recommended to UTOPIA that the project "recruit providers of unique FTTH-intensive applications to differentiate UTOPIA from Comcast and Qwest [now CenturyLink] broadband capabilities…". The same advice could easily have gone to the iProvo project. Attracting unique FTTH-intensive applications would have created a reason for subscribers to select the fiber network over the incumbents and would have helped create a virtuous cycle of network effects.

Unfortunately, neither network was able to recruit providers willing to offer fiber intensive applications. In point of fact, both networks restricted their ability to do so by providing wholesale packages that encouraged service providers to offer services very similar to the incumbent providers. Rather than creating the environment of bandwidth abundance and application innovation that a fiber network should offer, UTOPA's and iProvo's wholesale packages encouraged marketing bandwidth scarcity and forced service providers to think of services in traditional triple play silos.

Lessons Learned from UTOPIA and iProvo

A fiber to the premises network is significantly different than a traditional copper based network. Municipal fiber projects must emphasize bandwidth abundance and innovative application delivery.

If the municipal project is not able to recruit innovative application providers, the project may have to develop innovative services it makes available to its service providers on a wholesale basis.

Business Community

The Dean & Company feasibility report suggested a "Strong focus on serving the business community to capture the productivity benefits of fiber broadband." Both UTOPIA and iProvo indicated they were focusing on businesses but their practices demonstrated otherwise.

First, UTOPIA and iProvo chose pricing models that charged businesses higher rates than residential subscribers – not because the services being delivered were better than residential services, but rather simply because the subscriber was a business. This pricing model is a legacy arbitrage model based on the days when incumbent providers were forced to compensate for regulated thin margin residential price caps by charging businesses premiums. While the industry accepts the practice, it does not represent a strong focus on serving the business community.

Next, UTOPIA and iProvo chose to handle business order fulfillment differently than residential order fulfillment. In both projects cases, the business order fulfillment timeline was significantly longer than the residential order fulfillment timeline. The business order fulfillment timeline penalty discourages businesses from switching to the community networks.

Finally, neither UTOPIA nor iProvo established relationships with business service integrators or built any kind of effective business channel partnering.

In sum, saying you have a focus on businesses does not mean that you do.

Lessons Learned from UTOPIA and iProvo

The residential marketplace represents the vast majority of potential subscribers for a ubiquitous fiber to the premises deployment. Some fiber over-builders (like Google) have elected to focus almost exclusively on the residential marketplace. However, a true focus on businesses can help spur revenues and accelerate take rates for both business and residential subscribers. The focus has to be substantial and more than simply words.

Financial Planning

Both UTOPIA and iProvo made three critical financial planning mistakes:

1. Neither project included sufficient capital for customer connections.
2. Neither project established financial backstops, guarantees, or insurance mechanisms.
3. Both projects advertised early that they would not only be self sufficient but would also generate revenue for their participating cities.

UTOPIA further exacerbated its financial distress by not having sufficient funding secured to finish the scope of the project at the project's outset.

Include Sufficient Capital for Customer Connections

Both UTOPIA and iProvo deferred drop level infrastructure costs to the order fulfillment process. Because of this, financial analysts for both projects considered drop level infrastructure costs to be operational costs, not a capital costs. Averaged through time, drop level infrastructure has little impact on operations. However, in the initial weeks and months after a service area becomes available, new connections consume significant resources. This imbalance can tip the project into failure – especially if there is no source of funds for customer drops.

Establish Financial Backstops

UTOPIA and iProvo are frequently used by opponents of municipal projects as case studies of why cities should not get engaged in broadband projects. The argument goes that municipal projects are financial drains on the cities who try them because municipal broadband represents a group of broadband amateurs entering a very competitive marketplace. Returning to Senator Pugh's op-ed, "Those who want to win the argument about whether government can stimulate a struggling economy would be well advised to stick with what we know works and stay away from fanciful boondoggles."

There is certainly financial risk involved in building a municipal broadband network. However, we believe we have found mechanisms to guarantee against that risk. We propose using a life settlement investment vehicle to create a principal assumption and repayment program – thus removing principal repayment from the project's debt service model. We further propose using an annuity based performance bond to guarantee project success.

Of course these insurance policies come at a cost. To create a near zero financial risk project, we would nearly double the capital outlay required at the outset of the project. However, the financial backstops are designed to protect not only the capital required to build the network but also the capital required to protect the investment.

Alternatively, a community can determine that the benefits of the network outweigh the possible need to subsidize capital expenditures and operations from other revenue sources.

Do Not Focus Conversation on Excess Positive Revenue

Municipal networks have many community benefits. One of them might be generating positive cash flow that can be transferred to other community development projects. Unfortunately, UTOPIA and iProvo emphasized positive cash flow as a key benefit of the projects. When positive cash flow failed to materialize, opponents of the projects had an easy time arguing the projects were failures.

Secure Sufficient Funding to Finish the Project

The UTOPIA project originally envisioned three phases of construction. Because of restrictions in Utah law, the project was only able to use tax backed bonds for the first phase of the project. The intent was that revenues from the first phase would be sufficient to justify revenue bonds for additional construction. When revenues were insufficient to justify revenue bonds, UTOPIA had no backup plan and was left with a partially completed quilt like footprint of available addresses.

Network Design

Network design must accommodate the guiding principles of:

- Open access offering wholesale services to all qualifying service providers,
- Carrier class security, functionality, and reliability,
- High scalable bandwidth, and
- Based on an open and independent architecture.

UTOPIA and iProvo had very similar network designs – network designs that were well suited to support the success of the projects if the other success requirements had been met. The two projects made different electronics choices and different configuration choices but architecturally the networks are very similar active Ethernet designs. We will take a moment to review some of the design guidelines driving both projects.

Outside Plant Design

In competitive overbuild scenarios the need to defer complexity and cost to as close to revenue generation as possible dictate that initial network construction be limited, as much as possible, to required elements. This typically means initial construction will end at the property line of potential subscribers – only extending to those addresses that pre-subscribe. In other words, drop level infrastructure is deferred and fiber is placed up to, but not beyond, the property line for each residence and business. In this scenario, sufficient planning must be done to ensure order fulfillment is easy. Relief planning must also be well thought out in order to accommodate for greater than expected success and for new growth.

To reduce the cost of construction, the access and distribution network is run predominantly up one side of the street only, with laterals crossing the street at reasonable points. During initial construction phases, these laterals can be left as empty conduits connecting the subscriber splice box to a lateral pull box. In this deferred drop model, when a consumer requests services, a conduit is placed between the lateral pull box and the new subscriber's premises. The drop fiber is spliced at the subscriber splice box and pulled (through the lateral pull box if across the street) to the home for connection to the interior or exterior electronic termination point. The termination point is a piece of customer premises equipment (CPE) known as the optical network terminator (ONT) or the access portal (AP).

Redundancy

The next consideration in architecting the network examines the value/requirements of single vs. dual physically redundant fiber paths to each end point. If there are two paths the fiber can take to get to the end user, then the reliability of the solution increases – but so do the costs. An appeal to municipal network guiding principles leads municipalities deploying open access fiber to the premises to a determination to provide redundancy in all layers of the network down to, but not including, the home run.

A typical analysis of potential revenue opportunity, construction costs, and the frequency of outside plant cuts, usually suggests that the extra cost associated with providing a redundant path to every end-point exceeds available revenue streams. More specifically, under current market conditions, physically diverse paths to most businesses could be offset by projected business revenue, but redundancy to support residential services could not. Further, business premium rates are likely to diminish through time as deregulation eliminates arbitrage opportunities making long-term dependence on premium business pricing unrealistic.

The distinction between business and residential customers is not determined by zoning: businesses will co-exist with private residences in many areas. Certainly with the advent of the Internet almost anyone with the desire to develop a website could also develop a work-from-home economic model. In point of fact, open access fiber to the premises encourages more work at home and home based businesses. This means that plans for what are traditionally viewed as "residential neighborhoods" must allow for the inclusion of redundant fiber runs to home-based businesses – both now AND in the future. Rather than attempting to deploy redundancy to all addresses in the initial design, it is important to be able to add access and drop level redundancy as customers demand it (and as they are willing to pay for it).

Strand Counts

An additional question that needs to be answered is how many fibers should be taken from the different physical locations back into the network. For a typical residence, a single strand of fiber is sufficient. This conclusion is supported by the understanding that a single strand of fiber has over 150 Tbps theoretical carrying capacity. Businesses, MDUs, and MTUs may require, in some cases, not only redundant connections, but also multiple fibers to service their needs. To accommodate possible redundant connections and multiple fibers to certain units, municipal open access networks should be designed with fiber counts to address immediate needs and with relief plans to ensure the ability to meet future demands.

Optimal Fiber Aggregation

After evaluating some basic decisions as to how the outside plant should be structured, the cost associated with deployment must be considered. Since construction costs are the single largest capital expenditure component of a municipal open access fiber to the premises implementation, a careful analysis of the impact that design has on construction costs is critical.

The goal for a proper outside plant analysis is to gather and analyze information on all of the pertinent material, components, and labor costs related to both aerial as well as underground deployment. Such an analysis should identify the most cost efficient location to terminate the dedicated fiber strands and to implement fiber sharing technology. In other words, how many homes will be serviced by a single aggregation point, or community cabinet (determining the optimal fiber aggregation point or OFAP)? The OFAP approach has been applied to various network deployments for quite some time, including design work to support digital loop carrier deployments, fiber node placement for HFC, and in the 1990s WINfirst FTTP deployments in Sacramento and Dallas where the OFAP technique was used to layout the most efficient fiber aggregation cabinet sizes and locations.

In the analysis, it is important to note that costs for construction vary not only region by region but city by city and even neighborhood by neighborhood. The primary variables affecting construction costs are related to the density of homes/structures per constructed mile and the type of construction required - either buried or aerial plant. Because of constant variation in costs, the optimal engineering design needs to be flexible enough to adjust fiber routing and aggregation strategies during engineering. As service areas are outlined and as the outside plant design gains detail careful consideration and reconsideration of the OFAP must be taken.

Distribution Network

Identifying the Community Cabinet location where each of the dedicated access fibers terminates allows the design of the distribution network. The distribution fiber should be deployed with thought given to the principle of providing a carrier class network.

The most obvious approach should be to deploy physically diverse redundant paths from these access nodes back through to the core nodes. This distribution network, which connects the dedicated access plant from the community cabinets through to the hub locations, should have a fiber count based on the type of access technology chosen.

Access Portals

Despite commonalities in these areas among certain available solutions, aspiring open access fiber to the premises network owners should evaluate the interaction of different vendor solutions across each layer. During this evaluation, an interesting debate presents itself: where to place the customer premises equipment that terminates the fiber connection (the access portal or AP). Should it go inside or outside the premises?

Different deployments across the country show that both are reasonable options – it's really a question of balancing trade-offs. Placing the AP indoors leads to questions of ownership and liability, maintenance access to equipment, and so on; placing it outside leads to questions about security from tampering, protection from the elements, and so on. Ultimately, the additional cost of hardening the enclosures for outdoor placement seems a greater concern than an indoor placement with less access.

Logical Network Considerations

As with all other key decisions, municipalities implementing open access fiber to the premises must select transport layer topology through an appeal to principles guiding municipal deployments. To discover what options exist, aspiring network owners may solicit proposals from vendors through a public procurement processes or other means.

As might be expected, vendors offering anything other than the Ethernet or SONET compliant solutions are unable to commit to interoperability – even those compliant with the industry standards. Even though the FSAN standard has been under development for quite some time, few vendors can propose solutions using that standard that can provide a list of other vendors with whose solutions theirs were compliant. The other common industry standard, SONET, has vendors who are, in fact, interoperable. Of course vendors representing unique solutions or solutions based on the developing GPON standard are unable to commit to any kind of interoperability whatsoever. Clearly, in appealing to the guiding principles and by committing to adopt solutions that supported open and independent network standards, only vendors offering Ethernet solutions, with dozens of interoperable respondents, make sense.

Traffic Management

The guarantee that services can be delivered in a carrier class manner is affected by more than cable cuts; it also requires sufficient bandwidth and traffic management capabilities. Network designs should be scrutinized for traffic management support, including the ability to manage traffic flows in a sufficiently granular fashion to preclude one service provider's services from over-riding or interfering with another's. ATM and SONET have been designed with significant traffic management capabilities. With their deterministic cell and pipe characteristics, these protocols excel at traffic management and isolation. SONET is a bit less flexible; the lowest level of granularity for traffic management is by definition a virtual tributary, but SONET vendors offer a mix of Ethernet and ATM interfaces complete with switching fabrics with their products.

Native Ethernet has had the ability to identify or tag different types of traffic, but it was not expected to scale to city-wide proportions and certainly not to provide bandwidth management. However, supplementing Ethernet with the standardized implementation of MPLS and label switch paths allows for the utilization of predominantly switching protocols to provide connectivity in a reliable and managed fashion without intruding on the service provider's quality of service management techniques. Prior to employing MPLS, Ethernet access infrastructures utilized ATM core switches or even SONET to ensure traffic handling characteristics suitable to maintain availability of services. Today, Hierarchical Virtual Private LAN Services support scalability, and Ethernet access infrastructures can be aggregated through MPLS core networks to allow for the entire pertinent network characteristics required: availability, bandwidth, packet loss, latency, and jitter.

From the perspective of traffic management, then, there may be no clear differentiator: ATM, SONET, and Ethernet/MPLS all addressed the need for reliability as it pertains to building a carrier class network.

Scalable Bi-Directional Bandwidth

Inasmuch as there is no practical difference in the reliability of managing bandwidth among ATM, SONET, Ethernet/MPLS solutions, the availability of high, scalable bandwidth itself remains as an area of prime differentiation.

Included in the principle of high scalable bandwidth is the requirement for symmetrical transmissions. Examples of networks that follow an alternative logic are the hybrid fiber coax networks deployed by the cable companies. The HFC networks which were initially engineered with the assumption that the download usage would be roughly 17-19 times that of the upload, do not provide symmetrical transmissions. This assumption may have been the result of the cable industry's focus on their previous pure broadcast model, or it could have come about due to the belief that most people would be satisfied with browsing and downloading from the Internet while only a select few would actually generate content to push. Shortly after these networks were deployed, capacity planners began to see download to upload ratios much closer to 3 to 1 rather than 17 to 1.

Today, the Internet has become a network for interactive communications. A predominant value of the Internet is its ability to bring people with similar ideas together and to create virtual communities around real communities or common interests. These groups interact through their web pages, blogs, instant messaging, voice services, video conferencing, email and other bi-directionally intensive methodologies. Their interaction, however, is limited to what their bandwidth supports, and this is proving to be a growing source of frustration for many. In recognition of the growing need to push information out to the Internet in an interactive fashion, any practical solution to the demands of building a network with high, scalable bandwidth should include symmetrical high-speed transmission.

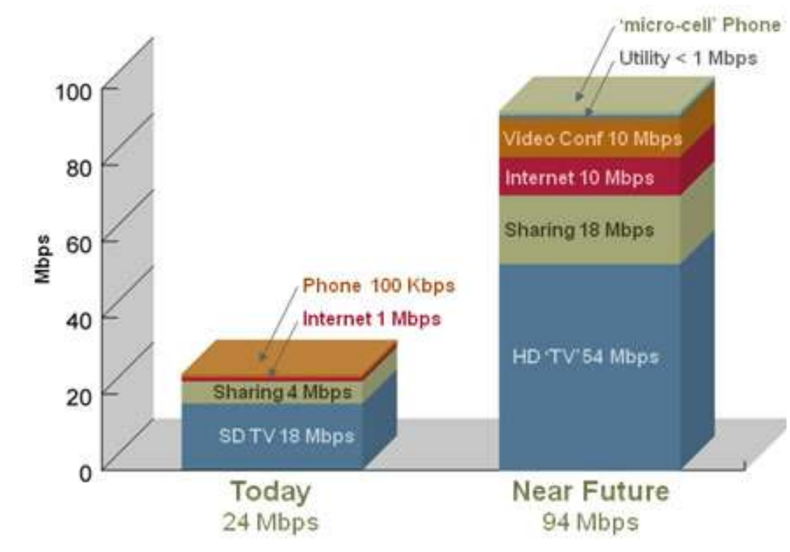


Figure 8: Near Future Bandwidth Requirements

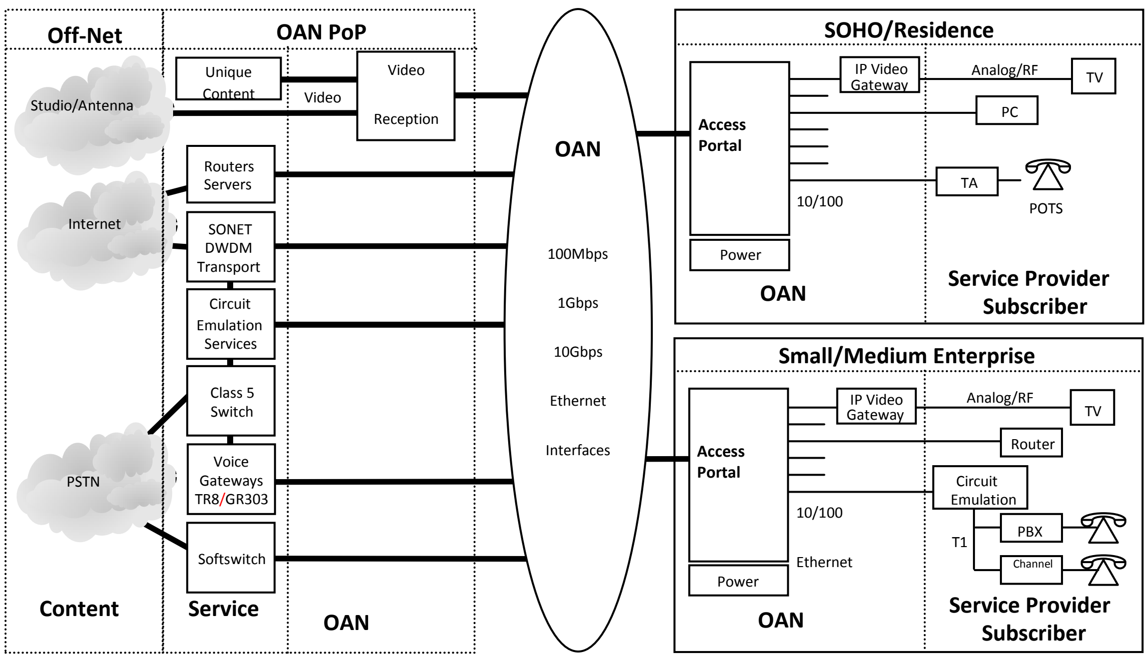
Bandwidth needs are projected to continue to expand as capacity is provided for expansion. "Figure 12: Near Future Bandwidth Requirements" shows today's bandwidth needs compared with projected needs in the near future.

Network Interfaces

A Layer 2 Ethernet infrastructure is very well suited for native data applications. Since most applications are already designed to accommodate Ethernet's dominant global standard for data interfaces, the network needs offer just a couple of options to support the bulk of these applications:

- The Access Portal (or AP) represents the media conversion point, and traffic mapping interface, for data applications.
- Optical Interfaces may be required for more sophisticated businesses, both via multimode as well as single mode fiber. Those interfaces can be handled directly off of the open access network (OAN) access distribution switches.

Other standard applications, such as telephony and voice, should not require end-users to change their telephony device. To overcome the need for specialized equipment a terminal adapter could be deployed by the service provider. “Figure 13: Network Interfaces” illustrates the applications interface.



- Data Services interfaced via standard CAT5 and optical Ethernet
- Traditional POTS/T1 services through terminal adapters
- Video received into IP Head-end and through video gateways

Figure 9: Network Interfaces

As with voice and telephony, video-based services should not require end-users to upgrade all of their equipment to support a digital data only delivery mechanism. Using video gateways in the premises to convert and deliver standard video signals to existing TVs and receivers, the network can control ingress and egress of traffic and still remain open.

Service providers benefit from these common interfaces as well as end-users. If a retail service provider was required to build a head-end, integrate the middleware and digital rights management and purchase and deploy their own residential video gateway, then the barrier to enter the video market on the municipal network would be too high for all but the most resource rich providers. By integrating these functions, based on global standards, into the design and scope of the municipal open access fiber to the premises network, content providers who do not have any interest in those facilities can still be able to deliver services to the end-user. This same logic can be applied to other services as well. It is important that the network owner provide multiple network interface models to accommodate varying degrees of service provider sophistication.

The decision to incorporate certain services layer functionality demonstrates a municipal network owner's engagement in ensuring an open and competitive environment across the shared infrastructure. By no means should a network owner prohibit resource rich providers from deploying their own head-end or other facilities based services. However, the economic development and other public policy interests of the project may drive owners to extend service availability to a larger number of competitors.

Capacity Management

The correct operations model is as important to the success of a municipal network than is any particular technology decision. Once an operational model is selected and the technology has been chosen and deployed, the business of asset management, and in particular capacity management, becomes the architect's primary focus. With the utter failure of the mystical, metaphysical, and alchemical industries to deliver a working crystal ball, most engineers find they are only able to guess at the actual demands and performance of the network or determine how the infrastructure is going to behave with the deployment of advanced services. Using imagination and a good spreadsheet, planners can make a few basic assumptions to illuminate the potential capacity issues infrastructure might experience.

An overview of a typical municipal deployment shows four main paths along which traffic will flow through a cascading aggregation topology.

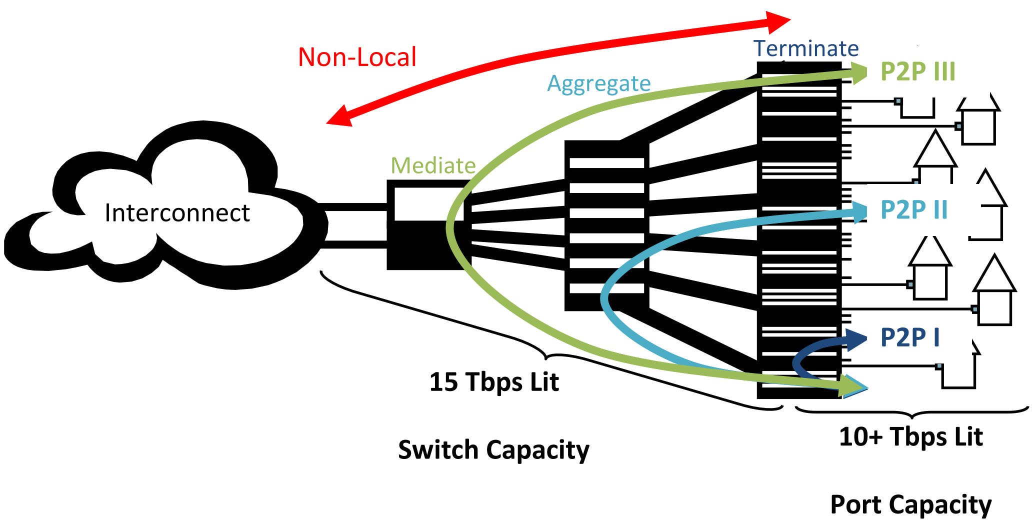


Figure 10: Cascading Aggregation

Terminate traffic or P2P I traffic is localized within a given footprint (about 900 addresses or 360 subscribers at a 40% take rate) and is limited primarily by the port speed and the ADS device backplane.

Aggregate or P2P II traffic is between devices within a community (up to about 30,000 addresses or 12,000 subscribers at a 40% take rate) and is limited by distribution ring capacity and the DCS devices.

Mediate traffic or P2P III traffic is between devices anywhere on the network and is limited by core ring capacity and the performance of the RCS devices within the distributed core.

In order to fully capitalize on the traffic management properties of cascading aggregation (to achieve the traffic patterns depicted above) and maximize the network's capacity for future services, service provider peering must be in place. Without service provider peering, a device from one resident service provider's customer communicating with a device from another resident service provider's customer must traverse all levels of cascading aggregation, leave through the one service provider's interconnect, re-enter the network on the other service provider's network and again traverse all levels of cascading aggregation thus behaving as non-local traffic. Implementing service provider peering will:

- *Mitigate Cascading Aggregation Point Traffic*. Without service provider peering all inter-service provider traffic must traverse the entire network. This requirement forces unnecessary traffic onto the aggregate, mediate and non-local levels of the cascading aggregation model.
- *Reduce Service Provider Interconnect Costs.* Without service provider peering all inter service provider traffic must flow through both service providers' interconnect points. Most service providers pay for their interconnect in steps based on the amount of throughput they require. The more services they can provide their customers "on net," the more manageable their interconnect costs become.
- *Encourage High Intensity Bandwidth Application Development.* Without service provider peering, high intensity bandwidth applications are loosely limited in availability to only the developing service provider's subscribers. With service provider peering, the potential user base for high intensity bandwidth applications opens up to all fiber subscribers. The larger user base should help encourage development of distinct high intensity bandwidth applications.

Service provider peering does not come without its challenges. Nonetheless, the advantages are great.

One method for analyzing capacity is to break potential services into three groups: existing, imminent, and possible. Each service should be given defined characteristics that allowed a general impact assessment on the network. The typical usage cycle, bandwidth required, and traffic connectivity (point to point and level of locality) are sufficient to discover some relatively obvious conclusions.

Advanced services are defined only for the purposes of stressing the network resources. An analysis can be performed by network layer to discover which layers would need reinforcing based upon various services mixes and associated traffic patterns. By introducing different scenarios of service penetration evaluators get a sense of how the links between the layers in the network are stressed beyond their initially planned levels.

As results of an analysis are reviewed, evaluators will note that the bandwidth available on the dedicated link to the home, with only one subscriber sharing that link, is the least likely portion of the network to fail. Typical service penetration scenarios will show adequate capacity. Evaluators will most likely conclude that the most difficult part of the network to change - the portion deployed to every end point - will be the last part of the network to require an upgrade. As would be expected, the more subscribers that share the network resources, the more likely it is that that portion of the network will require the deployment of additional, more advanced technologies. Evolving the connections between switches in the core of the network from a 20 Gbps link to an equivalent of a 200 Gbps link is likely to be the most important evolution after the initial deployment of the network resources has been accomplished.

4 Conclusions

Deploying a municipal open access fiber to the premises network is not an easy task. However, it is also not a new endeavor. Potential network owners can learn lessons of both what to do and what not to do from projects that have gone before them. We have identified scope, execution, financial planning, and network design as four critical factors affecting a project's potential for success.