Martinsville, Virginia

Fiber to the Premise Feasibility Study
November 30, 2012

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Overview of the Project

The City of Martinsville engaged CCG Consulting, LLC ("CCG") to study issues associated with building and operating a fiber-to-the-premise (FTTP) network within the City. In its Request for Proposal the City detailed the scope of work for the project as follows.

Scope of Work

The City requested that we look at the following things:

- Current Operational Issues
  - Additional workload anticipated resulting from fiber expansion
  - Bookkeeping Issues – establish "fiber" as an enterprise fund or as a separate City department
- Financial Business Plan
  - Consider at least two possible options – (1) expansion to serve businesses /government entities only; and (2) expansion to serve (1) and also a FTTH (fiber to the home) expansion.
- Preliminary Engineering – some level of engineering will need to be performed in order to determine a cost estimate associated with a fiber project expansion.
- Evaluation of Incumbent Providers – an evaluation of the products and pricing structure of incumbent providers will need to be performed to determine competitive pricing levels for service.
- Written Report/Deliverables
- Identify Potential Future Tasks for Consideration

To meet these objectives CCG took the following steps:

- We conducted residential surveys for a statistically valid sample of residences in the City.
- We used the results of the survey to customer penetration rates of services that can be sold over the network.
- We analyzed the products and prices of existing providers in the community.
- We discuss pricing strategies the City ought to consider for a FTTP business and recommend prices to use in the feasibility report.
- We discuss marketing strategies that can be used to accomplish the projected customer penetration rates.
- We include a discussion of how much speed broadband customers are going to need today and into the future.
- We discuss why broadband is important and look at the benefits of a fiber system in the City.
- We performed a high-level engineering design of a fiber-to-the-home system that can deliver the triple play (Cable TV, data and telephone) to the businesses and residences in the City and the County. We also discuss the technologies in use in the City today and the fiber technology that you are considering using in the future.

- We developed several versions of financial business plans to determine if there is a viable economic model that would work for bringing broadband to the City. We talk in detail about the assumptions used in the financial models.
- We discuss ways the City can get the project financed.
- We prepared a time line showing the major tasks required and one possible time path for implementing a FTP business in the City.
- We discuss the best administrative models for operating this kind of business including looking at an enterprise fund along with the issue of subsidies.

Executive Summary of the Results of the Study

CCG Consulting, LLC (CCG) submits this report on our findings and recommendations concerning broadband in Martinsville.

FINDINGS

CCG reports the following findings:

- The survey showed overwhelming support from residents who said they support the idea of the City entering the communications business. 82% of households said that the City should offer telephone and data directly to households and businesses. There was no one particular service that drove these responses and 64% of households said they would buy data services from the City, 81% said they would buy cable TV and 84% said they would buy telephone service. These are among the highest percentages we have ever seen in this sort of survey.

- The survey shows that the County has 53% of households that already use some form of high speed Internet connection, primarily DSL from CenturyLink or cable modem from Comcast. This is lower than the national average of around 65%.

- Our analysis shows there would be many benefits to the City and to the community from the deployment of a ubiquitous fiber network.

- The time line we developed shows that the City could be serving the first customers about 18 months after you raise the money to build a fiber network.

- Since by law the City cannot get into the cable TV business, your best offering is to offer retail voice and data and to find a partner who can bring cable TV to your system.

- We looked at several financial scenarios of the City entering the communications market. We found the following:

    - We looked at three different financial models. We looked at providing service for the City of Martinsville only. We looked at a plan that added Collinsville. Finally, we looked at a financial model that looked at the whole County.
    - The bond for Martinsville only would be around $20.5 million. This includes a conservative assumption that you would require a Debt Service Reserve Fund that would cover a year of bond payments. The model also assumes that the bonds would capitalize 3 years of interest. At a 60% residential market penetration this model ends up with a small amount of negative cash in years 2 through 4. After that the model generates significant excess cash and would generate $13 million in excess cash by the year 2037. The cash issue for the first few years is due to bond law requirement that only 5% of a bond can be used for working capital – that is cash needed to pay the bills. That works out to be $1 million and that is not quite sufficient to make the business plan work through the early years. It is likely that a solution could be fund

for this issue, including issuing several different types of bonds at the same time to overcome this restriction.

- The financial projection that includes Collinsville would require a bond of $37.2 million. The biggest difference of serving Collinsville versus Martinsville is that the fiber is probably best buried in Collinsville since the City does not own the poles there. Unlike the Martinsville-only study, at a 60% residential market penetration this scenario never runs short of cash. In fact, by the year 2037 the model predicts that you would generate $28 million of excess cash at that penetration rate. The breakeven penetration rate for this scenario is 42% of residential customers, meaning that if you get that many customers the model looks to be sustainable in the long run.
- The model to serve the whole County looks to be a bit of a challenge. The bond needs to be $145.2 million to build the network needed to serve all of Henry County. Because large parts of the County are rural, the breakeven on the project looks to be around a 62% residential penetration. This number is not impossible to achieve, but needing that many customers just to make the project breakeven increase the risk of the project significantly.
- In all three scenarios there are ways to lower the financing costs. The financial models we ran assume that you would sell revenue bonds to finance the new businesses. This means that the assets and revenues from the business are the backup to guarantee bond payments. However, if you would consider backing up the bonds using more convention general obligation bonds you would get a lower interest rate, would avoid needing to borrow a Debt Service Reserve Fund and would have lower bond closing costs. But general obligation bonds do require a public vote. It's also conceivable to get a 35-year bond and our models assume 30-year financing.
- A summary of the financial results of the three scenarios is as follows:

	Martinsville Only	Plus Collinsville	Whole County
Size of Bond	$20.5 M	$37.2 M	$145.2 M
Capital Spending from Bond	$14.5 M	$26.5 M	$104.2 M
Positive EBITDA	Year 4	Year 3	Year 1
Positive Net Income	Year 5	Year 6	Year 12
Bond Breakeven	Year 19	Year 21	Year 30
Total Employees	14	19	37
Cash after 25 years	$19.0M	$30.5 M	$9.4M
Breakeven Penetration	42%	42%	62%

RECOMMENDATIONS

1. We believe that the survey provides support for the City to move forward and explore the various alternatives described in this report. The positive responses in the survey were some of the highest we have ever seen. The survey showed overwhelming support from citizens for better broadband and for more competition.

2. If the City moves forward, we strongly recommend that you use some sort of pre-sale campaign to identify your potential customers before you raise bond money. Getting customers to sign-up to show support for the network will make it easier to raise bond money and will also take away a lot of the risk of building the network.

3. The first two scenarios both work financially. Whether you build Martinsville only or both Martinsville and Collinsville, the breakeven is around a 42% residential penetration. This is far below the support indicated by the survey. In our opinion the scenario where you build both Martinsville and Collinsville is the better of the two options. By building both towns you increase the chance for success and are also able to generate a lot more cash. The fiber business is an economy of scale business, meaning that the larger the potential customer base, the easier it is to succeed.

4. In our opinion going straight to a project that would build to the whole County increases risk too much by creating a very large bond with large annual debt payments. The whole County scenario requires you to get 62% of all residences as customers to just break even, and in our mind this is much riskier than the other two scenarios. A better option might be to tackle adding the County in stages after having success in the base area.

5. The City should create a formal mechanism of some sort to evaluate and implement a fiber plan if it is going to pursue the project. Other cities have created a formal Board, Committee or Working Group that reports to the Council and which is given the funding and authority to find the facts and report back to the Council. In CCG's experience, somebody needs to be given specific authority to make a fiber business happen if it is going to have any chance of success. Generally staff is too busy with other work to give this magnitude of project the attention needed to get it off the ground, although staff would be an important player in the suggested working group. We have seen Committees made up of many different interest groups and could include members of the community or could be made up entirely of Staff - but without a formal group that is assigned specific responsibilities, a project of this magnitude tends to get delayed and lose momentum.

6. If you move forward you need to establish the fiber business in an Enterprise fund or some equivalent business structure. Bond financing is going to require separate bank accounts and Virginia MLEC rules require no subsidization of services, and the best way to achieve both of those requirements is to put the fiber business into its own silo from accounting purposes. The fiber business also needs to bill the City and the Utility as if they were any other commercial customer in order to fully comply with the subsidization requirements.

I. BASIC RESEARCH

In this section of the report we will look at the results of the research done by CCG. Specifically in this section we will cover the residential surveys, possible customer penetration rates, the products and prices of existing service providers in the market, a strategy for pricing and a strategy for marketing.

A. Residential Surveys

CCG conducted a residential survey of a statistically valid sample of residents of the projected study area. In this survey we asked about residential issues concerning cable television, data and telephone service. A full copy of the survey and the results are included below.

The survey was for the entire County. We also looked at the results for Martinsville alone and will discuss these two sets of results below.

The first step in developing the survey was to determine how many residents must be surveyed for the results to be considered statistically valid. In our line of work we routinely have helped clients to determine sample sizes. At CCG we use tools to help us determine sample size. For several years we have consulted two web sites,

www.surveysystem.com/sscalc.htm#terminology
and http://calculators.stat.ucla.edu/

which have online sample size calculators. The first site is from the web site for Creative Research Systems, a firm specializing in market research. The second site is from the Statistics Department at UCLA. Prior to using these sites, we performed these calculations manually and we have tested both of these sites to make sure they produce the same results as manual calculations. For both websites the sample size provided by the website has always been the same or nearly the same (sometimes varied by 1 because of rounding) as the results obtained by manual calculation.

In creating the sample size for this survey we first determined, the level of desired confidence. We selected a sample size that would produce results with a 95% confidence level plus or minus 5%. In layman's terms this means that the results are reliably accurate (the 95% number) and that the results are within 5% of the results you would get if there was a survey of everybody in town. We then calculated the sample size using the results given by both web sites. There are roughly 5,550 households in the County and to obtain the results we needed we had to talk to 359 residents in town. In the end we surveyed 370 households, meaning the accuracy is slightly better than expected and is 95% plus or minus 4.92%.

We determined who to call using a systematic sampling approach. We decided to use the white page telephone listings for the area and we called every tenth resident. If we were unable to get an answer we continued with the tenth household after the one we missed. This type of methodology isn't strictly random, but is the approach that almost all telephone surveyors use and it is a valid sampling technique. Since our callers didn't know anybody in the area, we

believe this method achieves the same results as using a pure random calling pattern and introduces no bias.

The survey produced some interesting results. A full copy of the survey and answers are at the end of this report. Here are highlights of the survey results:

1. **Survey Results for the Whole County**

Data (High Speed Internet Access)

53% of residences currently have high-speed Internet access of some sort with 29% using DSL, 22% using cable modem, 2% using their cellphones, and 1% with high speed but unsure of the type. The nationwide average for broadband penetration today is estimated to be around 65% of homes by various experts, so the area has a lower broadband penetration rate than the country as a whole. Only 3% of customers still use dial-up which is lower than the nationwide average of around 9%. 44% of customers have no Internet access at home compared to the nationwide average of around 26%.

All of the customers with dial-up said they have considered changing to a high-speed connection.

66% of customers are buying data as part of a bundle.

Residents were basically satisfied with the current Internet service providers. Only 10% were dissatisfied with repair and customer service response times. Only 7% were dissatisfied with download and upload speeds. However, 17% were dissatisfied with the value for the price they pay.

A very high 64% of households said they would buy Internet access from RS Fiber if it were offered at a discount compared to today's prices. Another 1% said they might buy. These two results equal more residences than have high speed Internet access today (65% compared to 53%). This seems to say that households want high speed Internet access if it would be more affordable.

Cable TV

About 90% of residents subscribe to cable TV. This is considerably higher than the 75% nationwide average for cable service. 59% of those with cable use Comcast while the other 39% use one of satellite dish providers. The nationwide average penetration for the dish providers is at around 16%, so the area has far more dish customers than a 'normal' market.

40% of residents said that it is important to have a local business office for cable TV service.

Residents were basically satisfied with the current cable TV serve. Only 4% were dissatisfied with repair and customer service response times. Only 5% were dissatisfied with picture quality. However, 17% were dissatisfied with the value for the price they pay.

In maybe the most significant result, 81% of residences said they would buy cable TV if the government could offer it at a discount. Another 2% said they might buy. This is the one of the highest such response we have ever seen from this type of survey and the positive responses represent almost all of the cable subscribers in the County (83% positive versus 90% total).

Telephone

74% of households with telephone service use CenturyLink (formerly Qwest). Another 24% use Comcast. 2% use a VoIP provider like Vonage.

Residents were basically satisfied with their current telephone service. Only 6% were dissatisfied with repair and customer service response times. However, 13% were dissatisfied with the value for the price they pay.

4% of customers said they were considering dropping landline service for cell phone service in the coming year. Nationwide it's estimated that about 80% of households still have a landline telephone.

81% of residences said they would switch if the City could bring a competitive service at a discount. Another 2% said they might switch.

General Questions

We asked some general questions about the communications marketplace.

Only 1% of households report having somebody who often works at home. 9% of homes have somebody who occasionally works at home. Very few, only 2% of these households said they would work at home more if they had faster Internet access.

In probably the most important set of questions, we asked residents if the City should build a fiber network if they brought a commercial operating partner.

> 84% said the government should get into the communications business with a partner.
> Another 1% were undecided on the issue.

When asked if the government should directly offer services without a partner

> 82% said the government should get into the communications business.
> Another 1% were undecided on the issue.

Conclusions from the County Survey

Overall the surveys produced some interesting results.

One thing to keep in mind when looking at all of the results is that the area has fewer homes with high-speed internet customers compared to the rest of the country. While most customers seem

satisfied with the current service providers, a vast majority of the respondents think the governments ought to provide a competitive alternative. Most of the households said they would buy service from the City and it didn't seem to make much different if you do this with a partner or directly.

In looking under the number, it seems that price is the driving issue in the County. Customers are not unhappy with the current providers, but they are almost all willing to consider changing if they can get a competitive discount.

Overall the number of people who say that they would buy from the City is higher than what we see in most other surveys we have performed. We have done around 100 similar surveys and the positive responses from this survey would put this area in the top ten percent of responses from that group of surveys. With that said the positive response for the desire for faster Internet access is lower than the desire for competitive cable TV and telephone, certainly due to the fact that fewer households have Internet than the other services.

2. Survey Results for Martinsville Only

The Martinsville is a subset of the total responses to the County-wide survey and 163 of the responses were from people who live in Martinsville. We must note that when looking at the responses for anything less than 100% of the surveys that you cannot state with certainty that the results for Martinsville alone have the same degree of reliability as the survey as a whole. However, with that said, for the most part the results from the City are very similar to the results from the whole County on most questions, which is an indicator that the people in Martinsville basically feel the nearly the same about the potential project as do the respondents to the larger survey. This gives me some degree of assurance that you can trust the results for Martinsville, although mathematically that certainty cannot be calculated in the same manner.

Data (High Speed Internet Access)

51% of City residences currently have high-speed Internet access of some sort with 29% using DSL, 21% using cable modem, 1% using their cellphones, and 1% with high speed but unsure of the type. The nationwide average for broadband penetration today is estimated to be around 65% of homes by various experts, so the area has a lower broadband penetration rate than the country as a whole. Only 2% of customers still use dial-up which is lower than the nationwide average of around 9%. 47% of customers have no Internet access at home compared to the nationwide average of around 26%.

All of the customers with dial-up said they have considered changing to a high-speed connection.

65% of data customers buy the product as part of a bundle.

Residents were basically satisfied with the current Internet service providers. Only 6% were dissatisfied with repair and customer service response times. Only 6% were dissatisfied with download speeds. However, 26% were dissatisfied with the value for the price they pay.

A very high 61% of households said they would buy Internet access from RS Fiber if it were offered at a discount compared to today's prices. Another 1% said they might buy. These two results equal more residences than have high speed Internet access today (62% compared to 51%). This seems to say that households want high speed Internet access if it is more affordable.

Cable TV

About 88% of residents subscribe to cable TV. This is considerably higher than the 75% nationwide average for cable service. 74% of those with cable use Comcast while the other 26% use one of satellite dish providers. The nationwide average penetration for the dish providers is at around 16%, so the City has more dish customers than a 'normal' market.

37% of residents said that it is important to have a local business office for cable TV service.

Residents were basically satisfied with the current cable TV serve. Only 6% were dissatisfied with repair and customer service response times. Only 5% were dissatisfied with picture quality. However, 23% were dissatisfied with the value for the price they pay.

In maybe the most significant result, 85% of residences said they would buy cable TV if the government could offer it at a discount. Another 1% said they might buy. This is the one of the highest such response we have ever seen from this type of survey and the positive responses represent almost all of the cable subscribers in the County (85% positive versus 88% total).

Telephone

74% of households with telephone service use CenturyLink (formerly Qwest). Another 25% use Comcast. 1% use a VoIP provider like Vonage.

Residents were basically satisfied with their current telephone service. Only 9% were dissatisfied with repair and customer service response times. However, 17% were dissatisfied with the value for the price they pay.

4% of customers said they were considering dropping landline service for cell phone service in the coming year. Nationwide it's estimated that about 80% of households still have a landline telephone.

81% of residences said they would switch if the City could bring a competitive service at a discount. Another 2% said they might switch.

General Questions

We asked some general questions about the communications marketplace.

No households reported having somebody who often works at home. 7% of homes have somebody who occasionally works at home. Also, no households said they would work at home more if they had faster Internet access.

In probably the most important set of questions, we asked residents if the City should build a fiber network if they brought a commercial operating partner.

> 83% said the government should get into the communications business with a partner. Another 1% were undecided on the issue.

When asked if the government should directly offer services without a partner

> 86% said the government should get into the communications business.

Conclusions from the Martinsville Only Survey

One thing to keep in mind when looking at all of the results is that the area has fewer homes with high-speed internet customers compared to the rest of the country. While most customers seem satisfied with the current service providers, a vast majority of the respondents think the governments ought to provide a competitive alternative. Most of the households said they would buy service from the City and it didn't seem to make much different if you do this with a partner or directly. In fact, a few more of them said they wanted the City to directly provide the service.

In looking under the number, it seems that price is the driving issue in the City. Customers are not unhappy with the current providers, but they are almost all willing to consider changing if they can get a competitive discount.

Overall the number of people who say that they would buy from the City is higher than what we see in most other surveys we have performed. We have done around 100 similar surveys and the positive responses from this survey would put this area in the top ten percent of responses from that group of surveys. With that said the positive response for the desire for faster Internet access is lower than the desire for competitive cable TV and telephone, certainly due to the fact that fewer households have Internet than the other services.

B. Customer Penetration Rates

Below in this report we will look at potential business models for offering broadband in Martinsville. One of the key assumptions in any business plan is the number of customers a new broadband business might be able to get in the market. This is referred to in the industry as the customer penetration rate.

We can make some generic predictions of residential penetration rates based upon the results of the survey. However, when implementing a new business there are a number of factors that can affect the final penetration rate. First among these is the ability of the new business to deliver what it has promised. This means execution of the implementation of the business plan – launching on time and delivering the services and the quality that can come with a fiber network. Should a new company stumble and have technical problems, customers will hesitate to sign up with the new business. The second important factor in getting customers is delivering outstanding customer service. This is something that generally municipalities do well; however, it is vital in a new business that customer

service is done right. Customers need to feel that the business is listening to them and that you will respond to problems, questions or concerns in an accurate and timely manner.

How many customers can a municipal broadband business expect to get assuming that the new business handles its launch well and is delivering quality products, good prices and good customer service?

Residential Penetration Rates

The first answer to that question is to look at the minimum number of customers that might be expected. CCG's experience in the telecommunications market has shown that almost any new competitor ought to be able to count on getting at least 30% of the market. In market after market all across the country we have seen our clients get 30% of customers just by showing up. The first 30% of the market seems to be those customers who are just looking for change or who dislike the incumbents for some reason. Again, a company needs to execute well to stay at 30%, but we have never seen a well run company fail to get to 30% of the market.

What does it take to move above this minimum level of success? We know that price discounts help. Most competitive systems in the country offer discounts of 10% to 20% lower than the incumbent rates. While the incumbents often immediately drop their prices to match the new competitor, customers realize that it is the competitor that brought cheaper prices and will generally give them a try. Perhaps even more important than the initial price discount is a promise by a new provider to keep rate increases at a minimum. A majority of customers in the U.S. are frustrated by the constant sizable rate increases from the cable company incumbent and they are very responsive to a new business that promises to hold down future rate increases.

Another important factor in getting customers is name recognition and customer trust. These two factors are important reasons why municipal systems have done so well. Generally customers think highly of the existing businesses run by their city – things like electric and water. We find that customers are willing to give a City a chance strictly due to their trust that the City is going to be looking out for their welfare.

Municipal businesses also tend to make promises to their customers that they will use any profits wisely. The profits earned by incumbents are sent out of town while any profits earned by a municipal business are plowed back into the community.

So, how does this translate into a predicted market penetration for Martinsville? In the financial business models below we look at penetration in two ways. First, we calculate the market penetration rate that is needed for a FTTH business to break even. The result of this produces a target market penetration that would define minimal success for the new business. In Martinsville, the minimum break even penetration turns out to be 42% of the residential market, gained over a five year period.

The City will have to judge your ability to achieve a 42% penetration should you decide to pursue the FTTH business. Our experience is that FTTH is an economy of scale business meaning that in larger towns the minimum breakeven threshold would be smaller. The City will ultimately have to weigh the risk of being able to get to reach to that many customers. One factor to consider is the results of the residential survey. Residents told you:

64% of households said they would buy Internet access from the City
81% said they would buy cable TV.
81% said they would buy telephone service.
82% were in favor of you building the network and getting into the business

We do not recommend that the City ever count on getting a penetration rate as high as the survey results. In the end, the incumbent providers will put up a battle for customers and the City would be performing extraordinarily well to achieve a penetration rate as high as suggested by the survey. However, if you do everything well you are going to get a lot of customers.

One thing to strongly consider is that if you are going to get into the business that you pre-sell to residential households. This means that you should get some type of pledge from customers that they are interested in buying your service before you go to bonding. And then you need to turn these pledges into firm orders before construction is started.

As you can see in the financial analysis, the project would require a significant bond to pay for the network construction. It is going to be easier to raise the bond money, and easier for the City to approve such bonds if you know that the public is behind this project, in a tangible way. There have been many fiber projects built where there was no pre-marketing At CCG we describe this as a philosophy of 'build-it-and-they-will-come", meaning that you believe people will be attracted to what you have to offer. But in our experience, sometimes the expected penetration rates have panned out and sometimes they haven't. It is far better to greatly reduce the risk of failure by identifying your customers before committing to taking substantial bond funding.

Business Penetration Rates

Almost all of CCG's clients sell to business customers. We have learned a number of things about selling into services into the business market:

- Businesses care more about reliability than price. Businesses won't move to a new network until they are convinced that the network and the business are reliable. Because of this, one generally sees the business community as a whole being slow to change to a new network. You already have some grasp of this since you have been selling services to a handful of businesses for the last several years.
- In general, larger businesses are likelier to try a new network than are smaller businesses. This is often due to the fact that they are really hungry for real bandwidth. And these are the kinds of customers you have already gotten. Bigger businesses will often try redundant and back-up bandwidth while keeping existing services. When the new network performs well they will try more services over time. Since these businesses are often the more influential businesses in town, their acceptance of the network is a major factor in convincing smaller businesses to try the network. Smaller businesses often become convinced to try a new network after trying it out at home first.
- If there is any one factor that will drive some businesses to try a new network it will be the ability to get services that are not available from the incumbent. If a new company can use a fiber network to deliver a superior bandwidth product – much more bandwidth than available

from other providers at a great price – they will get some businesses to convert to the new network.

- Some businesses do not make purchasing decisions locally. For example, a branch of a national chain store may buy all services from one provider nationwide and will not consider the local network provider, regardless of your prices and services.
- Businesses may already be on long term contracts for telephone or data services which would preclude them from becoming an immediate customer of a new system. Incumbents have been known to make a big push to get customers onto contracts when they know a new competitor is coming to town.
- There is only one way to sell to business, which we call the consultative sales model. This requires the company to send out a salesman and a technical person to meet with each business to determine their needs and convince them how you can meet their needs. Sales to businesses are not accomplished through normal marketing channels, only live multiple visits by your staff.

Over time, in most markets the business penetration rates generally approach the residential penetration rates. However, businesses are slower to accept a new network and will remain skeptical until word of mouth convinces them that you know what you are doing.

C. Incumbent Provider Products and Prices

There are two incumbent providers today in Martinsville – CenturyLink and Comcast. Comcast offers the triple play while CenturyLink offers voice and data. Additionally, there are several satellite providers offering cable services in the City. As noted earlier in this paper, St. Olaf Telco also provides data services to some businesses in the city. Probably the hardest question for any City to answer is how hard the incumbents might fight to keep the City out of the broadband business. Around the country the experiences of other communities are all over the board. In some places like Bristol, Virginia and Lafayette, Louisiana the incumbents have put up a fierce fight. In other places there has been very little resistance. To date in Virginia, Monticello has been sued by TDS, the incumbent telephone provider. Monticello won the initial lawsuit on all points and the case is now in the Court of Appeals, an appeal brought by TDS.

CenturyLink

Telephone service is provided in Martinsville today by CenturyLink, formerly Qwest. CenturyLink is a publicly traded company with corporate headquarters in Louisiana. CenturyLink is the third largest telecommunications company in the country and has projected annual revenues of over $14 billion for 2012. CenturyLink has around 8 million telephone subscribers.

As the incumbent provider, CenturyLink is considered as the “provider of last resort.” This means that CenturyLink is required to serve all residential and business customers for basic local telephone services, and it must provide facilities to all customers. The rules that govern the way that CenturyLink serves customers in Martinsville are embodied in their “General Customer Services Tariff“, which is approved by the Virginia State Corporation Commission. This tariff contains all of the regulated products and prices, along with the terms and conditions under which CenturyLink will sell them to customers. The tariff sets forth rules for such customer

service procedures as the manner and amount of customer deposits, the rules by which they will disconnect service for nonpayment, and the rules by which they will reconnect service. We'd note that a recent trend is to get states to deregulate many services as competitive and take them out of the tariff and the Virginia tariff has had many products removed in recent years.

CenturyLink also sells data products. In recent years CenturyLink has been investing significant capital in improving data speeds in metropolitan areas. For the last decade the rural CenturyLink properties have had DSL speeds of between 1 Mbps and 3 Mbps. Recently CenturyLink has been upping those speeds by installing new DSL equipment. DSL speeds are advertised in terms of 'up to' speeds and customers can get slower speeds than the speeds advertised. Some of the factors contributing to slower speeds include the distance the customer us from the CenturyLink central office, and the age and size of the copper wiring in a neighborhood.

Comcast

From their web page: "*Comcast Corporation (Nasdaq: CMCSA, CMCSK) (www.comcast.com) is one of the world's leading media, entertainment and communications companies. Comcast is principally involved in the operation of cable systems through Comcast Cable and in the development, production and distribution of entertainment, news, sports and other content for global audiences through NBCUniversal. Comcast Cable is one of the nation's largest video, high-speed Internet and phone providers to residential and business customers. Comcast is the majority owner and manager of NBCUniversal, which owns and operates entertainment and news cable networks, the NBC and Telemundo broadcast networks, local television station groups, television production operations, a major motion picture company and theme parks.*"

Comcast is the largest cable TV provider in the country with over 21 million current cable customers. Comcast provides cable TV service using a technology referred to as hybrid fiber-coax. Cable customers are served at the using coaxial cable. Comcast is a major provider in Virginia and has customers throughout the state. Comcast provides voice and cable modem services wherever they serve cable TV,

Comcast also has expanded service to business customers in recent years and serves business both on the coaxial network as well on newly built fiber networks.

Competitors Prices

In this section we review voice, video and data prices available to customers today in Martinsville.

CenturyLink is the incumbent telephone company. The rates listed below are from CenturyLink's Local Tariff and the rates are on file at the Virginia Corporation Commission. The following rates are the flat rate option, meaning that a telephone line using these options can make unlimited local calls. Extended Local Service is included in the flat rate option. There are options available for customers who want to be able to make and pay for fewer local calls.

Monthly

Flat Rate Residential Phone Line	$15.19
Flat Rate Business Telephone Line	$30.43
Trunk	$37.80
PBX/Centrex	$49.98

	Extended Local Service
Flat Rate Residential Phone Line	$.02
Flat Rate Business Telephone Line	$.05
Trunk	$.07
PBX/Centrex	$.10

	Total Flat Rate[1]
Flat Rate Residential Phone Line	$15.21
Flat Rate Business Telephone Line	$30.48
Trunk	$37.87
PBX/Centrex	$50.08

In addition to these rates CenturyLink charges a Federal Subscriber Line Charge (SLC). The SLC is often presented on the telephone bill as if it is a tax, but it is revenue that is kept by the telephone company. The SLC charge represents a shift in revenues from long distance carriers to local customers. The rates billed to long distance carriers to access the local line have been reduced over the years and the SLC charge has been implemented to replace the access revenues. This shift is a large reason why long distance rates have decreased over the last decade, but these local charges have passed some of that savings back to local subscribers. The residential and small business SLC at CenturyLink is $3.96 per month. The SLC for PBX/Centrex is $4.10.

A flat rate residential line is the normal telephone line found in a home. A flat rate business line is a single line in a business and is the sort of line that might be used by a small business such as a restaurant. A trunk (sometimes also called a key trunk) is a line used by businesses that have multiple phones working on one line. Such a business would have its own phone equipment called a key system if it's small or a PBX if it's large. For example, a business might have 10 PBX trunks and have fifty phones at the business. In this example, only 10 phones could be talking to the outside world at the same time while all other phones could be making internal calls within the business.

Both residents and businesses in Martinsville can make free calls outside of Martinsville to Axton, Bassett, Collinsville, Fieldale, Ridgeway, Spencer, and Bachelors Hall. These are the names in the CenturyLink tariff of their exchanges and exchanges don't always follow political boundaries but follow how CenturyLink built the original lines.

[1] The total cost of a residential line is $15.19 for the line, $3.96 for the SLC and $.02 for the Extended Local Service (ELS) additive = $19.17. The total cost of a business line is $30.43 for the line, $3.96 for the SLC and $.05 for the Extended Local Service (ELS) additive = $34.44. The total cost of a trunk is $37.80 for the trunk line, $4.10 for the SLC and $.07 for the Extended Local Service (ELS) additive = $41.97. The total cost of PBX/Centrex is $49.98 for the line, $4.10 for the SLC and $.10 for the Extended Local Service (ELS) additive = $54.18

In addition to lines, customers can buy features. Some of the most commonly purchased features are call waiting, 3-way calling, voice mail and caller ID. CenturyLink offers dozens of features and they range in price from $2.38 to $10.35 per feature. There are also packages available to buy multiple features at a discount. Some of the more popular features are as follows:

	Residential	Business
Caller ID	$10.35	$10.35
Call Waiting	$ 5.35	$ 5.75
Voice Mail	$ 7.95	$10.00
3-way Calling	$ 2.38	$ 3.96
Last Call Return	$ 5.41	$ 5.99
Call Forwarding	$ 2.00	$ 3.31
Call Rejection	$ 3.57	$ 3.57
Continuous Redial	$ 5.41	$ 5.99

Long Distance

CenturyLink also sells long distance. Customers are also free to buy long distance from any other carrier.

CenturyLink Long Distance Rates

Unlimited Long Distance	$29.99
Per Minute	$8.98 per month plus 5 cents per minute

CenturyLink DSL

CenturyLink sells high speed Internet using DSL. Following are the rates charged for residential DSL. Note that the quoted speeds are "best effort" speeds, meaning they are not guaranteed. CenturyLink does not publish the upload speeds, but they are generally slower than download speeds.

Residential High Speed Internet

	Basic	With Modem
1.5 Mbps download	$29.95	$34.44
3 Mbps download	$34.95	$39.44
10 Mbps download	$39.95	$44.44
20 Mbps download	$64.95	$69.44

The modem fee varies between $4.49 and $6.49 per month depending on type of installation. The above prices assume a $4.49 modem.

CenturyLink High Speed Business Internet

Office Plus. This includes up to 10 email accounts per customer, priority customer service, 25 Mb of web storage.

	Basic	With Modem
1.5 Mbps download	$68.91	$73.40
3 Mbps download	$73.91	$78.40
10 Mbps download	$78.91	$83.40

The modem fee varies between $4.49 and $6.49 per month depending on type of installation. The above prices assume a $4.49 modem.

CenturyLink T1 Products

For decades before DSL the standard data product for businesses was a T1. A T1 is a 2-way symmetrical circuit, meaning it has the same speed for both upload and download. A T1 delivers 1.544 Mbps both in the upstream direction and in the downstream direction. A T1 typically can be installed anywhere and is not limited by distance from the central office, like DSL.

T1s are very expensive when used for Internet access. In order to buy a T1 a customer must pay for the local T1 circuit (often called the loop) plus an additional charge for the Internet Access. CenturyLink has detariffed T1s, meaning they can quote different prices to different customers. If Martinsville is typical of other small CenturyLink towns, then the local loop charge is probably around $300 per month and Internet T1s costing between $600 and $700 per month.

Comcast Cable Modem Residential Services

The other primary data product in town is the cable modem, which has been discussed elsewhere in this paper.

Following are the residential cable modem prices:

12 Mbps download, upload unspecified (probably about 2 Mbps)	$48.95
50 Mbps download, upload unspecified (probably about 10 Mbps)	$58.95
Cable Modem rental	$ 7.00

Comcast charges more for cable modem if a customer doesn't bundle it with regular cable services. Rates for Internet-only subscribers are $14.00 per month higher. Comcast also offers a product called Blast that is a turbo-charger. This means that when you download a file you get a guaranteed faster rate for the first minute of download. The Blast additive is $10 per month.

Comcast Cable Modem Business Services

Comcast also sells cable modems to businesses.

Starter - 12 Mbps download 2 Mbps	$59.95
Premium - 22 Mbps download 5 Mbps upload	$99.95
Deluxe – 50 Mbps download 10 Mbps upload	$189.95
Deluxe 100 – 100 Mbps download 10 Mbps upload	$369.95

We were unable to get a specific price for Comcast business cable modem service since they don't have a set price, but instead negotiate a price with each business customer. In other markets we have found that Comcast normally only negotiates with complex or larger businesses, so most businesses in town probably pay these rates. However, one would expect that there will be business in towns with different rates for the same service.

Comcast Cable TV Services

Following are the Comcast Communications Rates for residential cable TV service:

Basic Cable	$23.00[2]
Digital Economy	$29.95
Digital Starter	$65.95
Digital Preferred	$83.90
Digital Premier	$133.99
Digital Tiers	
Sport & Entertainment	$ 4.95
Bollywood On Demand	$12.99
Add here! On Demand	$ 7.99
Howard Stern On Demand	$10.99
WWE Classics On Demand	$ 7.99
Settop Box	$ 5.00
HD TV	$ 9.95
HD DVR Service	$16.95
Movie Channels	$17.00 each package

Comcast Residential Bundles

Comcast also offers a number of bundles where they put telephone, cable TV and high-speed internet into a package. These bundles tend to have a discount compared to normal pricing, but it

[2] Comcast does not advertise this rate and we used this rate that was obtained from several other Comcast markets instead of Martinsville.

is impossible in a bundle to say which products have the discount. Note that Martinsville will have a cable TV partner on the network. But for sales purposes it might be sensible for you to create bundles that include cable TV so that you can go after that market. The surveys showed that a significant percentage of customers in town buy one of the many bundles.

Following are the current Comcast bundles. These change fairly often. Note that Comcast often has an 'introduction' price that is less than these prices for new customers or customers they are luring back from competitors. These promotional specials generally last about 6 months and then the customer reverts to the normal package prices.

Double Play Digital Starter $114.95
80 Channels of programming
Up to 12 Mbps download data

Double Play Digital Preferred $128.85
100 Channels of programming
Voice line with unlimited long distance

Double Play Digital Premier $182.91
200 Channels of programming
Up to 12 Mbps download data

Triple Play Starter XF $139.95
80 Channels of programming
Voice line with unlimited long distance
Up to 12 Mbps download data
One free HD settop box and HD service

Triple Play HD Preferred XF $159.95
100 Channels of programming
Voice line with unlimited long distance
Up to 12 Mbps download data
One free HD settop box and HD services

Triple Play HD Premier XF $204.95
200 Channels of programming
Voice line with unlimited long distance
Up to 50 Mbps download data
One free HD DVR settop box and HD services

Following are the Comcast Communications Rates for business cable TV service:

Public Cable (means can be seen by the public):

Basic	$29.95
Digital Basic Plus	$54.95
Digital Standard	$84.95

Digital Deluxe	$109.95
Deluxe	$189.95
Private Cable:	
Basic	$24.95
Digital Basic Plus	$44.95
Digital Standard	$74.95
Digital Deluxe	$74.95
Deluxe	$89.95

D. Pricing Strategy

This section is going to look at the issue of how to price services. Perhaps the best way to open a discussion of pricing strategies is to look at some of the other firms in the country that are competing with the big cable companies to see how they have set prices, and how their pricing strategies have affected their customer penetration rates. Following are some examples of existing competitors selling against a major cable company:

- Verizon. In the areas where Verizon has built residential fiber they now offer competitive TV service. Verizon has set prices at a modest discount from the existing cable companies. Verizon tries to set cable rates by state and in many states they compete against multiple cable companies. Overall, the Verizon discount seems to be roughly 5% to 10% less than the competition. Verizon's line-up seems to be very comparable to the large cable company's lineups. Verizon seems to increase rates annually just like the cable companies. I think one can assume their strategy is going to be to maintain their existing discount and to stay a little cheaper than the competition over time. Verizon has been closed about sharing their specific market shares in given states, but overall they claim to have over 5 million FiOS data customers as of the second quarter of 2012.

- AT&T. AT&T sells cable TV and data over DSL. To do this they are using IPTV technology and delivering only the channel a customer is watching. AT&T has established two very large headends nationwide and serves all the customers from these two locations. AT&T has a very robust lineup and offers a number of options that most cable companies don't have such as unique foreign language channels. AT&T has a number of pricing plans. AT&T has set prices at a modest 5% to 10% less than the existing cable companies. AT&T advertises their prices nationwide, so the amount of discount is going to vary by market. To date AT&T has focused almost entirely in the suburbs of major cities.

- Knology. Knology is a cable overbuilder that has built systems in about a dozen southern cities. Knology gives a modest discount of around 5% from existing customer rates. However, they have bundling discounts that increase the discount to around 10% for those customers who buy a lot of services from their menu of products. Knology has been in business in some cities since 1998. They say that they can count on getting around 30% to 35% of the market in any city based upon a very modest discount. They believe

this represents those customers that don't like the existing monopoly provider for some reason and who want options.

- RCN. RCN is much like Knology and they have built systems in medium sized cities and in suburbs in the northeast. They also give modest discounts of around 5% growing to 10% with bundling. They also expect and seem to achieve market penetration of around 30% to 35% in most of their markets.

- EATEL. EATEL is an independent telephone company in Louisiana who has built FTTH networks in places like Baton Rouge. EATEL is a bit unusual in that they don't give any discount against their competitor Cox. They match Cox rates almost to the penny. EATEL reports that they get about a 30% penetration in every neighborhood they have entered.

- Other Municipalities. Most other municipalities have launched their systems with discounts of 12% to 15%. Two exceptions are Burlington, Vermont and Lafayette Louisiana that both launched with a 20% discount. However, the initial discount does not tell the full story for most cities. Municipal systems tend to hold down rate increases compared to the competition. The best way to measure this is to look at the rates in the municipal market compared to neighboring markets with no competition. The major cable companies have raised rates by 7% to 9% for the last 6 – 7 years. None of the municipal systems have raised rates as fast as the incumbents in the areas surrounding them. Most of them have instead had a modest rate increase every year. Thus, while a municipal system may start out with a modest price advantage, over time they end up with a much larger price advantage due to the fact that they hold rate increases down. The competitor in their market also typically holds down increases while rates in surrounding communities rise to become much higher.

A Pricing Strategy For Martinsville

We would recommend that if Martinsville gets into the business, that the City ought to pursue the same strategy that has been used by other cities. This would be to set a modest discount initially of around 10% for telephone rates. Since you will not be directly offering cable services I would hope you can persuade your cable partner to offer a similar discount.

It's hard to talk about the discounts on data services since you are offering a service that is drastically different than the incumbents. Where the competition might be offering 3 Mbps download and a slow upload your initial product ought to be something like 30 Mbps in both directions. Thus, the goal with broadband ought to be to offer for more bandwidth than similarly priced products. As mentioned elsewhere in this report, it's very difficult to make a side-by-side comparison with incumbent data products since they almost never deliver the speeds that are advertised. And the, over time, it is typical for fiber providers to raise speeds as the underlying cost of bandwidth decreases.

The largest U.S. provider of FTTH is Verizon. Press reports differ in quantities, but Verizon reported that it has built FTTH to pass 9 million households by the end of 2011 and has 5 million data customers in 2012.

Verizon markets its FTTH product under the brand name FiOS. Verizon is taking full advantage of the technology and is supplying some of the highest speed and most affordable bandwidth in the nation over the FIOS systems. Verizon's current FIOS data products and prices are:

	Base	2-Year Contract
15 Mbps Download / 5 Mbps Upload	$ 69.95	$ 64.95
50 Mbps Download / 25 Mbps Upload	$ 79.95	$ 74.95
75 Mbps Download / 35 Mbps Upload	$ 89.95	$ 84.95
150 Mbps Download / 65 Mbps Upload	$ 99.95	$ 94.95
300 Mbps Download / 65 Mbps Upload	$209.95	$204.95

We would recommend something similar for Martinsville. You are probably going to want some inexpensive starter product and your lowest price needs to be cheaper than the FiOS starter price. That price may be adequate in major metros, but they survey tells us that customers in your area are very price conscious.

E. Marketing Strategy

As stated earlier, our basic financial models have been used to determine that a 42% minimum penetration rate is required for residential data services. The City has conducted a formal survey that showed that a substantial percentage (between 64% and 81%) of households in town would consider buying services from the City. At the end of the day the City is going to have to decide how much you believe these survey results and if you think the business would do better than the minimum penetration required.

Further, Virginia law prohibits the City from directly offering cable TV service. If you want to have cable on your network you will have to find a cable partner.

The question to be answered in this section is: If the City pursued this venture as a retail provider, how should the City go about getting customers? What marketing strategies have worked for other municipal and other FTTH networks?

Residential Marketing

As been mentioned elsewhere in this paper, other fiber overbuilders have reported that they get between 30% and 35% penetration in any new market just by showing up. This seems to represent the customers who want change or who are frustrated by the incumbent providers. This is not to say that these companies don't have to make some effort to get these customers, but these seem to represent the low hanging fruit that can be obtained with the least amount of marketing effort. Here are some of the marketing ideas used by other overbuilders to capture this basic market segment:

- Pre-Sign-up List. A number of systems have pre-signed customers before the network us built. For example, the City of Bristol, Virginia had customers sign-up for service starting about a year before the launch. During that period the fiber network was always in the local news, perhaps due to the efforts by the incumbents to stop the project. In any event, the constant publicity resulted in Bristol having nearly 40% of the potential customers in town on their pre-sign up list. This list did not in any way obligate customers to buy service when it was available. However, Bristol found that all but a handful of customers did take service once they were contacted. The one worry with using a pre-sign-up list is that it may create customer expectations that they are soon going to get service. This means that the City must be very careful to explain how the sign-up list will be used and must stay in contact with prospective customers to keep them informed and happy.

  Ideally you would conduct a pre-sign up campaign that would get approval from all of most of the customers needed to achieve breakeven. If this kind of marketing can be done before bonding the perceived risks of the bonds will be greatly reduced. There are a number of ways that pre-sign-up campaigns have been done around the country. At the most basic level you ask households to sign a pledge that they will take services once the network is built. Such a pledge would not be binding, but would be a good indicator of who will be taking service. You might want to do something like promise free installation or some giveaway product for people who will sign-up early.

  At the other end of the spectrum would be to ask for a small deposit from potential customers as part of a pledge. This would require a firmer commitment from customers while raising a little bit of cash that would not have to be borrowed.

  Hopefully there will be people in the community excited about the possibility of getting fiber everywhere. In the communities where pre-sign up campaigns have been the most successful there has been a significant volunteer effort to get people to sign. The City generally kicks in for materials and handouts and volunteers do the hard work of knocking on everybody's door.

  If the sign-up campaign is highly successful it is quite likely that you would connect only customers for the first year or two who were on the pre-sign-up list. This is an additional incentive for people to sign up early.

- Customer Newsletters. Many cities make liberal use of customer newsletters to keep customers and potential customers informed about the progress of a fiber system. Typically with a fiber system there is a lot of public awareness of the project at the stage where bond money is being raised to build the system. However, once the construction starts there is often a rather dead period of a year where there is not a lot of public notice of the project in the press. This is the period where it is vital for the City to keep the project in the minds of citizens. We have seen liberal use of newsletters, press releases, public events such as groundbreakings, email lists, web sites with constant updates and other tools used to keep customers informed during the construction period.

- "Cable Sales Model". In the seventies and eighties as cable systems were first built, the cable companies settled in a marketing plan commonly referred to as the cable sales model. In this

model, the cable company had salespeople accompanying the construction crews. Generally a week or two before a neighborhood was ready to get service the sales crews would be out knocking on the doors in each neighborhood. The cable companies had great success with this sales model and it still works today with fiber overbuilds. Some companies distribute doorhangers, which are packages of information left on each door, that say that the new network will be finished in the neighborhood soon and ready to provide services. The doorhangers are generally followed up with door-to-door salespeople or with phone calls (which can be problematic in these days of the Do Not Call List).

The above methods are generally the first marketing plan for network overbuilder. Companies that do these programs well report getting to 50% of the customers in the market on the first pass. However, the marketing effort is not finished at this point and companies then continue marketing to make sure they have talked to every customer in town. There are always customers who are committed to contracts ho may note able to sign with you on the first marketing pass. Some of the ways that companies continue marketing after the first pass:

- Smart Databases. The companies that want to be as effective as possible in the market develop a database of all of the homes in the community. With this database they know which homes are already their customer, which other homes have clearly rejected service from them (such as being an employee of the cable incumbent), and homes that still might take service. The use of this database allows you to do very targeted marketing. For example, the company can do mailers, but you can save a lot of money by only sending mailers to homes that do not have your products. One of the most effective ongoing campaigns is to continue the door-to-door effort. As companies continue to knock on the doors they continue to get new customers. We have seen door-to-door campaigns be most successful when employees of the company knock on doors rather than using hired guns from out of town.

- Maintenance Marketing and Up-selling. A good company will spend effort to continually up-sell their products. A modern triple play provider will have dozens of niche products and many of these products are hard to sell on the initial service order. However, campaigns that describe the benefits of various products inevitably result in sales of these services. The successful overbuilder will have a marketing plan that constantly introduces their products to their existing customers.

Business Marketing

CCG clients have reported to us over the years that there is only one successful way to sell to businesses. This is the consultative sales model. This is a tried and true approach that is used by many industries, such as copiers, in selling services to businesses.

The consultative sales model generally consists of multiple visits to a business. On the first visit the salesperson introduces the company and asks if they can get a copy of the current communications bill in order to return later with a proposal. The salesperson generally asks enough questions so that they can understand the telecom needs of the business.

The salesperson will then prepare a proposal based upon what they understand about the business. A good salesperson will not always stick to replacing existing services but will offer alternative services that will best serve the customer. For a small business the salesperson will return alone and propose the new solution. For more complex customers the salesperson generally will bring along a technical person to answer questions.

The consultative sales model works for several reasons. First, businesses rely heavily on their communications to function. The vast majority of businesses will care much more about reliability than they will about price. This means that the new company must give them a feeling of confidence about the new network to get a sale. One thing to realize is that the majority of business customers have never been visited by a salesperson from the incumbents. These businesses ordered service when they first opened and then added or modified the service over time. However, since they have never had a visit from the phone company it is likely that they do not have the optimum communications network. Businesses really respond to a sales process that listens to their needs and then offers them a solution specific to their needs. For many businesses this is a new phenomenon.

The consultative sales model also works because it allows a direct conversation with the decision maker(s) at the company. Every company is different in how they make purchasing decisions and in one business the decision on buying phone lines might be made by the president or owner and in the next business be made by the president's secretary. The live sales visit lets the salesperson find and talk to the right decision maker.

Ongoing marketing at businesses is generally done by having periodic follow-up visits by the salesperson. Very few companies mail marketing literature to businesses because each business thinks they are unique.

F. Does Fiber Require an Enterprise Fund?

Currently the fiber business is part of the electric utility and the fiber revenues and expenses are not tracked specifically as they would be for a separate business. The RFP asks whether the City should track fiber separately as a profit and loss center of some sort. We will look at the various issues associated with accounting for fiber separately and then will look in more detail at what it would mean to create a profit and loss center for fiber.

Nature of the Fiber Entity

What sort of accounting entities have other municipalities formed for their fiber business? The three ways I have seen this done include:

> Department / Division. With this option the fiber business becomes a standalone Department or Division within the Electric Company. Department or Division in this case normally represents a budgetary designation and there would be an entity established that would receive the fiber revenues and all of the associated fiber expenses. Typically a Department or Division does not require a separate bank account, but is rather just an accounting and budgetary entity.

Enterprise Fund. A more formal arrangement than a department is establishing the fiber business as an enterprise fund. This generally takes action by the City Council because an enterprise fund is an entity that is expected to create revenues sufficient to fund its operations. An enterprise fund will generally be a separate accounting entity from the Electric Company and would have a separate income statement shown in the annual report of the utility and the City. Cities often create enterprise funds for small businesses they operate like liquor stores, golf courses, stadiums, convention centers, etc. Depending upon the specific charter of the City, an enterprise fund might require a separate Board, although in most places that have created a fiber enterprise fund, the person or board in charge of the utilities is also in charge of the fiber enterprise fund.

Utility. The most formal way to create a separate entity is to create a separate utility. States differ on specifically what it means to be a utility, but utilities typically have their own board that governs them separate from the City Council. We typically see utilities created for things like electric, water and wastewater, gas, and airports.

Issues with Creating a Profit or Loss Center

Many other municipalities have created some sort of profit and loss center for their fiber business. Generally this is done sometime after they get into the business of selling fiber products to outside entities. Following are some of the issues to consider for tracking the profit and losses for fiber.

Creates Pressure for Fiber to be Profitable. If you create an accounting entity for fiber that will show the revenues and expenses associated with fiber, you will have created an expectation that fiber ought to cover its expenditures with fiber revenues. A municipal venture is normally considered successful if it can generate enough revenue to cover the cost of operations, the cost of debt and the capital costs needed to maintain the business. The creation of a separate entity for accounting purposes is going to bring together the revenues and associated expenses from the fiber business, at a minimum. It probably means recognizing the depreciation expense to recognize the cost of building the network and might also require the imputation of internal debt payments to repay the cost of building the network.

The very act of creating fiber as a separate entity tends to then put pressure on the fiber business to eventually ‘pay for itself’. But until you bring all of the fiber costs together it is often difficult to understand the expenditures made on fiber’s behalf by employees of other divisions and departments.

Separate Income Statement and Balance Sheet. When you bring the revenues and expenses associated with fiber into a single entity, you will have created an entity that is going to produce some sort of an income statement. If you create a department or division you will be bringing together the direct revenues and direct costs of operating the fiber business, and your ‘income statement’ will be the same as EBITDA (Earnings Before Interest, Taxes, Depreciation and Amortization). EBITDA is basically the comparison of direct revenues versus direct operating expenses. This is also sometimes called net margin.

However, if you create an enterprise fund or utility, then the income statement will be a fully-allocated traditional standalone income statement, meaning that it will show both direct and indirect costs like overheads and allocations from other parts of the city.

It is unlikely that you would ever produce a balance sheet for a department or division, but only for an enterprise fund or a utility. This is often dictated by state law.

Subsidies. One topic that gets discussed a lot in other states and in many cities is the idea of subsidies. You can expect to hear the argument made by the incumbent providers that you have unfair advantages that make it easy for you to compete against them. They will say that you are only able to take the business from them because you subsidize the fiber business.

Many states such as Louisiana, Virginia, and Wisconsin require that municipal fiber businesses employ fully-distributed fully-allocated accounting to eliminate the chance of subsidies. What this means on a practical basis is that under the rules in those states the fiber business must account for every cost that is spent on their behalf, both direct and indirect, and in some cases even imputed.

Direct costs are the costs of running the business and are the costs you would normally see in a departmental budget – labor, benefits, vehicles, travel, training, etc. Indirect costs include other expenses that benefit the business such as accounting, payroll, human resources, insurance, etc.

However, it is possible to also bring in the other associated expenses. Municipal systems that use the fully-allocated cost method to track fiber costs will allocate indirect expenses like allocated floor space rental, interest, self-insurance, depreciation, taxes, etc.

It is even necessary in some states to track imputed expenses. Imputed expenses are those that the fiber utility doesn't pay due to the nature of the environment it is in. For example, since your fiber business is part of the electric utility, you probably do not charge fiber for pole attachment fees like you would with an external carrier. In some states it is even required to impute taxes, as if the fiber utility had to pay them and the fiber business will have to impute property tax, income tax and other taxes to which it is naturally exempt.

The last item that often comes up in the discussion of tracking fiber costs is interest expense. A large fiber system built to supply fiber-to-the-home might have been financed with an external bond issue. However, in some states the fiber business must impute an internal loan if any of the network was constructed with funds that were not derived directly from the sale of fiber products. In your case this kid of allocation would probably be done by creating an internal loan between the electric utility and the fiber business.

Charging the City for Using the Fiber Network. Another issue that always comes up is whether to charge the City for the use of the fiber network. Some states require this. However, many other municipal fiber networks bill the City even when it is not required by law.

The argument for billing the City for using the fiber networks is that they were using the services from other carriers before you created the fiber network and these costs were once in their

budgets. There is a definite cost of providing fiber services and if you don't bill the City for using the services then you have created a subsidy.

Most places that bill the City for fiber services will use the same rates for billing the city that they charge to any external provider.

Give Somebody Direct Responsibility to Make Fiber Work. One of the main reasons to create an enterprise fund is to clearly have one person in charge for the success or failure of the business. If the fiber business is to be long-term successful, then one person in the organization must be in charge of the effort. You can only be successful with the fiber business if you run it like a business.

Does a Standalone Entity Have to Have Employees? Does creating a fiber profit center mean that there has to be direct employees of fiber?

The short answer is no. Generally accepted accounting principles would suggest, although not require that an employee be based in the accounting entity for which they do the majority of their work. I know of cities where all of the employees who work for the fiber business also have responsibilities with the Utility. However, that structure leads to a dilution of priorities and generally the Utility will take precedent when there is a crisis.

The purpose of the separate accounting for fiber is to make sure that you capture all of the costs associated with fiber so that you can understand the extent, if any, that the business is subsidized by other utilities. Thus, creating a fiber department or enterprise fund does not carry with it the requirement to create full-time fiber employees. That is a separate decision that is made based upon the work performed, and probably as the fiber business grows there will come a time when the work load will justify that some employee be assigned to the fiber business. The business plans I have created for this project assume the equivalent of around ten people to achieve the work that must be done to keep fiber successful. I suspect, that like most cities, you will find it easier to manage if most or all of those employees are direct employees of fiber and not shared with other parts of the utility.

One thing that is required if there are shared employees is that some reasonable method must be found to assign employee time between fiber and other utilities. These kinds of assignments of time are generally done on one of two ways. One is by completing a time sheet each accounting period showing the hours worked for fiber and for other entities within the utility or within the city. The second method is to do periodic time studies to determine what percentage of a person's time should be booked to fiber or elsewhere.

And again, even if fiber has no direct and dedicated employees, the department or enterprise fund needs to assign somebody within the utility to be in charge of fiber.

Adds More Work to the Budgetary and Accounting Process. As can be seen by the previous discussion, accounting for fiber as a separate entity will create additional work for the accounting and budgeting efforts. You will essentially be establishing a set of books for the fiber effort within the current budget and accounting system.

General and Administrative Costs. Earlier I mention general and administrative costs like accounting, payroll, human resources, etc. These kinds of costs are generally referred to as G&A costs. If you employee fully-allocated accounting so that you understand the full costs of providing fiber, then you will want to assign these kinds of costs to the fiber cost center. Some municipalities do this and others have elected not to do so.

Capital Budget. One of the biggest ongoing expenditure of the fiber department is the cost to maintain and expand the fiber network. Any new entity created for fiber should have its own capital budget.

Recommendations

The only way you are ever going to know how fiber is doing as a business is to create a profit center. In Virginia the MLEC rules suggest strongly that you should be keeping fully-allocated books for the fiber business, which fits nicely with an enterprise fund.

CCG recommends that you do the following:

- If you sell bonds to finance FTTP, then those bonds might require a separate accounting. If so then you will almost certainly establish fiber as an enterprise fund. One of the features of an enterprise fund is that it has separate bank accounts and this is something that bond financing might require. However, if bonds don't require an enterprise fund, then creating fiber as its own department or division underneath of the electric utility should be sufficient. This is essentially a budgetary creation of a business rather than the more formal creation of an enterprise fund or a utility.
- It does not make any sense for a business of this small size to create a separate board to govern fiber separately from any governance that applies to the other utilities.
- However, there has to be one person in the organization who is 'in charge' of fiber.
- You should create a separate income statement for fiber to analyze the performance of the business internally. You probably only need to create an audited income statement if you create an enterprise fund
- To the extent that you allocate overheads from the City to the electric or other utilities, the same sorts of assignments should be made to the fiber entity.
- The fiber entity ought to have its own capital budget for the purposes of tracking assets built on behalf of the fiber effort.
- The fiber entity should bill the rest of the City and the other utilities for using the fiber network.

II. Community Uses for Broadband

A. How Much Broadband is Enough?

How much bandwidth does America realistically need to satisfy current and predictable future needs? Today broadband in Martinsville is mainly being supplied by cable modem from Comcast and DSL from CenturyLink. Industry experts almost universally agree that household Internet usage within the foreseeable future will soon outstrip the capabilities of the current technologies available in the City.

While your survey showed that many households are satisfied with today's download speeds, we are already beginning to see sophisticated users demand more bandwidth. In the near future experts all agree that households are going to demand far faster speeds than are currently being delivered. We have already seen the rapid evolution from early dial-up access increasing to 56 Kbps dial-up increasing to cable modems and DSL. There is no reason to believe that we have reached the end game in terms of the need for faster broadband. Consumers are finding more and more uses for broadband. Users are routinely swapping pictures, video files, and other large files. Gamers are using the Internet for live play across the street and around the world. The Internet is quickly becoming the prime mechanism for delivering videos to households. Of even more interest is where technology is going. There are already some brands of 3-D video technology that enhance the gaming and movie experience (and require gigantic data files compared to today).

Predictions about the future growth by some of the experts are:

- In May 2008 the Chief Technology Officer of Comcast Communications said, "ISP traffic is increasing at more than 50% every year. So it is not far-fetched to see 100 Meg products becoming the norm in 5 or 10 years, and we expect our customers will find exciting ways to use that capacity." In the same interview, the Chief Technology Officer of Comcast agreed, "For the short term, 100 Mbps is a marketing advantage – in the longer term, who knows? People didn't need 1 Mbps when we started delivering it." [3]

- Cisco says that Internet bandwidth usage has grown increased 8-fold over the last five years. They are projecting that bandwidth usage will increase 3-fold over the next five years and will grow at a combined annual growth rate (CAGR) of 29 percent from through 2016."[4]

- Bret Swanson and George Gilder predict fast growth through 2015: "From YouTube, IPTV, and high-definition images, to "cloud computing" and ubiquitous mobile cameras—to 3D games, virtual worlds, and photorealistic telepresence—the new wave is swelling into an *exaflood* of

[3] Brian Santo, "It's the End of Cable as We Know It (And We Feel Fine)," *CED* (May 1, 2008), http://www.cedmagazine.com/Article-End-of-Cable-As-We-Know-It.aspx.

[4] Cisco, "Cisco Visual Networking Index: Forecast and Methodology, 2011-2016," http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-481360_ns827_Networking_Solutions_White_Paper.

> Internet and IP traffic. An exabyte is 10 to the 18th. We estimate that by 2015, U.S. IP traffic could reach an annual total of one zettabyte (10^{21} bytes), or one million million billion bytes."[5]

If the growth rates predicted by this diverse group of experts materialize, then all would agree that DSL and cable modems, as they exist today, will be unable to supply households with the bandwidth needed to fully utilize the services and benefits of the Internet. Only fiber can give households access to full web functionality within a few years from now.

It is interesting to see executives at cable and telephone companies talking about 100 Mbps and 1 Gbps connectivity during the next decade, since their current technologies have no hope of ever delivering those kinds of speeds. The following table shows CCG's best estimate at the commercially available bandwidth that is available today and in the future with the primary commercial technologies. It is clear that fiber is today, and will remain for the foreseeable future as the most robust technology.

Data Download Delivery Speeds[6]

	Today	10-years	25-years
FTTH	2,400 Mbps	10,000 Mbps	25,000 Mbps
DSL[7]	Up to 25 Mbps	Up to 50 Mbps	Up to 100 Mbps
Cable modem	Up to 100 Mbps	Up to 200 Mbps	Up to 300 Mbps
Wi-Fi[8]	50 Mbps	100 Mbps	200 Mbps
4G	60 Mbps	100 Mbps	200 Mbps

B. Why Broadband is Important

We could write an entire paper describing why broadband is important to Martinsville, and we expect that the City knows most of these reasons, which is what led you to study the issue. There are many clear advantages of having ubiquitous broadband. Following are some of the major benefits that communities see when wanting to have a fiber network:

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[5] Bret Swanson and George Gilder, "Estimating the Exaflood: The Impact of Video and Rich Media on the Internet: A zettabyte by 2015?" *Discovery Institute* at 2 (January 2008). http://www.discovery.org/scripts/viewDB/filesDB-download.php?command=download&id=1475.

[6] Note that this table is discussing the practical speeds that can be achieved with these technologies, not the theoretical speeds.

[7] DSL requires bonded pairs, that is, using more than one copper pair to achieve the speeds listed in the table. The problem in the real network is that very few neighborhoods have been built with the extra copper pairs needed to provide this service to more than a few customers. There are DSL technologies that can exceed the current listed speed, but only for very short distances.

[8] Note that wireless technologies are generally capable of delivering a lot more bandwidth than is actually deployed in field conditions. For example, for public Wi-Fi to be fast it needs to be connected to a very fast data source like fiber. 4G also has a lot of potential, but in actual practice has a number of practical limitations that are inherent in wireless networks.

Government

Many governments across the country are using broadband to improve service to constituents. This movement is often referred to as e-government. Following is a list of the sorts of services and uses that the City could achieve over the next decade by adding City-wide fiber.

- Teleworking. Fiber would allow City employees to telework and/or have easy access to City systems and files from anywhere and any device. This would require more bandwidth at the City, but also more bandwidth at their home. With teleworking, City employees could have access at home to all data files, and ideally would be able to make and receive VoIP calls using their normal City phone numbers from home as well.
- Video Conferencing. Videoconferencing is finally coming into its own. Video conferencing has been limited to specialized video conferencing centers that have expensive equipment designed for this purpose. However, with real bandwidth, almost any computer can become a video conferencing center. Cameras have become inexpensive so the only issue to overcome for video conferencing is bandwidth.
- Video Surveillance. The City has a few surveillance cameras today, but with ubiquitous fiber, cameras could be put anywhere when needed, even temporarily.
- Communicate Electronically. Larger bandwidth means easier communications. For instance, it will be easier to send large data files. This would include improved communications with:
    - Constituents.
    - Between city employees.
    - With vendors – the ability to send large files such as maps, blue prints, data files.
    - With larger constituents such as developers, landlords and large businesses.
    - With politicians, boards, commissions and other external government entities.
    - With job applicants.
    - With attorneys – the ability to send electronic evidence files of pictures, test results, videos and other evidence instead of in hard-copy formats.
- Economic Development.
    - Provide video tours of the City for interested businesses.
    - Provide easier access to mapping and geologic data.
    - Provide easier access to census and other key data.
- Streamline Public Processes.
    - Automate the building permit process.
    - Automate zoning verification.
    - Automate building inspection including allowing floorplans to be electronically sent to field.
    - Automate job applicant testing.
    - Automate citizen payments for various permits and other fees.
    - Automate business and landlord licensing.
    - On-line registration for recreation events and classes.
- Operational Improvements.
    - Have real-time GPS vehicle tracking.
    - Computer aided dispatch.
    - Plow routing and efficiency.

    - Automate vehicle maintenance data.
    - SCADA monitoring of pools and irrigation systems.
- Improvements at the library.
    - Moves the library into the next century.
    - Expand offerings to include streaming videos of story time, author visits, classes, etc.
    - Expand catalog to be accessible by hand held devices.
    - Give public access to City and County data such as GIS.
- Public safety.
    - Real-time cameras in squad cars.
    - Floorplans available real time to firefighters and police.
    - Police officer briefings – officers can meet from their cars.
    - Monitor parolees and probationers.
    - Real time monitoring of firefighter biosigns
- Information Systems.
    - Create back-up redundant crisis center.
    - Connection of critical servers to backup sites.
    - Be able to send large data files.

Economic Development

The purpose of municipal economic development is to generate new jobs and increase the tax base of a community. The pursuit of these outcomes is a result of efforts to attract, retain or expand commercial and industrial business. Although financial incentives are often highlighted by the news media, most economic development efforts undertaken by cities involve the provision of basic infrastructure to support the needs of new or expanding business.

Economic research shows that public infrastructure investment is a powerful driver of business productivity, investment, and economic growth. In addition to basic infrastructure like streets, sewer and water, cities often promote the quality of schools, access to affordable health care and the availability of cultural amenities in their efforts to attract new business.

Broadband access is being used as an economic development tool in those cities that have built fiber networks. There are now nearly 100 cities that have built FTTP networks and hundreds more that have built fiber to connect City buildings as has been done in Martinsville. CCG knows many of the cities that have fiber networks and almost every one of them has at least one economic development success story. Fiber can be used an incentive to lure new jobs to town or to keep existing employers from leaving.

The availability of high-speed broadband lowers entry barriers for new firms and encourages self-employment. High-speed broadband opens markets and brings together market participants, thereby generating greater access to products while lowering transaction costs. Many municipalities have constructed, or encouraged the construction of high-speed fiber networks for wide-spread use within their community. These cities were motivated by the lack of the private telecomm offering the internet services their city needs to compete in a global marketplace.

Education

Broadband can enhance education throughout the community. Since many school systems now have ultra-fast broadband, there is much evidence of the ways that broadband can improve schools. Broadband is being used in the following ways in schools:

- Can provide real time and on-demand interaction and collaboration across distances, enhancing access to professional development workshops, degree and certification programs, virtual tours, field trips, special events, etc.
- Broadband can transform the learning experience for students as it can expose them to a range of exciting and innovative learning content that was previously either inaccessible or unpractical in the narrowband environment. For example, students can work on projects with students in other schools or other countries. They can learn new languages by talking to native speakers in the language.
- Broadband can provide greater use of data, text, graphics, voice, and video to supplement textbooks and instruction with multimedia formats that tap into the many different learning styles of students and teachers.
- Broadband can bring the ability to model or simulate "what-if" scenarios to help students understand difficult concepts.
- Broadband can improve cooperation between educational institutions. One of the real benefits of broadband is that it can facilitate and enhance inter-institutional collaboration. For example, broadband can be used to share scarce teacher resources between schools and colleges. It can also be used to link different institutions to create innovative joint projects that encourage communication and cooperation.
- Networking can help address the demand for more teacher professional development at a time when funds are being reduced. Video conferencing and Web-casts can improve access to training while reducing travel and training costs.
- Broadband can help advanced students by allowing delivery of instruction by highly qualified teachers for courses where the number of students is too small or a teacher is not available.
- Broadband networks can bring an opportunity to train students in the use of technology through integration with academic instruction in a meaningful way enhances learning and ensures that students have the skills necessary to be successful in today's knowledge-based workforce.
- Broadband can widen access to education. Broadband can also be exploited to widen access to educational material and new learning opportunities by using links from schools to the wider community. Broadband is also used as a means of widening access in rural areas and providing access to education materials to learners with disabilities or behavioral problems.
- Administrative applications and efficiencies.

Health Care

Access to broadband networks can benefit both health care providers and consumers. These benefits can include improved quality of services, reductions in cost, dissemination of health information to the public, reduced time in hospitals and more efficient administration. We are just now on the cusp of

seeing a healthcare revolution in terms of using broadband. Those communities with broadband are going to be the first to share in the new technologies for your citizens.

To summarize the benefits of broadband for health care:

- Makes doctors more efficient and allows them to review files, x-rays and other patient material remotely, as needed.
- Telemedicine allows local health facilities to consult real time with experts elsewhere, saving on transporting patients and reducing time for treatment.
- Telemedicine can save money and improve patient treatment by allowing for faster diagnosis of problems. It can also save money by reducing the frequency for doctor and hospital visits. With in-home monitoring possible the necessity and length of hospital stays can be reduced.
- Will allow for more effective treatment of patients by allowing for 24/7 monitoring of patient vitals and condition.
- Remote monitoring offers the ability for the elderly to live at home for longer, thus drastically reducing costs and improving the quality of life.
- Nurses and doctors can use two-way connections for examining and talking to patients in their homes.

Businesses

Businesses are become huge users of bandwidth and are becoming more and more reliant on robust networks. Following are some of the key ways that businesses are using bandwidth today.

- Transmitting Large Data Files. Companies today need to send massive data files that consist of such things as drawings, blueprints, videos, and other formats that create large files.
- Redundancy. Companies are so reliant on bandwidth that most of them want redundant paths to the Internet. They want to be able to get services from more than one internet provider to provide reliability when provider networks crash (which they do). Very data intensive companies also seek physical redundancy, meaning they want more than one physical wire path leaving their location to get to the world, to protect from local problems like cable cuts.
- VoIP. Large companies that operate in multiple locations have almost universally adopted VoIP as a way to manage long distance costs and to bring uniformity to corporate communications.
- Disaster Recovery. Businesses are creating large amounts of data and they understand that it would be crippling to lose their data. Thus, firms are using disaster recovery techniques to make sure that corporate data is secure in the case of a disaster at any one location in the company. Disaster recovery involves several techniques. Primary is the storing of data in more than one location, usually at least in one spot that is outside of the company. Disaster recovery also involves systems and software that would allow the company to continue working using external servers should they physically lose their hardware from a fire, flood or other disaster.
- Video Conferencing. Because of the ever increasing cost of travel and due to a drive for efficiency, companies are using more and more video conferences. At any given time there can be multiple video conferences emanating from the same location at the same time, requiring significant bandwidth.
- Training. Training is become a constant need for businesses. Training does not involve only new employees, but all employees need to be trained in new processes and procedures. Without

broadband, training involves sending the employees to a distant training center. However, with the use of video conferencing and the use of large interactive training programs, companies can train for a few hours per day and get productivity from workers. These new training processes require significant broadband.

- Cloud Computing. Cloud computing is a relative new business model whereby businesses have abandoned servers and computers in favor of using virtual servers located at large, remote and secure locations. Companies have come to realize that operating their own servers and trying to keep up with new computers and software is costly and sometimes dangerous. Almost every company has had major problems when their server was compromised by a virus or when a key computer crashed and destroyed key data. Thus, cloud computing now offers a set of services that make it easy for companies to manage the IT process:
    - Companies can use 'dumb' terminals to access smart virtual servers accessed through the web. These servers are managed to be secure from viruses and service attacks. The software on these servers is always kept up to date. This model relieves the company from trying to be an expert on computers, security and software and to focus on their core business.
    - Mass computing. Companies can buy time on many computers when they need to process a large application or use a big burst of computing power.

Home Use

Just a few years ago home Internet use consisted of reading emails, gaming and web browsing. However, the advent of real broadband has greatly expanded the way that households are using bandwidth today. One can imagine that in a decade the following list will seem somewhat quaint as households find many more ways to use broadband.

Entertainment

While people still use the Internet to read emails, entertainment has grown to be much more. The most popular use of broadband today is video. Video has become ubiquitous on the web and a large number of commercial web pages now include video. As more and more video is transmitted in high definition video, the vast climb in bandwidth is expected to continue to grow rapidly.

Streaming audio has also grown rapidly in the last year. Reports are that there are now more people streaming music through Spotify and Pandora than are downloading songs through places like iTunes. And this is growing with an announcement that Microsoft is joining the streaming audio race through the Xbox.

Online gaming is also becoming a major driver of home bandwidth. Gamers understand bandwidth and are always looking for the fastest upload speeds available. Unfortunately for gamers, DSL and cable modem are skimpy with upload speeds. One of the fastest growing categories of online gaming is known as Massively Multiplayer Online games (MMO) and includes such games as World of Warcraft, Lineage, RuneScape, Final Fantasy, Eve Online, Dofus and many others. MMO games allow huge numbers of games to play simultaneously on gigantic game boards.

Even more millions of gamers play games using the interactive versions of games available on the various game boxes. Some game boxes like the Xbox now also allow simultaneous VoIP conversation among games as part of the gaming bandwidth.

Telework

Broadband enables many people to work from anywhere. As US jobs continue to shift from manufacturing to service and information industries, more and more jobs can be done remotely, at least part of the time. Teleworkers are not only those who work full time at home, but increasingly are becoming those who work occasionally from home, or who work from home on weekends.

Teleworkers need bandwidth in order to simulate the environment they have at the office in their home. They want access to the company servers and voice systems to seamlessly be able to work from wherever they are at.

Job Training and Re-training

Several experts have estimated that the average US worker will now have 4 to 5 different types of jobs during a career. This means that job training and re-training has to become a normal part of any worker's career. Even today, interactive training videos are among the largest files that are transmitted on the internet. These videos are not simple movies by include an interactive nature where the student interacts with the information presented and also takes tests. These files can easily be a gigabit or larger and will not be readily available to workers without real broadband. Further, many Internet service providers like the telephone and cable companies are placing monthly limits on the amount of bandwidth a customer can download. The combination of slow data speeds and bandwidth limits is going to limit the ability of many communities to retrain their citizens as they are forced to change jobs over their careers.

Elderly

We are now at a point in our history where the baby boomers are starting to age. The country is going to be faced with a crisis of having millions of elderly and caring for this generation is going to swamp the health care industry.

A number of Internet-based technologies and companies are holding out the possibility that the elderly will be able to stay in their homes longer and not need to be sent to institutions. For example, there are now sophisticated monitoring services available that allow doctors and nurses to examine patients daily at home. These same services allow family members to stay in touch and check in on family members frequently. Some of these monitoring programs can constantly monitor vital signs, can report when an elderly person falls down or falters in any way.

These kinds of services are going to require significant broadband because they involve using constant video surveillance. Further, the medical monitoring requires high quality video and not the grainy sort of videos one sees from much commercial surveillance tapes.

Disabled

The disabled face the same kind of challenges as the elderly and there are starting to be a number of broadband-based services that give a better quality of life to the disabled. Just as with the elderly, these programs begin with monitoring and surveillance where needed. However, in many cases broadband is also used to help operate devices that ease the life tasks for the disabled.

Finally, telework has brought the opportunity for many disabled to work from home with a much better lifestyle than with difficult commutes.

Surveillance and Security

The advent of inexpensive video cameras has led to a boom in home surveillance and security. Millions of homes are now operating surveillance cameras that can be accessed from the web so that they can check on their homes when they are absent. These cameras are used not only for general security, but are also being used to watch babysitters and to check on pets and kids.

Video cameras require a significant amount of upload bandwidth since they run a continuous bit stream. Homeowners desire to have video streams with greater clarity, meaning even more bandwidth. As high definition cameras get cheaper, the bandwidth need for cameras will continue to grow.

Device Management

A new phenomenon is the use of the Internet to manage devices. Homeowners are beginning to connect interactive chips for energy management and are able to control thermostats, hot water heaters, and other energy-using devices to save on energy when they are not at home, but to have the home ready on their return. Security systems also can be made to switch lights on and off at random to make the home look occupied.

Some companies are now marketing smart home devices that go even further and that can be used to turn on the oven, the coffeemaker, the alarm clock or any device connected to the system.

All of these systems are being made easy to use by giving control of the connection to cell phones. This is an industry that is just beginning and one can expect the country to embrace these technologies more as we turn to become a greener nation.

More Routine Use of the Web

People are using the web more often and in new and creative ways.

- Content Creation. Millions of people now routinely create web content in the form of uploading videos, writing blogs, creating podcasts, editing and adding to wikis.
- Combining Web Applications. The web is getting more powerful as users and companies find ways to combine web applications. For example, almost any database can be overlain on Google maps – a list of French restaurants, people who donated to a political cause, members of a club – to create useful visual data that is very different than the raw maps or the raw databases.

- Personalized News – Users can use web bots and RSS feeds to keep track of news that matters to them. Web bots are tools that will search for articles related to specific topics. RSS feeds allow users to get an automatic update any time a web site of interest changes.
- Data Mining. Companies like Amazon.com and eBay use the data of things you've searched for and what you've bought to make suggestions of things that could be of interest to you. More and more companies are mining data to try to reach out to individuals. There is a big move towards individually aimed advertising where firms will only advertise to those they think would be interesting in their products.
- Architecture of Participation. This is a fancy way of saying that as new websites gain recognition and users, word of mouth quickly drives new users to the website. This explains how new web applications and sites can explode to millions of users in a relatively short period of time.

As the web moves towards greater and greater collaboration and interactivity, the amount of bandwidth needed increases.

III. Engineering

In this section we will examine the cost estimate made for the network, the electronics and other assets. A fiber optic network consists of building a fiber up every street in the City so that fiber can be made available to every home and business in the community. For a tutorial on fiber cable see the web site for the Fiber Optic Association.[9] This web site explains everything about fiber from a glossary of terms to how it's manufactured and used.

In making this estimate CCG made a trip to the City to look at local conditions that would affect fiber costs.

A. The Technologies in Use in the City Today

Since the focus of this study is on data services, we thought it would be useful to briefly describe the technologies used today by the telephone and cable company incumbents, so that the City can understand the difference between these technologies and fiber.

CenturyLink DSL

DSL (Digital Subscriber Line) is a technology that allows the delivery of data at high-speed over existing copper telephone wires. It is a proven technology that has been in wide use for over twelve years. Where available, DSL is typically offered in a number of different bandwidths, which allows users to select the bandwidth that it needs and can afford. DSL service uses only a portion of a copper line's capacity and thus permits users to make telephone calls at the same time that they are working on the Internet.

There are a number of different types of DSL in use or under development. These are often referred to as the various "flavors" of DSL. They are typically marketed under the acronyms ADSL, ADSL2, ADSL2+, SDSL, HDSL, VDSL, VDSL2, IDSL and G-Lite.

Deploying DSL was capital intensive for CenturyLink when the technology was new. However, the cost of DSL hardware has dropped significantly as the product has matured. The DSL network begins at a telephone company central office with a transmission device referred to as a DSL Access Multiplexer ("DSLAM"). A DSLAM is, in essence, a small data switch that can support multiple DSL users. Each customer must also have appropriate hardware to receive DSL. Most brands of DSL use a DSL modem at the customer location.. DSL also requires that the relevant copper be stripped of all load coil extenders which leaves only the copper wire pair. . In the telephone industry, this is referred to as "deloading the line." The copper in the telephone system often was built using a system of power boosters and signal repeaters that allow the normal telephone signal to be carried with greater strength and for greater distances. In order to deploy DSL, such repeaters and boosters must be physically disconnected from the

[9] At http://www.thefoa.org/tech/ref/contents.html#Understanding

copper pair, and this usually requires a field crew with bucket trucks to trace the pair and to physically strip the copper pair.

The hardware cost of deploying DSL varies widely by brand purchased and by the specific flavor of DSL being deployed. The lowest costs varieties of DSL can now be purchased for as little as $150 per customer for both ends of the hardware. Some of the variations of ADSL2, ADSL2+ and VDSL can cost as much $400 per customer.

DSL is not readily available everywhere for a number of reasons. First, DSL is subject to distance limitations. DSL can reasonably be served up to 18,000 feet from a central office switch in the most favorable conditions, but poor or older copper wiring makes this limit closer to 10,000 to 12,000 feet in many places, depending on the brand of equipment. This distance limitation is further shortened in reality, since it is measured in cable feet rather than "as the crow flies" in a straight line. The copper wiring coming out of a central office often wanders up and down streets and rarely runs in a straight line to reach areas away from the switch. Realistically, in many exchanges, this 10,000 to 12,000 foot distance limitation creates a potential delivery circle of only about a mile-and-one-half around the switch. Some proprietary versions of DSL allow for "Extended Range" DSL, but comes with increased costs and slower DSL data speeds.

There are two solutions to DSL's distance limitations. One solution is to use higher bandwidth and extended reach DSL so that some bandwidth will go further. DSL bandwidth delivery over copper is not linear, meaning that the amount of bandwidth that can be delivered drops off with distance from the transmission point. For example, with most DSL around 20% of the initial bandwidth will make it past the nominal working range of 12,000 feet or roughly 2.5 miles of copper wire.. Thus, a 20 Mbps DSL card might still deliver 4 Mbps to a customer three miles from the central office, depending upon the quality of the copper. With extend reach DSL, the DSL bandwidth can "reach" beyond 18,000 feet, but the bandwidth that is able to be delivered is still less than 5 Mbps. The most important point to note about DSL and distance is that a customer three miles away from the hub will get a far inferior product to a customer living near to the central office.

The second solution to DSL distance limitations results from what are referred to as "remote" or "mini" DSLAMs. This technology allows DSLAMs, or central DSL hubs, to be moved into more remote locations in the network – e.g., to the cable junction in front of a housing development or a business park. From such a remote DSL origination point, the DSL signal can still be delivered for the same distance, but this distance is now measured from the new field-installed hardware and not from the central office. Such technology should mean that DSL can be made available to most customers.

The second problem with DSL delivery is the existing copper network. Copper plant was not originally built with DSL in mind, and there are many places in current networks where DSL will not work, regardless of the distance from the central office. In some cases, the copper is too small in gauge or thickness, since the thicker the copper the better that DSL will work. In other cases, there are signal leaks into the system, cross talk

between copper wires or there are other reasons why some copper pairs will not readily accept DSL signals. There is very little that can be done to fix stray "noise" problems, other than to replace the portions of the network that has such problems. Replacement is an expensive solution that often means re-wiring an entire neighborhood.

Third, DSL is a copper-only technology. This means that if any path between a customer and a DSLAM includes even one foot of non-copper cable, such as fiber, then DSL will not function. For many years large companies have been building new feeder cables using fiber. Feeder cables are large capacity cables that carry signals from the central office to large neighborhood clusters of homes and businesses. Fiber is cheaper and more reliable for this use, and almost all new subdivisions and business parks built in the last ten years are fed with fiber feeder cables. Additionally, phone companies have been replacing older copper feeder cables with fiber cables as they do routine upgrades. This has led to the strange phenomenon that the newer the neighborhood, the less likely that DSL will be available. Older neighborhoods that are built throughout with copper may be good candidates for DSL, whereas in newer areas with fiber feeds, DSL will not work without field deployment of the DSLAMs, a more costly way to provide service. This phenomenon is not favorable to rapidly growing communities in which a large percentage of homes and businesses have been built in the last ten years.

Comcast Cable Modem

The most popular source of high speed Internet access today is cable modem service. Nationwide, about 60% of all high-speed customers use cable modems.

Cable systems were originally designed to deliver, through sealed coaxial cable lines, the same radio-frequency signals that residents with good reception could obtain from television broadcast towers over the air. Over the years, cable operators have upgraded their networks to Hybrid Fiber Coaxial (HFC) systems by replacing some of their coaxial cables and associated facilities with fiber optic lines and electronics. They have also increased the bandwidth capacities of their systems and today rural cable systems like Martinsville probably have from 550 MHz to 1 GHz in system bandwidth. As a result of increased bandwidth and digital video compression technology, cable systems today have the capacity to provide hundreds of television and music channels as well as high-speed Internet access. Many cable systems are now also providing or experimenting with telephone service.

Cable systems that provide cable modem service generally use multiple cable television channels (6MHz per channel) for downstream signals and one channel for upstream signals. At the cable company headend, a cable modem termination system (CMTS) uses these channels to create a virtual local area network with cable modems attached to computers at subscriber residences. Depending on the transmission technology used, cable operators can theoretically send up to 36 Mbps per channel downstream from the cable headend, and users can send up to 10 Mbps per channel upstream. This upstream and downstream bandwidth must, however, be shared by all active users connected to a network segment called a "node." The level of usage at a node at any point in time can

have a significant effect on the performance that individual customer's experience, as downstream speeds can drop from 1.5 Kbps to 500 Kbps or less as the number of simultaneous users on that node increases. Upstream capacity is even more limited, as cable operators typically do not allocate as many channels for upstream use as they do for downstream use. In fact, some cable providers limit users to upstream speeds of only 128 Kbps.

If congestion occurs because of high usage, cable operators can add additional channels to a node or run fiber-optic lines deeper into neighborhoods to add more nodes, thus reducing the number of users per node. Years ago, cable systems often served up to 2,000 – 5,000 homes per node. That number has decreased significantly, with new systems generally designed to serve 500 homes per node.

Currently, cable modem service is not a viable option for many businesses. First, cable service is often not available in commercial areas. This is in large part a historical phenomenon – cable operators typically did not build their systems out to commercial areas because few, if any, businesses subscribed to cable television service. Most cable companies are now willing to extend their systems to commercial establishments if they could solve an even more significant problem – most cable systems do not currently have the bandwidth to support widespread business usage of their systems. For example, businesses typically cannot obtain web hosting services from cable companies.

Cable systems are capable of delivering significant amounts of bandwidth to customers. However, what we see in the marketplace is that cable providers seem to have the goal of just staying ahead of DSL in capability. In Martinsville you have an interesting phenomenon where CenturyLink DSL offers more bandwidth than the cable system, something rarely seen in the US. Most cable providers are very leery about dedicating too many channels for data service unless they have to – they would rather keep the channels for TV programming. Cable providers are wresting today with the desire to carry High Definition TV channels (HDTV) since these channels require much more bandwidth than traditional channels.

The cable TV providers have all banded together nationwide and created a firm that they all use to do research and product development – called Cable Labs. Cable Labs develops the specifications for cable modems and all of the cable providers have agreed to only use products that are Cable Labs compliant. Through this process the cable providers have been able to get really low prices for such things as cable modems and settop boxes.

With that said, competition with Verizon FiOS has driven Cable Labs and the providers to develop faster cable modem products. For example, Verizon is currently offering a 30 Mbps product on its FiOS fiber network for residential customers. Many of the cable companies competing with Verizon are offering 20 Mbps data services in response to Verizon. In general, cable companies could offer greater amounts of bandwidth, but economics, the need to offer more HDTV channels and a commitment to Cable Labs means we won't see great breakthroughs in cable modem speeds unless the market

demands it. It seems like the industry always does enough to just stay even rather than pull vastly ahead of the competition.

B. Active versus Passive Fiber Network

One of the first decisions to be made when looking at deploying a fiber network is determining if you want to use active or passive fiber electronics. This is a key decision because it impacts the way the fiber network is constructed.

The Active Optical Network (AON) dedicates a single fiber from each user back to the electronics. This means each customer has a dedicated path to the electronics and does not share bandwidth directly with another customer in the neighborhood. An AON network has many more field lasers than a passive network since there is a field laser for every customer.

In an AON network, everything is encoded as data between the electronics and the customer. This means all services must be digitized and delivered as an IP data stream to the user. The AON uses only 2 wavelengths on each fiber - one for transmittal of data to the users and one for transmittal of data from the users.

Since everything on an AON is data, the only possible video product is IPTV. IPTV delivers one (or a few) channel(s) at a time to customers as they request it. This is a different model than normal broadcast TV, where almost all channels are delivered to a customer all of the time. With IPTV, a customer must have a settop box for each TV that wants to receive its own channels.

The current vendors making Active Optical Network equipment includes Pannaway, World Wide Packets, Occam, and PacketFront.

The Passive Optical Network (PON) uses passive hardware to "split" the signals so that a single high-powered laser can be shared by up to 64 customers (more typically by 32 customers). This technology requires less fiber than an AON since many customers in a row or in an area share the same single fiber over which the information carried on the fiber is ‘split’ into 32 individual fiber drop paths for delivery to homes or businesses. In construction, one feeder fiber “feeds” a passive splitter that takes the information that is transmitted onto the feeder fiber and distributes across 32 or 64 individual fiber drops similar to the way water in a single pipe can be sent to 32 individual locations by placing a 1-to-multiple pipe junction on a single feeder water pipe.

PON technology uses bandwidth on the fiber differently than the AON. The PON electronics divides up the optical wavelengths on the fiber to allow 1 wavelength to transmit data and voice to the users, another wavelength to receive data and voice from the users and a third wavelength to transmit RF video (like normal broadcast CATV video) to the users over one fiber strand. In this manner, the PON network can transport both analog signals and digital signals into the home.

A PON network can transmit video at the RF level and have it split into multiple fibers drops. This means that a PON does not require a settop box to deliver analog cable TV. A PON also uses existing wiring more easily since the video signal is delivered in the same way as the

existing Cable TV video is delivered by the cable company. This gives easier access to existing telephone and cable wiring.

The current vendors for PON equipment include Alcatel, Motorola, Tellabs, Calix, Wave7 and AllOptic.

Within a PON network there are three additional options for delivering signal to customers – known as BPON, GPON and EPON.

Early PON systems used BPON (Broadband Passive Optical Network) technology. This technology uses a protocol for addressing multiple customers over a single fiber which is based upon the architecture used by the incumbent telephone companies. The use of ATM did not allow for the full utilization of the fiber's capabilities. In a BPON system there are separate segments of customer bandwidth assigned for voice, Cable TV and data. The biggest drawback of the BPON technology is that it used up transmission space sending empty data. For example, during a voice call, the ATM protocol of a BPON system would send an empty signal for those times when nobody is talking. That is to say that ATM technology reserves the bandwidth of services over the fiber, whether the service is being used or not. Newer technologies are much more efficient.

Today passive optical networks use either EPON (Ethernet Passive Optical Network) or GPON (Gigabit Passive Optical Network) technologies. These technologies use native Ethernet signaling for the customer delivery path, meaning that the bandwidth to the customer can be used more efficiently. In a GPON or EPON system there are still multiple separate data streams – for cable TV (to and from the customer) and for voice and data (to and from the customer). If a BPON and an EPON system were to carry the same amount of total bandwidth, the EPON system would actually deliver much more practical bandwidth. At full capacity the EPON system could use every available bit of capacity while the BPON system would devote a lot of transmission time to sending empty data paths because of the way that ATM reserves capacity.

The major difference between the three technologies is the amount of data that is delivered. Following is a chart of the maximum amount of bandwidth that can be delivered to a node of houses (32 homes) by standard available technology:

BPON - 622 Mbps downstream, 150 Mbps upstream
EPON - 1 Gbps downstream, 1 Gbps upstream
GPON - 2.4 Gbps downstream, 1.2 Gbps upstream

FTTH technology is expected to continue to grow in available bandwidth as volume sales of the technology decrease laser costs. The limiting factor is the development of these cheaper lasers. Already in the lab are systems that will deliver a terabyte of download speed and such technology upgrades will be introduced as laser prices drop.

Anyone trying to build a FTTH system will be beset with FTTH salesmen touting one technology over the other. At CCG we have done several major assessments of the technology and we make the following comparison between Active networks and Passive networks. We note

that each technology has its place, but that just one of the technologies generally fits any specific situation.

Active Optical Network

Advantages

- Can serve customers up to 36 miles from last active field device.
- Does not require as much complex pre-planning and engineering. With AON there is a separate fiber to each customer, making it easier to engineer as you go.
- A single point of failure will affect fewer customers
- Can support multiple service providers. This allows for an open access system with multiple CATV or data providers. A wholesale provider is given direct access to customers though their individual fiber.

Disadvantages

- Uses More Fiber. Since there is a home run fiber to each customer, there is much more fiber in the network. This also means fiber bundles are much larger in the field since they contain multiple fibers. This also means a lot more splicing during construction or during repairs.
- Cannot support RF video broadcast TV (only IPTV). This is a major drawback. Typically about 35% of customers want only analog TV and many of them do not want a settop box. An AON system requires every customer to get a settop box (a settop box for every separate TV, in fact), thus increasing capital costs.
- Shares data and CATV bandwidth in the same data stream. Today an AON system can cost effectively deliver 100 Mbps to each home. This is not a shared pipe with neighbors and each customer can get a dedicated 100 Mbps. There are some systems capable of providing 1 Gbps at each home, but these systems become expensive due to the number of lasers and the laser costs inherent in the system. With AON, one data stream must support CATV, data and voice together. Thus, if a customer is watching multiple HDTV sets, the amount of bandwidth left for data can be greatly diminished.
- Requires additional home wiring. Since the AON provides only one bandwidth (the data stream), the video service (IPTV) requires a high bandwidth data wire, such as category 5 or 6 wire to each TV location. This increases the cost of home wiring.
- Active field devices require backup power throughout the network. This means many more locations in the network that need battery or generator backup if we engineer for power failures.
- The CATV head-end is more expensive. An AON system must use IPTV and therefore sends every signal out in digital format in an IP packet, meaning there are no analog channels.
- It's harder to serve T1s. Some telephone customers will still want to purchase traditional T1s to support existing telephone systems. T1s are harder (but not impossible) to serve on AON compared to PON. There are technologies being developed that make T-1 delivery easier.
- Larger buildings or huts are required for the placement of network electronics because there are more fiber terminations onto the electronics. If the electronics are

located in the field, the cabinets housing these electronics and fiber terminations can be very large. This means most cabinets need to be on private land and not on public rights-of-way.

Passive Optical Network

Advantages

- Uses less fiber than an AON since multiple customers in a neighborhood use the same fiber back to the electronics.
- Can support both RF Broadcast TV and digital IPTV.
- Can deliver analog TV without a settop box, saving capital.
- Has a separate bandwidth stream for CATV and data services. This means that a subscriber's data bandwidth is not diminished if the subscriber is watching RF Cable TV.
- Much more efficient use of bandwidth at the customer premise. A GPON network delivers 2.4 Gbps of data to a small cluster of houses and an individual customer will normally have access to much of this bandwidth for data transmission, thus giving the customer a faster bandwidth experience at his home. By contrast, a typical Cable TV system shares 45 Mbps between 500 homes and an AON shares bandwidth farther into the core network.
- For the most part can use existing home wiring. The PON network is delivered to the side of the house and can use existing telephone and cable wiring as long as they are conveniently located and in good working order.
- No field electronic devices. The key word about a PON network is that it is Passive. This means that no power is needed except in those locations, generally at major hubs, where the provider places electronics.
- Fewer Electronics locations. Since a single fiber port serves 32 to 64 subscribers, the electronics can serve many subscribers with a small footprint.
- Can easily provide traditional T-1s for larger business customers.

Disadvantages

- Customers must be within 12 miles of the PON electronics when using 1 X 32 splitter. This means with very large installations that multiple hubs are required. For the normal town this is not a limitation.
- Cannot easily support open access systems. Because multiple customers share the same electronics and same fiber, it is more of a challenge to allow multiple service providers to share the system. It can be done. An AON is, however, better suited for an open access network.
- More customers potentially are affected by a fiber failure in the field.

We chose a GPON PON network for the Martinsville design for the following reasons:

- More Bandwidth. The GPON system delivers more bandwidth to each customer, bringing a better customer experience.

- Easier construction. There are literally 32 times fewer fibers going to each neighborhood network with PON, vastly reducing the complexity of construction and future repairs.
- Can support multiple options for cable TV. On a PON system we can use either broadcast TV or IPTV. With an AON network, only IPTV can be used. Since we are expecting to contract with an existing CATV provider to serve Martinsville with CATV, we needed a system that supported analog CATV.
- All customers in the City will be within the range of a PON network.
- For the most part a passive network can use existing home wiring. The PON network is delivered to the side of the house and can use existing telephone and cable wiring as long as they are conveniently located

C. Network Design

In designing a PON network there are several different network architectures in use in various systems around the world. Each of these designs can be appropriate depending upon the circumstances. The first issue to consider is whether to centralize or distribute the electronics in the network. The second design issue looks at using a star versus a ring topology for core the network. A third issue of the design is to determine whether to use distributed splitter locations or local convergence points for splitter locations.

Large communities need to use distributed huts where PON electronics are housed. In a larger town, a design will place huts in several locations about town that will contain PON Electronics that will light the fibers which will be split and assigned to each home. However, in a smaller town, it's possible to have a design where the PON electronics can all be placed in the headend building. A centralized PON electronic design allows consolidated power and access to the electronics, but for communities who have reliable power and dedicated access in several places within the community, a distributed electronics design can limit the amount of subscribers affected by a potential network outage. A distributed PON electronics design also provides more launch points for PON system expansion in a growing system.

In a distributed PON Electronics design, a PON network can be built using a star design, where the fibers all go from the head-end directly to each electronics hut, or using a ring design, where there is some sort of a circular fiber path throughout the community from which the fiber goes to each PON electronics hut.

A ring design is used when the town is large enough because a ring adds one added layer of reliability to the network in that a fiber cut anywhere on the ring would not disrupt service on the ring and to each PON electronics site. Rings are self-healing, meaning that transport on the ring can travel both clockwise or counterclockwise, thus bypassing a fiber cut.

When considering splitter location design, there are two options – a) Distributed Splitter locations where a PON fiber is split at several locations and thus splitters are distributed along the PON fiber and b) Local Convergence Point splitter locations where all PON fibers feeding a certain geographic area are located at the same cabinet. A distributed splitter design works best when a FTTH provider is not in a competitive environment and will supply service to all homes

and businesses in the service area. In this situation, the provider knows that he will utilize every fiber to every home and thus utilize the PON fibers to their maximum capacity. A Local Convergence Point design is used in a competitive environment where the FTTH operator does not know who will take his service or where that customer will be located. In this case the Local Convergence Point allows the operator to utilize his PON fibers (and subsequently his PON electronics) very efficiently by allowing the operator to fill up each PON fiber (and PON splitter) as customers are added to the network. Thus, the Local Convergence Point design allows a competitive FTTH operator the same benefits as that of a non-competitive FTTH operator, by adding splitter cabinets in each neighborhood and dedicating individual fibers from each home to this cabinet. Splitters are added to the inside of the cabinet only as subscribership grows.

In the preliminary design for Martinsville used for this study, we chose a distributed PON electronics design, meaning the PON electronics will be spread among several hub sites. We would suggest that those hubs are all built onto a redundant ring. From each electronics hub site, we suggest that the customer network use a star topology for fiber distribution between a hub site and each Local Convergence Point splitter site.

C. PON Electronics

Following are the basic elements of the electronics used in a Passive Optical network. These terms are the industry lingo that is used by the manufacturers of the equipment.

1. Optical Line Terminal (OLT)

This is the device that lights the fiber on the network and distribution side of the PON system. In Martinsville, the OLTs will be located at the head-end and at 2 other PON electronics locations (Hubs). The OLT creates the bandwidth on the single fiber that is then passively split to serve 32 customers. The OLT also provides bandwidth into the backbone network so that the customer bandwidth can access the service provider elements such as the Internet Service Provider, the Telephone Service Provider and the Video Service Provider. In the GPON design for Martinsville, the OLTs would supply 2.4 Gbps downstream from the headend to the customer for each PON (32 homes) and 1.2 Gbps upstream from the customers to the head-end.

2. Optical Network Terminals (ONT)

The ONT is the electronic device that goes onto the side of the home or business and that converts the optical signals to an electrical format. From the ONT are connections to the existing home wiring for telephone, cable TV and data. The ONT is powered at the customer site and typically has battery backup to keep phone service in place in the event of a power failure at the customer site.

3. Splitters

These passive devices are the hardware that take the single fiber from the OLT and "split" them into 32 fibers that in turn terminate at the ONTs. The splitter divides the bandwidth/light on the

single fiber to multiple fibers. These devices require no power (which is why they are called passive) and they are housed in a small enclosure in the field.

4. Element Management System

The element management system is the underlying software that manages the network. It allows monitoring of the OLTs and ONTs and is used to establish service to a customer. The software can be used to address field hardware remotely so that software can be changed or service can be established without a service person being dispatched.

5. MPLS Router

The MPLS router is a device in the head-end supplies Quality of Service (QOS) routing for the FTTH network and manages the network bandwidth associated with the services delivered to subscribers. QOS is the process whereby different services are given priorities. For example, it's typical to give voice traffic a higher QOS than data traffic. Thus, when somebody is talking on the phone, the call would not be interrupted when somebody in the home started to download a large data file.

D. Martinsville Specific Network Assumptions - City Only Study

Outside Plant Network

- The City today has about 95% of existing utilities above ground on poles and 5% below ground. We have designed the network to follow the electric distribution system and to be above or below ground in the same manner as the power. It may turn out with final engineering that a few more areas ought to be underground – for example, in anticipation of areas where the power might be buried in the next five years.
- Construction on poles means that we have to consider the issue of 'make-ready'. This is the cost of modifying existing poles to accommodate the fiber. Since the City owns the poles this cost is expected to be minimal. We have been told that the City has required almost no make-ready work in the fiber you have constructed to date, so we have estimated very little cost for this effort. If we took this project to bonding we might want to take some time to make sure this is a good assumption before raising the construction funds.
- We designed the network using pre-connectorized drops. This a relatively new technique that consists of installing connectors into the distribution fiber and then using drops that are pre-manufactured to plug into the fiber. These drops speed up installation and repairs since no splicing is needed to install a drop. Splicing requires an experienced fiber technician and bulky equipment while any technician can learn to plug in a pre-connectorized drop. Our cost analysis shows that the pre-connectorized drops are not only more efficient but would cost less for Martinsville.
- In looking around the town we are estimating the average drop length to be around 300 feet. This is a little longer than we see in some towns and is due to the fact that many homes are set back from the curb. Again, we have assumed that the drops will be buried where the power is buried and will be overhead when the power is on poles.

- In the study we have assumed that you will use an outside construction company to install fiber on each street in the service area. Once you have borrowed money to finance the project the goal will be to get the network constructed as quickly and efficiently as possible. However, we have assumed that your employees will install the fiber drops. In the study we have assumed that you will run three construction crews to do installations. Two of these crews would be temporary employees that would leave at the end of the project. The other crew would remain as your permanent outside technicians to be used for future installations, repairs and maintenance. This method of constructing drops is generally significantly less expensive than hiring a construction company to do the work.
- The residential market is estimated to consist of 5,546 housing units. We have been told that within that number is 318 multi-dwelling units (MDUs), which are apartments, townhouses and other structures where more than one family live under the same roof. In pricing out the network we have assumed that the cost for serving an MDU customer is the same as serving a single family home. Sometimes the cost of serving MDUs can be lower. For examples, MDUs can often use fewer fiber pairs and can benefit by using larger ONTs. However, this savings can be offset by MDUs requiring more extensive wiring to make FTTH work. Our experience in other communities is that the cost of MDUs ends up being nearly as high as the cost of serving single family homes.
- We have been told there are 908 businesses in the City. Like in any City almost all of these businesses are small. We have been conservatively high is estimating the cost of serving businesses. Some businesses require much more expensive fiber drops since getting the drop into the business requires passing under large parking lots and other obstacles. Larger businesses also require greater services from the fiber system in terms of number of data connections, etc. Thus, the electronics used to serve larger businesses are more expensive than the electronics used to serve single family homes. However, many small businesses are going to look just like homes in terms of bandwidth needed, so many small businesses will be able to use residential electronics. Further, a number of businesses will fit within the same average drop length as homes and will not require more expensive fiber construction. However, to be conservative we have estimated that all businesses will require the more expensive drops and electronics.
- Today a FTTH system only delivers shared data since there are up to 32 customers sharing each fiber. Some larger businesses in town are going to want to buy dedicated data, meaning they don't share it with others. The schools and other government sites will also probably want dedicated data. The way to serve these types of businesses and the government is to design spare pairs of fiber in the network that can be used for 'homerun' fibers, meaning that a dedicated customer would get a fiber directly back to the headend, not shared with other customers or split by splitters. The technology to serve these locations is generally referred to as Metro Ethernet, and the termination devices for this technology are roughly the same as the cost of a business ONT.
- The cost of the fiber network is estimated at $4,831,000. This cost includes engineering, construction and inspection during construction. In addition to this cost we have put a construction contingency in the cost study of $725,000 as a safety net against construction cost overruns.

Network Electronics

- We have assumed the use of a GPON technology for study purposes. The GPON system provides 2.4 Gbps Downstream over a single fiber to be shared/split to serve up to 64 Homes/Businesses. The GPON system modeled and priced provides 2.4 Gbps over a single fiber that is split to a maximum of only 32 times. This means that the 2.4 Gbps is only shared by up to 32 subscribers. Thus each subscriber can be guaranteed a greater portion of the 2.4 Gbps than if we used a 64 split model. Splitters, which allow the single fiber to be shared by 32 homes/businesses would be placed in splitter cabinets about the size of a dorm room refrigerator scattered throughout the network.
- In the design for the feasibility study we designed the system to have three FTTH node sites (OLT Sites). One FTTH node site would act as the headend and would be at the existed building at Fishel Street. The other two sites can be at many places around the City, but for study purposes we assumed that they are at City controlled properties at Ainsley Street and Smith Street.
- The percentage of Households and Businesses served by the FTTH gear at each site are as follows:
    a. Fishel Street hub would serve 35% of the homes and businesses in the City.
    b. Ainsley Street would serve 20% of the homes and businesses.
    c. Smith Street would serve 45% of the homes and businesses.
- Each FTTH Node site will consist of racks, fiber termination equipment, wave division multiplexing equipment (WDM), FTTH/OLT equipment and video fiber amplifier equipment. Each site will also have battery backup gear required to support the equipment at each site in the event of a power outage.
- Each node would be connected by a core ring that is expected to operate from 1Gbps to 10 Gbps. In the future, the core ring bandwidth can be increased as the network capacity increases.
- Initially we would suggest that you equip each node to be capable of handling about a 50% customer penetration. More equipment can be added to nodes where the capacity climbs higher than that. However, we have found that in most cities the customer take rates vary by neighborhoods so you don't want to overstock a node too far above expected needs. Each node will have an ONT bay that is capable of supporting up to 6,900 subscribers, which is more capacity than you should ever need.

Customer Electronics

- We priced the FTTH electronics based upon recent quotes we got from Calix. CCG is vendor neutral and we are not suggesting that the City use Calix. Rather, our experience is that the cost of the FTTH electronics is similar between vendors and thus using a recent quote from any of the vendors is sufficient for predicting the cost of the network electronics. Calix just happened to be the most recent bid we have in hand.
- We have assumed that the Optical network Device (ONT), the electronics at the customer home and business will be powered from an outlet inside the home or business. Sometimes this requires an electrician to install a new outlet when there is no outlet near to the entrance of the FTTH cables. Alternatively the units could be powered from the power meter using a device called a meter collar. However, there is not always a meter for every customer in places like MDUs.
- Many of our clients have installed a battery back-up so that telephones can continue to get power in the event of a power outage. However, since almost all telephones today

require power, we now advise our clients to not install these batteries except for those customers who want them and are willing to pay extra for the backup. The batteries last around four hours in continuous use up to eight hours with occasional use. But the batteries also have to be replaced every few years which requires a large number of truck rolls.

- In this model we have assumed the use of HPNA for distributing bandwidth within the home. HPNA is a technology that uses the existing coaxial cable to deliver cable TV and broadband. There are other technologies available. For example, we also could have used broadband over powerline (BPL) which would use the existing electric wires in the house to deliver broadband. The cost for using various technologies for distributing the bandwidth throughout the home cost is roughly the same and the determination of the best technology can be determined in the future as needed. Some newer homes are already wired for all of the services and the ONT can be hooked directly to the wiring without an intermediate technology. Additionally, in many cases, the cost to run one or two Ethernet wires within the home is roughly the same as using the HNPA device. In any case, we have modeled sufficient money to account for bandwidth distribution within the home.
- You will want to use ONTs that use an RF return. It is highly likely that when you add the wholesale cable product that you will be doing an RF overlay, and that kind of system is going to need the RF return for Pay-Per-View orders and polling the Set Top Boxes for usage billing events.

Cable TV Service

- Martinsville is prohibited by current law from deploying your own video offering. In order to offer the triple play you will need to find somebody else willing to put their product on your network. This means the following:
    - If you want to interface with a traditional cable provider you must use the Passive Optical Network (PON) technology. We have modeled a GPON FTTH system to achieve this requirement because GPONs provide the most bandwidth with currently deployed equipment. GPON offers a separate data path to the customer than that used specifically for traditional CATV signals and PON is the only technology that will interface with a traditional cable headend. If you can find a provider that has an IPTV headend then you are not limited to the PON technology choice.
    - The Martinsville “Headend” will serve as an interface hub for the contracted CATV provider to interface with the Martinsville FTTH system.
    - The contracted CATV provider will “overlay” his video offering onto the FTTH system. If the provider selected is a traditional cable provider, his signal will be considered an RF overlay (the alternative being IPTV).
    - The study assumes the construction of fifteen miles of fiber outside of the City to give you more options to meet a cable TV provider. If this is not needed there will be a savings in the fiber construction costs.
    - Two fibers are required between the Martinsville Headend and the CATV provider
        - One fiber is required to extend the broadcast channels to the customers over the FTTH network

        - Another fiber is required to extend the Reverse Channel frequencies from the customers back to the CATV provider. The Reverse Channel frequencies are used for Pay-Per-View ordering, billing and VOD controls from the customer's STBs to the CATV provider's headend.
    - The only traditional CATV equipment to be installed in the Martinsville Headend will be to facilitate the broadcast fiber interface to the FTTH system and to facilitate the Reverse Channel fiber interface to the FTTH system.
    - The FTTH system must be able to accept the broadcast interface fiber from the CATV provider, split the fiber signal into three separate signals and then send those three separate broadcast frequencies to the three FTTH node sites.
    - The Model does not contain any settop boxes since we assume these will be the responsibility of the CATV provider.

Voice Switch

- Our base study assumes that the system will include a voice switch in Martinsville. We further assume that the City would purchase a softswitch, which is a small modern switch that includes advanced voice features. A softswitch today will support traditional telephone and will also support IP telephones with advanced features. Advanced features include such things as the ability to tie voice mails to emails so a customer can get voice mails as an email file; the ability to tie calling lists from the computer to the phone so that a call can be initiated using Outlook; a follow-me service where a customer can direct a call to any number of phones in any sequence, so that a call could first try his cell phone, second try his landline and third try the babysitter's before being routed to voice mail.
- The switch will also support all basic business features such as supporting trunks for customers with their own phone system, or Centrex for customers who want advanced features such as the ability to put calls on hold or transfer calls.
- Today's softswitches also support IP Centrex and the latest services and features such as SIP trunks.
- The switch will support full long distance service including international calling.

Building

- We have assumed that the headend site at Fishel Street will also house the voice switch and the internet service provider (ISP) equipment and serve as the primary hub for FTTH electronics. As such, the headend will be the site where the PSTN voice trunks and signaling interfaces will terminate and where the Internet backbone will likely interface. This site should have battery backup and backup generators to provide backup power.
- We have included some money in the model to upgrade or expand the existing headend site.
- One of the big needs for a head-end is air conditioning, even in winter. The electronic equipment in the head-end spins off tremendous amounts of heat.
- The building cost includes fire suppression and a backup generator.

Other Assets

- The business plan budgets for the data routers needed to provide customer ISP services. This would include providing email, security, IP addresses, web storage and other functions normally provided by an ISP.

- The business plan assumes that the business would use shareware software to operate the ISP. This is done by all the small ISPs in the country and there is very robust software available that performs the day-to-day tasks of being an ISP. The City is probably already performing most of the needed ISP functions today.

Other Assets

- The business plan also includes the other assets needed to operate a fiber business. This would include a few vehicles for outside technicians.
- The business plan includes a computer for every employee.
- The business plan includes furniture and office equipment.
- The business plan includes $400,000 of inventory which would consist of spare fiber, settop boxes, ONTs, and spare cards for all the electronics.

CALEA

- CALEA is the set of rules that require that you provide access to your data and voice offerings to law enforcement.
- Any softswitch will have CALEA compliance built into the product on a dial-up basis.
- We have built in funds for CALEA Compliance of the Data/Internet service. We have assumed a Trusted Third Party (TTP) solution where the TTP would provide the probe hardware on an as-needed basis when a LEA issues a valid subpoena for such action.

G. Specific Network Assumptions for Martinsville plus Collinsville

Many of the assumptions are the same as the Martinsville-only study, so I am only going to discuss those additional assumptions that apply to adding Collinsville to the project.

1. We have assumed that Collinsville would be added to the Martinsville build-out as an extension of the Martinsville OLT node site at Smith Street (Node 3).
    a. This means that needed electronic would be added at the Smith Street location to serve the additional subscribers in Collinsville.
    b. Depending on service penetration, either 1 or 2 additional ONTs will be required at the Smith street node.

2. Fiber feeder would extend out of the Smith Street (Node 3) location and travel up Virginia Avenue into Collinsville.

3. We have estimated that there are 106 miles of roads in the City of Collinsville and that we will have to build both sides of the roads on 30% of these roads in order to “pass” houses on both sides of the roads.

4. The total fiber feeder, distribution and drop length from the Smith street node to any subscriber in Collinsville is not expected to exceed the 12 mile limit of the GPON system. Rough Calculations show that fiber extensions will not exceed 10 miles from the Martinsville Smith Street Node to any subscriber within the Collinsville city limits.

5. The entire Collinsville extension is estimated to be built out with buried fiber feeder, distribution and drops. This is mainly due to a concern with using poles from the electric utility in that area. Past experience has shown that to be both costly and time consuming.
    a. The city of Martinsville previously conducted discussions with the power company serving the County areas including Collinsville and concluded that it was more costly to comply with the county power company's requirements and make ready prerequisites than it was to bury the fiber.

6. We have added costs to the voice switch needed to serve the additional subscribers.

H. Specific Network Assumptions for Building all of Henry County

Again, these assumptions talk about adding the rural parts of the County into the project and the assumptions for Martinsville and Collinsville would be the same as described above.

1. All areas outside of Martinsville will be constructed using buried fiber construction.
    a. We are estimating buried fiber construction because the City of Martinsville does not own the pole lines outside Martinsville.
    b. The city of Martinsville previously conducted discussions with the power company serving the County areas including Collinsville and concluded that it was more costly to comply with the county power company's requirements and make ready prerequisites than it was to bury the fiber.

2. In order to operate within the 12 mile fiber length maximum between the OLT node and the customer, we have estimated the requirement for 8 new hut sites outside of the City of Martinsville in order to serve the entire county. These nodes are described as follows:
    a. Basset – Hut in or near the city of Basset
    b. Henry – Hut in or near the city of Henry
    c. North Collinsville – Hut north of Collinsville
    d. Northeast Corner (Chatham Road) – Hut in the northeast corner of the County on Chatham Road.
    e. Spencer – Hut in or near Spencer
    f. Axton – Hut in or near Axton
    g. Southeast Corner – Hut in Southeast corner of County
    h. Ridgeway – Hut in or near Ridgeway

3. In order to round out the 12 mile limits all rural customers it would also be necessary to augment the electronic equipment in the Martinsville hub sites.

4. Each hut will be fed with a pair of fibers gleaned from the distribution fiber and no "core fiber" is assumed built to serve the huts.

5. The engineering we performed for the County was very high-level and if you were to move forward with this project we would recommend that more effort be put into more accurately looking at the costs to build fiber in the rural area. We estimated that there are 1,051 miles of streets and roads outside of Martinsville and Collinsville. We have estimated that fiber would

need to be constructed on 83% of all county road miles outside of Martinsville and Collinsville and that we will have to build both sides of 20% of these roads in order to pass all homes and businesses with buried fiber. The reason that all roads don't have to be built is that there are always stretches of road that do not lead directly to homes.

6. We have added costs to the voice switch needed to serve additional subscribers.

7. We have assumed that the fiber drops are longer in the rural areas. A drop is the fiber that goes from the street to any home or business, and in the rural areas buildings are generally set back further from the street, with some locations having long lanes and driveways.

IV. Business Plan Analysis

In this section we look at three different business plan scenarios – the City-only, the City plus Collinsville and the whole County. For each business plan option we will examine the ability for each option to be profitable and to pay for itself.

Why These Scenarios are Conservative

At CCG we always try to make our business plans conservative. We do this so that if you enter one of these businesses based upon our recommendation we want to make sure you can succeed. Following are some of the conservative assumptions used in the business plan:

- The revenue stream over 30 years assumes only basic double play revenues. One must suppose that over that time that there will be new revenue opportunities that arise from operating a fiber network. Already today we know of system operators who are offering burglar alarm and other security services. We know several systems that are looking into home energy management systems. Many experts believe that home medical monitoring is going to become a significant business over the next decade. Many fiber businesses are also selling cell phone services. Certainly over 25 years there will be new revenue opportunities that we can't even imagine today.
- One revenue opportunity that many of our clients are undertaking is to resale cellular telephone services. Generally a reseller is able to offer phone rates that are a little cheaper than the large carriers. But more importantly, there are technologies available that will allow you to improve cell phone coverage at farms and other rural homes and businesses. The models do not assume that you will go into this business line.
- The revenue stream does not include any 'home run' revenues. By that we are referring to the large bundles of services that might be sold to a few large customers. We are certain that the City would gain from a few such opportunities because every similar business does. However, to be conservative, we did not include any such revenue since we did not want to distort the results based upon the actions of a handful of customers.
- In the model we show a big drop in data costs over time. However, industry costs for raw data will probably drop even faster than we are predicting.
- Our model shows a major electronics upgrade every eight years. It is possible that upgrades will be needed less often than we have shown. Further, our assumption is that the cost of equipment at the time of each upgrade would cost as much as the equipment that was being retired. The experience of the electronics industry is that electronics get cheaper and more efficient over time, so the cost of upgrades is probably going to be less than is shown in the model.
- The model is probably conservative in predicting customer take rates. The model is driven by the number of customers who buy high-speed Internet. The model predicts that fewer customers will take telephone and cable TV services, yet your survey had a higher positive response to those two products. We know that both landline telephones and cable TV penetration rates are declining nationwide and so we have taken a conservative look at the those two products.
- If the City was to use a pre-construction sign-up list to identify customers, then capital expenditures would be lower since the customer drop and electronics could be installed during the initial construction at a lower cost than installing customers individually later.

- The bond assumptions assume that the bond will capitalize interest for three years. Further the models assume the bonds would require a bond reserve fund. The model also assumes 30-year bonds, but the term of the bonds could be longer. It is possible that actual bonds could be smaller and with more favorable terms than assumed in these studies.

Finding a Cable TV Partner

The study assumes that you will find a partner to supply cable TV signals to customers since you are not legally allowed in the business. CCG has helped a number of clients engage in these kinds of partnerships over the years and we offer the following observations and advice:

- While you are not going to be able to sell cable TV and must use a partner, your survey clearly shows that the existing residents in the area have a preference for bundling of services. Bundling implies have a customer have the experience of having one provider even if they don't. In order to give customers what they want, which is seamless service from one provider, you are going to have to do something like the following:
    - Arrange with the partner to have your technicians install the cable TV settop boxes when you install you other services. What you don't want is to have to separate visits by you and the cable partner, meaning the customer has to be home twice to get service connected. This will require the partner to supply you with settop boxes and train your installers. You also will charge the partner something for the installation, although if you charge him less than the cost him doing it himself you both win.
    - You are also going to want a billing and collection agreement with the partner so that you can send out a combined bill for all services. It's not a bundle if customers have to write two checks. Again, you will have to charge the partner something to add his products to your bill, but this should cost less than of the partner billed separately. Note that it must be made clear on the bill that cable TV is provided by your partner and not by you.
    - To the extent possible you also want your technicians taking all trouble calls and making all in-home repair visits. There will be issues that arise with cable service that will be hard to isolate as your problem or the partner's problem, and the nightmare scenario is two sets of technicians telling the customer a different story. You want your technicians to be the only one that talks to customers.
- You need to bill the cable provider for access to your network. In the model I have used a rate of $12 per cable customer per month as the suggested fee. I know a half dozen clients who have a cable partner on their network and the fees seem to range from $10 to $15 per month for network access. The cable partner is going to be responsible for getting his signal to your headend hub. The monthly fee is to cover the cost of the network that supports the cable signal. The partner will be separately responsible for obtaining and paying for the programming.
- You will have some issues to resolve between the two companies. For instance, what happens when a customer pays part of the bill; have they paid for their Internet or their cable TV? You might also have different policies about what to do with people who don't pay their bills at all. You will need to reach agreement with the partner on how to handle the most typical situations that you can be expected to encounter.
- Your employees must be trained to always mention the name of the cable partner when talking about cable with customers. Under an arrangement where you do some of the work you do not want to be accused of secretly being in the cable business.

- From a cash flow perspective, under the arrangement I have suggested you will bill customers and then subtract out the monthly connection fee and give the remaining revenue to your partner.
- One suggestion I will strongly recommend is that you not allow a customer on the network who is buying only cable as a product. It takes years to recover the cost of the installation if your only revenue is the $12 monthly fee. In fact, you probably want all customers to take at least two services in order to get onto the network.

A. City-Only Feasibility Study

Business Plan Key Assumptions

In order to explore the economics of offering broadband in Martinsville, CCG undertook a business plan study that contemplated all aspects of operations.

The business plan assumptions used in the forecast include our best estimate of the operating characteristics for such a business. As a firm we consult to over 450 other communications entities that operate voice, broadband or cable TV businesses. We also work with our clients to help them maximize profits and we are experienced in how businesses really operate under all sorts of conditions. We believe that the financial results shown in these models are characteristic of similar operations elsewhere and we believe these results can be achieved in Martinsville.

This study is based upon the assumption that the City would offer the double play of voice and high-speed data and that you would find a partner for offering cable TV service. The study assumes an average discount of 10% compared to what is charged in Martinsville today by the incumbent providers, CenturyLink and Comcast. In addition to the 10% discount on basic service, the business plan assumes that each service would be enhanced to some extent. For example, several telephone features might be included with the cost of basic telephone service. The network would support vastly faster Internet speeds at lower prices. With these enhancements, the network would actually be delivering an even greater customer value than the 10% price discount.

We first looked at a breakeven scenario. In this scenario we asked the question: what is the worst the new business could do in terms of residential penetration rates and still be successful? Breakeven in this case is defined by having positive operating cash throughout the life of the business. Breakeven for a municipal venture is defined as the ability to generate enough revenues to cover operating expenses, debt payments and routine annual capital expenses. A model that is just barely able to maintain positive cash flow would be at breakeven under that definition. In the case of the Martinsville retail model, a residential penetration rate of 42% would achieve breakeven.

One interesting result of the study for Martinsville only is that the cash for the business is very tight for years two through four. This is due to one of the limits in bond financing related to working cash. Federal bond law only allows for a bond issue of the type needed for this project to include a working cash reserve of 5% of the size of the bond issue. In this scenario that would be just over $1 million. There is a cash shortfall because that is not enough cash to see the business comfortable through to profitability. The model assumes a normalized bond issue,

meaning that the annual payments are assumed to be the same each year. It is possible to get the bond payments to vary by year, which is referred to as a step bond. With a step bond we could set the payments lower in the first few years and higher later to help offset the cash crunch. However, even with a step bond the cash looks like it will be very tight in this scenario. That is a problem because the business would have instant cash troubles if there were any delays or hiccups in the rollout of the business. This is not an ideal way to start such a significant new business which is one reason we are recommending the second scenario that also adds Collinsville. That scenario avoids the cash shortage problem.

We then produced a second retail scenario using a 60% penetration for residential cable TV service. This higher penetration roughly splits the difference of the penetration rate between the breakeven scenario and the results obtained by the survey. This is an arbitrary choice of penetration rates but gives us a scenario that might demonstrate what success might look like in the market.

If the City was to launch a retail business the actual penetration is going to be influenced by two main factors – how well the City executes on the business plan, and the reactions of the incumbent providers. The higher 60% penetration rate is achievable. For example, Bristol, Virginia achieved a 65% penetration rate after three years.

There is one major benefit to a retail scenario that cuts rates 10%. Customer savings on services would be injected back into the local economy. If we assume that the incumbent providers will roughly match the 10% discount, then the customer savings in Martinsville over 30 years is around $21 million.

In the end, these scenarios show that it is financially feasible for Martinsville to operate a retail fiber network. All of our models were run for a 25-year future period. The breakeven scenario does just that – it maintains cash throughout the 25 years. As the 60% scenario demonstrates, if the City does better than the breakeven penetration, then the business will do much better. The 60% scenario generates $17.6 M in extra cash over 25 years.

Capital Assumptions in the Study

The capital expenditures predicted in these models reflect the results of the engineering studies referenced in the section above. The launch of a FTTH Network requires a significant investment in fiber network and electronics. This capital includes several broad categories of equipment including fiber cable, electronics for FTTH, and a telephone switch. In addition to capital expenditures predicted by the engineering study we have added, furniture, buildings, computers, vehicles, tools, inventory and capitalized software to the study.

The fiber optics network will consist of a new fiber optics distribution system passing every home and business in the City and will be the largest single initial capital expenditure. The total cost of the new fiber distribution system is approximately $4.8 Million. For each new customer a fiber drop must be built from the fiber feeder cables to reach the house. Over the first four years, as all most of the customers in this business plan are installed, fiber drops would cost around

$1.8 million. Our engineering study assumes that fiber drops will be aerial where your electric service is aerial, which is in most of the City.

Another significant capital expenditure is for the electronics needed to provide the signal to supply fiber-to-the-home. The FTTH equipment can be separated into two categories: base network electronics and electronics at the customer location. The base network electronics light all of the fibers. Additionally there is a significant cost of electronics for each new customer installed. A device is installed at each new customer location called an Optical Network Terminal (ONT). This device converts the signal from fiber optics and converts it to traditional telephone, cable TV and data signals and is required at a customer site regardless of which of the three services are supplied to any given customer. The base electronics to light the network are estimated to cost $780,000. By the end of year four the customer electronics are estimated to cost $4.1 million.

Another major capital expenditure will be the voice switch. We estimate this will cost about $600,000.

We have assumed that your cable TV partner will provide settop boxes to customers.

We also have budgeted $625,000 to upgrade the existing headend at the City and to build several new huts around town.

There are additional smaller capital outlays for such items as vehicles, furniture, computers for the employees, tools, and equipment to route data to the Internet.

Following are the capital expenditures that would be built during the first five years for both the breakeven and the 60% penetration models:

	42% Penetration	60% Penetration
Vehicles	$ 90,000	$ 90,000
Tools	$ 165,000	$ 165,000
Buildings	$ 625,000	$ 625,000
Furniture	$ 29,500	$ 29,500
Computers	$ 80,000	$ 80,000
Voice Switch	$ 600,000	$ 600,000
Data Routers	$ 187,500	$ 187,500
FTTH Equipment	$ 4,813,761	$ 5,319,263
Fiber Drops	$ 1,712,550	$ 1,943,504
Fiber Network	$ 4,775,880	$ 4,775,880
Inventory	$ 400,000	$ 400,000
Capitalized Software	$ 700,000	$ 700,000
Total	$14,179,190	$14,915,647

Revenue Assumptions

We have assumed that a FTTH network in Martinsville would offer every major service offered today by either CenturyLink or Comcast. With that said, there are a handful of very complex businesses services offered by CenturyLink that the City might elect not to offer. However, it's likely that Martinsville today doesn't have any of these very complex situations (such as a very large call center). As described earlier, most Martinsville products would be enhanced, that is, they would be a little better than the same product as offered by the incumbents.

The business plan we have developed shows an overall discount of 10%. We have assumed that there would be periodic increases in the wholesale rate charged for a cable TV connection. We have assumed that data and telephone rates would never be raised in order to remain competitive. However, we note that after a decade where data rates have dropped, that the large providers like Verizon and Comcast have recently begun raising data rates. So it is possible that you will be able to raise those rates over time if Comcast is doing that elsewhere. We do anticipate that over time that the cost of wholesale data will decrease. If that occurs we would recommend that the City establishes a philosophy of increasing data speeds over time as you are able to buy bandwidth for less. Revenues in the model are somewhat specific and the models suggest rates for specific services based upon the services and prices offered today by the incumbents. To the extent the incumbents would change rates before launch, the rates would be changed to reflect the rates at that time.

Telephone Rates

The model assumes a residential telephone rate of $17.25. This rate is 10% lower than the rate charged by CenturyLink. They charge $15.21 for a basic line plus they bill $3.96 for a Subscriber Line Charge which they keep. Many customers think this fee is a tax, but CenturyLink has just divided the local rate into two components. We would recommend that the local product be further enhanced by adding several calling features to the base rate for no extra charge.

The model assumes that a business line will be $31.00 and a business trunk will be $41.97. These rates are 10% lower than the rates charged today.

The model assumes that the company will sell calling features for much less than CenturyLink. For example, many of our clients sell such things as call waiting, 3-way calling, call forwarding, etc. for $1 each. CenturyLink charges much more (see the section above for more details on the incumbent pricing for features).

Because the City would be buying a new voice switch, there also would be a number of features available today that are not available from CenturyLink. A softswitch will have a lot of advanced features like the following:

- Advanced Follow-me Service. Allows the customer to have a call answer on any phone. A call might first be routed to the cell phone, and then to the home phone and then to the office phone.
- Computer Tie-in. Allows the customer to synchronize their phone and computer. For example, calls could be placed by clicking on an entry in Outlook.

- Advanced Screening. Allow customers to customize who calls them. For example, it might let in calls from 20 close friends, send a list of other people you know to a recording and block calls from people you don't know. This all would be handled on a list on the computer that would make it easy to change who can and can't call.
- IP Centrex. The most exciting new feature on most softswitches is IP Centrex. This is a feature that brings the calling features found on cell phones to the office phone. This feature requires new digital phones. With these phones you can do all of the sorts of things that cell phones can do such as scroll through past calls. It also ties into the computer. IP Centrex phones also have the feature of mobility. A customer can use the phone anywhere they can connect to the Internet and thus can take the office phone home to work as if they were in the office.

The model assumes that the company would offer long distance in two packages. First would be to sell long distance by the minute with non monthly minimum charge. CenturyLink charge $8.95 per month to enable long distance before a customer makes the first call. The business plan also recommends an unlimited long distance product for $20 per month.

Cable TV Products

Since you are not allowed to sell cable TV on a retail basis, the model assumes that you will find a partner who can put the cable TV signal on your network. This provider will be the cable provider. It would be very helpful from a marketing perspective if you can work out a deal to bill the cable service on your bill and to also create bundles. However, your partner will need to hold a franchise agreement with the City, and all cable TV revenues are theirs.

The financial model assumes a wholesale lease rate of $12 per customer per month to give the cable provider access to your network. We have assumed in the model that this customer will use the cable TV tier available on FTTP systems. This would allow them to use a combination of analog and digital signals as they choose. We have assumed that the cable TV partner will be responsible for obtaining and paying for all programming as well as supplying any needed settop boxes to customers.

I have several clients who share products from multiple companies on their network and would caution you against some of the problems this can cause. Today a significant percentage of the customers in the town say that they buy their telecom products as part of a bundle. This tells us that they have a preference for dealing with one company for everything. While you will have a cable partner operating on the network, from a customer service and sales perspective it is going to be very helpful if you can somehow integrate the billing and customer service for the two products together at the City. Otherwise customers have to deal with two companies, and this is not good for them or for you. You also want to consider installing the cable for your partner when you are installing your services. Otherwise, the customer is going to be inconvenienced by having multiple visits to get service initiated and later on with repair calls. The two companies

can hopefully find a financial arrangement that will let you operate as one company in the customer's eyes.

Data Products

The data products that can be offered on a FTTH system are the big differentiator compared to the competitors. Today a FTTH system can deliver a 100 Mbps symmetrical data service to a household. In the next few years we expect the routine household electronics will be designed to carry 200 mbps. Already today there are electronics available that can deliver 1 Gbps (although this is still a little too expensive to use for the average household).

The products in the business plan are modeled somewhat on how Verizon has offered data services in their FTTH network. The model suggests a basic residential product that is 30 Mbps symmetrical (both upload and download). The other two suggested residential products are a symmetrical 50 Mbps and 100 Mbps. Over time the cost of buying raw data ought to decrease, and we would recommend that the City increase the speeds of these products over time as the price of bandwidth decreases.

Several other Cities are offering an exciting new product which they call the city-wide Intranet. For example, in Lafayette, Louisiana any data customer that buys one of the basic data products to the Internet also gets a 100 Mbps connection to everybody else on the City network. They believe this is unleashing creativity within the community and will lead to citizens developing and using data in new ways that will benefit the community.

Setting prices for basic Internet service is a bit tricky in Martinsville due to the very different way that CenturyLink and Comcast sell data today. It is very difficult to line up the residential products side by side. Additionally, both companies charge extra for modems and for other features, meaning that customers often think they are paying less for Internet access than they really are.

Following is the residential data pricing of the competitors as listed earlier in the paper:

CenturyLink	Basic	With Modem
1.5 Mbps download	$29.95	$34.44
3 Mbps download	$34.95	$39.44
10 Mbps download	$39.95	$44.44
20 Mbps download	$64.95	$69.44
Comcast		
12 Mbps download	$48.95	$55.95
50 Mbps download	$58.95	$65.95

As can be seen by this base comparison, Comcast is more expensive than CenturyLink. Comcast also has situations that make them even more expensive. For example, if a customer wants to buy data only and not buy cable TV, then Comcast charges $14 more per month. Comcast also offers a Blast feature that makes the data speeds feel faster for $10 per month. But to make things more confusing, Comcast then offers bundles that give discounts for buying multiple services. The problem with the bundles is that it is impossible to tell where the savings come from. But Comcast customers in bundles are paying something less than what is shown in the table above.

In most of the country the cable companies have gotten the majority of the data customers, but due to the price difference in your City, CenturyLink still has more customers than Comcast, with CenturyLink serving 29% of households to 21% for Comcast. This means that you probably need to set your prices off of CenturyLink prices.

CenturyLink offers a very inexpensive started product that offers 1.5 Mbps download for $34.44. However, they don't advertise it and thus very few customers buy it. Today that is such a slow speed that it makes it difficult to do the things that people want to do on the Internet. In the financial model I set the starting data product for the City at $38.44. This is $1 per month cheaper than the CenturyLink 3 Mbps data product and $6 less than the 10 Mbps product. The starting Comcast product is at 12 Mbps for $55.95 if bought outside of a bundle.

The suggested City data prices used in the model are as follows:

Residential	
30 Mbps Symmetrical	$ 38.95
50 Mbps Symmetrical	$ 49.95
100 Mbps Symmetrical	$ 73.95
Business	
30 Mbps Symmetrical	$ 49.95
50 Mbps Symmetrical	$ 89.95
100 Mbps Symmetrical	$149.95

Expense Assumptions

Employees. In order to operate a FTTH business plan we predict that the breakeven business plan will require 14 full time employees by the fourth year. We have assumed salaries at market rates with an annual increase for all positions at 3% inflation. We've assumed that the benefit loading is 43% of basic annual salary. The employees needed are a mix of different job responsibilities. The business will require a very rounded and experienced general manager. The business will require several inside technicians to maintain and operate the fiber, voice, cable TV and data equipment. There are also several outside technicians who maintain the fiber network. The business requires some customer service representatives to take customer orders, answer questions and collect cash. The business also will need several help desk technicians who will take trouble

calls from customers and who will help with computer and data issues. The business also has a full time sales / marketing person whose principle responsibility is to sell to businesses.

During the first few years when the system is connecting most of the customers the model assumes that you will hire temporary technicians to help with the initial flurry of new connections. It is much cheaper to hire temporary workers for a few years rather than pay a construction company to do installations. The cost for these temporary installers has been capitalized, that is included as a capital cost rolled into the cost of connecting new homes and businesses.

Start-up Costs. There are considerable start-up costs that would include legal, consulting and other general expenses needed to launch the business. We have anticipated a total startup cost of around $367,500 the first year to cover these extra costs. One thing that is not included in the study is additional legal costs that might come from having the incumbents challenge your ability to be in business. However, we think that Bristol blazed the trail in the state in terms of proving the ability for a municipality to sell telephone and data services and I would not expect you to be challenged in that area.

Marketing Expenses. In addition to the one full time salesperson, the business has a marketing budget. Because the City needs a substantial penetration rate to break even, we would strongly recommend that the City conduct some sort of pre-sign-up campaign to identify customers before deciding to go into the retail business. By getting people committed before you build, and even before you raise the bonds, the City can greatly reduce the uncertainty of launching the business. Of course, over the long run the City will have to perform in order to keep the customers. After the initial pre-launch campaign, additional residential sales would be achieved with an aggressive marketing and advertising campaign.

Cable TV Expenses. Since you will be seeking a partner to provide cable TV service there are no specific operating costs associated with bringing wholesale cable programming to the network.

Internet Backbone. The City already buys connection to the Internet today through redundant routes to the internet through two different providers. This is referred to in the industry as Internet backbone. The amount of bandwidth purchased for the backbone is a big factor in the quality of the Internet connection sold to customers. The quality of a backbone is measured in the industry by use of an oversubscription factor. Oversubscription is the sharing of bandwidth between customers. For example, if we had one customer in our system, then the network would not be oversubscribed and we would have an oversubscription factor of 1:1. However, since customers don’t all use the Internet all the time to download or upload, we are able to share a data pipe among multiple customers. The cable and the telephone companies are believed to use an oversubscription ratio of 200:1 or even much higher meaning that at least 200 customers share a data pipe to a neighborhood. We have calculated the price of bandwidth in this model at an oversubscription rate of 150:1. This is a very high quality oversubscription

ratio and most customers will get the bandwidth they want most of the time. The business will also be selling dedicated Internet to some customers, meaning bandwidth that is used just for that business. But our clients have found that there is also some ability to oversubscribe dedicated data and I have estimated an oversubscription factor of 4:1 in the model.

Another issue to consider with Internet backbone is the price per raw megabit. Our model has a price per megabit starting at $36 per megabit initially dropping to $25 range after a few years. This price is a blended rate that includes transport. This is a lower rate than you spend today, but this is due to the increased bandwidth you will be buying due to having more customers than today. We believe this is a very conservative price and that the company is likely to beat the prices in this model throughout the life of the business.

Interconnection. Interconnection is the cost of connecting the voice switch to the world. It will be necessary to connect the switch in Martinsville to the CenturyLink local central office in Martinsville. It also will be necessary to connect the switch to the tandem, or large regional switch. Further, connections are needed to get to the local 911 center and to operators.

Cost of Goods Sold. The business plan contains estimated cost for other eternal services like long distance, operator services, SS7 (the way the telephone switch connects to databases and sends the customer phone numbers used in caller ID).

Billing. A company has two choices for billing services. The company can subscribe to an external billing service or the company can buy software and do the billing internally. In the long run, internal billing is more cost effective and these models assume the purchase of a billing system as part of a larger suite of software known as OSS/BSS. This software is used to take customer orders, to coordinate installations, to keep track of inventory as well as to bill customers. In the software costs built into the model we also have included the cost of auto-provisioning software, meaning that orders can be transmitted directly from a customer order to activate the voice switch, the cable TV services and data services. With this software, a customer can call and ask for a new service and have it active while they are still on the telephone.

Other G&A. The models are very comprehensive and also include all of the other normal costs or running a business such as utilities, insurance, human resources, legal, accounting, etc. I have made an assumption about the amounts of City and Utility overheads that might be allocated each year to this kind of new business and those assumptions need more work to determine how the City and the Utility might handle the creation of a new business like this one from an accounting perspective.

Taxes. The model assumes that the business will not be paying local taxes on the network or the business. This is due to the fact that you are a municipality and tax exempt. However, there will be a number of taxes on your customers that you will be expected to collect and remit to the tax authorities. This would include such taxes and fees as the 911 fees and other telephone taxes, sales tax on equipment sales, USF fees, and any state

regulatory fees. In the model we do not show these taxes. Generally you are only liable to remit whatever taxes you are able to collect from customers, and so the tax transition is revenue neutral to you. You bill the taxes to customer and remit what you collect, and you have no other tax liability.

B. City plus Collinsville Feasibility Study

After discussions with staff we also looked at a scenario that would bring fiber to Collinsville in addition to the City. Adding Collinsville makes a lot of sense for many reasons. It is nearby to the City, similarly densely populated and contains a number of businesses that are key to the City and to the area. The assumptions listed below only describe those assumptions that are different for this scenario. Any assumption not mentioned would be the same as the base Martinsville study (such as customer rates).

Business Plan Key Assumptions

As it turns out, the breakeven for Martinsville and Collinsville combined is 42%, just as it was for Martinsville alone. However, in this scenario the business is able to keep a larger amount of cash in the bank. Also, by adding Collinsville to the study you are able to borrow $1.9 million in working cash, which is enough to comfortably launch the new business.

There is one major benefit to a retail scenario that cuts rates 10%. Customer savings on services would be injected back into the local economy. If we assume that the incumbent providers will roughly match the 10% discount, then the customer savings in both towns for a retail scenario over 30 years is around $30 million.

We also produced a second retail scenario using a 60% penetration to make it easy to compare the different business plans. The 60% scenario generates $28 M in extra cash over 25 years.

Capital Assumptions in the Study

Following are the capital expenditures that would be built during the first five years for both the breakeven and the 60% penetration models:

	42% Penetration	60% Penetration
Vehicles	$ 90,000	$ 90,000
Tools	$ 165,000	$ 165,000
Buildings	$ 625,000	$ 625,000
Furniture	$ 29,500	$ 29,500
Computers	$ 96,000	$ 96,000
Voice Switch	$ 680,000	$ 680,000
Data Routers	$ 187,500	$ 187,500
FTTH Equipment	$ 6,604,422	$ 7,461,202
Fiber Drops	$ 2,285,078	$ 2,676,647
Fiber Network	$14,056,840	$14,056,840
Inventory	$ 400,000	$ 400,000

Capitalized Software	$ 700,000	$ 700,000
Total	$25,919,340	$27,167,689

Expenses

Obviously some operating expenses are higher when serving more customers. For example, there is a greater cost of buying wholesale long distance to supply the product to a greater number of customers.

The greatest difference in the expenses is that we are estimating that it will take 19 employees to operate a business that serves both towns.

C. All of Henry County Feasibility Study

Finally, we looked at a scenario that would bring fiber to the whole County. The assumptions listed below only describe those assumptions that are different for this scenario. Any assumption not mentioned would be the same as the base Martinsville study (such as customer rates).

Business Plan Key Assumptions

As it turns out, the breakeven for the whole County is a 62% residential market penetration. We have a hard time recommending this business plan because that a much higher penetration rate than is needed by be successful in Martinsville and Collinsville (42%). There is a much greater risk of not achieving such a high penetration rate, although it certainly is possible. For example, nearby BVU has achieved a 65% penetration rate in the City of Bristol. But our reluctance to recommend this business plan is mostly due to the large difference between the breakeven requirements for a business that does not serve the rural areas. In our mind, if the City wants to serve the whole County, it makes sense to us to first build Martinsville and Collinsville and get that business running successfully before tackling the larger area. That would give you time to get good at operating the business and would also make sure that you were doing good enough in those core areas before committing to the much larger amount of borrowing needed to build the whole County.

There is one major reason to consider eventually building the whole County, which is the amount of saving this scenario would generate and infuse back into the local economy. If we assume that the incumbent providers will roughly match a price 10% discount, then the customer savings in the whole County over 30 years is around $84 million.

In this scenario we are only showing the 60% scenario which is also very close to the breakeven scenario of 62% penetration. At 60% penetration the business basically pays for itself and does not generate any excess cash over the years. This business would always be tight with cash and would always be susceptible to having circumstances change enough to cash it to be cash short.

Capital Assumptions in the Study

Following are the capital expenditures that would be built during the first five years for both the breakeven and the 60% penetration models:

	60% Penetration
Vehicles	$ 150,000
Tools	$ 215,000
Buildings	$ 1,055,000
Furniture	$ 56,500
Computers	$ 200,000
Voice Switch	$ 875,000
Data Routers	$ 187,500
FTTH Equipment	$ 16,580,561
Fiber Drops	$ 6,348,606
Fiber Network	$ 77,035,509
Inventory	$ 700,000
Capitalized Software	$ 830,000
Total	$104,233,877

Expenses

Obviously some operating expenses are higher when serving more customers. For example, there is a greater cost of buying wholesale long distance to supply the product to a greater number of customers.

The greatest difference in the expenses is that we are estimating that it will take 37 employees to operate a business that serves both towns.

D. Summary of Study Results

Following are the results of the three retail financial options we studied. These three options are 1) serving Martinsville only, 2) serving Martinsville and Collinsville, and c) serving the whole County.

Following are some of the key results of these three studies:

	Martinsville Only	Plus Collinsville	Whole County
Size of Bond	$20.5 M	$37.2 M	$145.2 M
Capital Spending from Bond	$14.5 M	$26.5 M	$104.2 M
Positive EBITDA	Year 4	Year 3	Year 1
Positive Net Income	Year 5	Year 6	Year 12
Bond Breakeven	Year 19	Year 21	Year 30
Total Employees	14	19	37
Cash after 25 years	$19.0M	$30.5 M	$9.4M
Breakeven Penetration	42%	42%	62%

Following explains the Importance of some of these metrics:

- Positive EBITDA. EBITDA is Earnings before Interest, Taxes, Depreciation and Amortization. A positive EBITDA is the point where a company has revenues that are greater than operating expenses. Commercial firms always concentrate on EBITDA and set earnings goals based upon it.
- Positive Net Income. This is the traditional measurement of profitability by commercial companies. A positive net income is when revenues are greater than operating expenses, taxes, depreciation and amortization. Net Income is more important to mature companies than it is to start-up companies. By definition, almost every start-up company will have net income losses for a few years. This particular business plan happens to be capital intensive. One generally expects capital intensive firms to have negative Net Income in the early start-up years because of significant depreciation expense. Depreciation is an expense that is recognized to show the use of the assets over time. Depreciation tends to be highest in the early years, and thus has a significant effect on start-up profitability.
- Bond Breakeven. This is the year when the business would have accumulated enough cash to retire the bonds early.
- Cash Generation. One way to judge the potential of a business is to look at the ability of the business to generate cash. A business that can generate cash is able to self-fund future growth and can afford to replace its assets over time. When the customer penetration rates exceed the breakeven point the company will generate cash.

  Focusing on cash is extremely important if the City is to consider a retail business plan. The company would need to maintain a positive cash balance if the company is to run without the need to use any tax revenues or subsidies. The bondholders would also expect to see positive cash throughout the life of the business. The business must perform to expectations or else face eventual cash shortfalls. However, if this business plan operates with good customer service and if there are sufficient customers, then this business should be perpetually self-sustaining and revenues should always exceed expenses.

  There are a number of different policy decisions the City could make in regards to the build-up and use of cash from the fiber optic business. First and foremost the cash reserves of the enterprise should be used to maintain and enhance the long-term viability of the fiber optic system. A significant accumulation of cash reserves could also enable the lowering rates to customers. Cash reserves can and should be used to expand and improve the network. The network could eventually be expanded outside of the City boundaries. The use of cash reserves to expand the system should be done with careful planning so that over the long run the extra revenues from such customers would generate even greater profits for the system and thus contribute long-term benefits to the City. Some cities make transfers out of their enterprise funds to benefit the General Fund of the community. As an example, the City could impose an In Lieu of Tax assessment on the system so that some percentage of revenues or profits automatically flowed to the City's General Fund. It is likely that the system will eventually generate revenues over and above what is needed to maintain and operate the system, and thus provide another

source of revenues for the City's general fund or provide a source of funds to acquire and construct needed City facilities.

E. Interpreting the Study Results

In this section we will make some suggestions about how the City can interpret the study results along with the next steps you might take if you want to consider moving forward with expanding the fiber business.

What Does the Study Tell Us?

There are two findings from the study that are of the most importance. First are the survey results. CCG has done hundreds of similar surveys and the positive results of this survey are among the highest we have ever seen. The survey tells you several important things. It tells you that the people in your town want competition. It also tells you that they have faith and trust in the City. In many surveys we find that citizens like the idea of competition but don't trust their local government to bring a solution. There are places where we have asked nearly identical questions and have gotten half of the positive response that we see in Martinsville. On the questions asking if citizens would consider buying services from the City, the 83% positive response rate was about the highest we have ever seen. In the City Council meeting it was suggested that these questions were biased and resulted in high positive responses since they mentioned customer savings as part of the City providing services. However, in our experience we have often seen far lower responses than obtained in this survey and we think the difference is probably due to a higher trust in the City in Martinsville than in other cities. We also know from experience that the answers to these specific questions have a significant correlation with the actual performance of our municipal clients who have built the networks and entered the business. A high positive response to these questions is quite likely going to lead to a high interest in customers to buy services from a City fiber network.

The second important finding from our studies is that there are financial model that show that a fiber business can be financially successful. will work to bring competition if you want to pursue this further. This is not always the case. For instance, we can see that there is not a great economic case for building fiber to all of Henry County. It looks like that build would require that 62% of residents in the County subscribe just to achieve breakeven. We deem that to be a pretty risky venture and would have a hard time recommending that you pursue it.

But there does seem to be a decent financial business plan option for building to Martinsville and/or Collinsville. The key finding from those two financial studies is that the projects could break even at around a 43% residential market penetration. That is not an unreasonably high goal for this type of business. You have a survey that indicates an interest at twice that level. Many other municipal projects have done far better than 43% and nearby Bristol has achieved about a 65% residential market penetration.

This does lead to a discussion of what it means for a municipal fiber business to be successful, because it is a different definition than might be used for a commercial business who wanted to do the same thing. Generally, any municipal business is deemed to be successful if it can

generate enough revenue to cover operating costs. In the case of this fiber business that would mean that the revenues would need to cover operating expenses, debt payments and future capital maintenance and upgrades. Anything earned above those things would be profit.

Most municipal ventures are quite happy to achieve breakeven. However, success greater than breakeven is possible. As an example, you currently are able to fund some of the general fund from profits made from your electric operation. Over time fiber has the same potential. One has to recognize that building a fiber is very much like building the electric utility. A fiber business would be a very long term business. If a fiber venture is funded with revenue bonds, then until those bonds are retired you would be unable to contribute any cash to the general fund from the fiber business. However, the financial models for Martinsville and Collinsville suggest that you probably would be able to retire the bonds early, and after that this business could contribute something in the range of half a million per year to the general coffers. However, that is far off into the future and should not be a major consideration to move forward or not move forward with the project.

During the City Council meeting it was mentioned that Bristol Virginia was struggling with their fiber business. I would like to take an exception to that because they look to be one of the more successful municipal fiber businesses in the County. By the definition of success I have given above – success means at least being able to pay for all operating costs, debt and capital – Bristol has been very successful with the fiber business. They have been able to take profits generated in Bristol and use that cash to expand the business to other nearby communities.

Perhaps one of the factors that would make somebody observe that Bristol is not successful is something that you will need to know about a business in Martinsville. One of the most important aspects of operating a fiber business is that the business is capital intensive, meaning that a lot of assets need to be built to serve customers. When you build assets, accounting rules dictate that a business recognize depreciation expense, which is the act of writing off the assets over time as an expense. Depreciation is a cashless expense, meaning that it doesn't cost you anything. Many years after building the fiber you will still be recognizing depreciation on the fiber, which was funded and paid for up-front by the bond proceeds. Recognizing the depreciation can make the business look like it is losing money, while a municipal business is judged strictly by cash. Municipalities don't pay income taxes, and depreciation is really just a mechanism for a for-profit company to recognize the cost of assets for calculating income taxes. Depreciation is essentially meaningless to a municipal venture. So it is likely that Bristol is showing a net book loss when considering depreciation, but on a cash basis –which is how all municipal businesses are judged, Bristol is generating cash over and above their needs and is quite successful.

<u>What Other Business Models are Possible?</u>

I was only hired to generate business plans of one type - a plan where the City would provide retail telephone and data and where somebody else would provide cable TV. This model would be referred to as a type of public / private partnership. But there are other types of business structures possible and following is a discussion of the pros and cons with some ther models that can be found in the marketplace today.

Pure Retail Model. In a pure retail model the municipal provider would be the retailer of all products on the network. Most municipal fiber ventures are of this type including Bristol Virginia. However, Bristol is the only municipality allowed to provide cable TV service by law in Virginia, and so this business model would not be available to you without a change in legislation.

There have been a few municipal failures in the retail model and these are worth talking about in terms of seeing what lessons can be learned from them:

Crawfordsville, Indiana. The City borrowed the money with revenue bonds to build a fiber system everywhere in the City. However, the City's fiber business did almost no marketing and only got about a 30% market penetration. This was not enough customers and revenues to pay for the bonds and the City decided to default on the bonds. The lesson I learn from Crawfordsville is that before you spend a lot of money to build you better have some good assurance of getting the customers. Many commercial providers have always pre-sold before they will build to an area. And I now recommend that all municipal systems do the same. If you need 50% of the market to succeed, then you should sell to most of these customers before borrowing the money to build the network. Pre-sales also means keeping in contact while the network is being built to maintain customer enthusiasm in the project.

Monticello, Minnesota. Just after Monticello sold the bonds to build their system they got sued by the incumbent telephone company over issues related to the bonds. The City won the lawsuits, but during the few years it took to do so they stopped communicating with the public on the advice of their lawyers. There had been a referendum in the City to initially approve the project, but without communication the town seems to have lost enthusiasm for the project and sales went a lot slower than expected. Meanwhile the incumbent telephone company who had sued them also built fiber to many parts of the city and got into a fierce price war with the City. The business eventually got as many customers as they had projected they would need to get. However, the Courts had awarded them damages from the lawsuit that were a lot smaller than their actual cash damages. The City has threatened to default on the bonds rather than make up for the cash lost through the lawsuit process.

I think there are several lessons to be learned from Monticello. One is that you need to keep the public very well informed during the construction process or during any other delays. It is vital for the public to remain enthusiastic about the project and also for them to identify with a municipal project as belonging to the citizens. Secondly, when a City decides to borrow the money to build a fiber system they should strongly consider the consequences of not standing behind the project if it doesn't go as well as planned.

Pure Wholesale. In a pure wholesale model, the City would build the fiber network and other companies would provide the retail services on the network. These retail providers would pay a fee to the City to use your network. There are a number of municipalities using this business model, and a discussion of them will highlight the issues with this business model.

Provo, Utah. Utah law only allows for a pure wholesale model and municipalities there are not allowed to provide retail services. Provo built and operated a wholesale network throughout the City of Provo. When they started the business they could not find any carriers willing to serve on the network, so they assisted several local IPSs to get into the triple play business. Since none of those little companies offered cable TV, or had the financial resources to build a headend, Provo built a cable TV headend. The Provo business wholesale business always lost money and never paid for itself. The City ended u selling the network at a large loss to a service provider. However, the City carried the note and when that service provider failed they have found themselves operating the wholesale business again.

Provo is a prime example of the biggest problem with the wholesale model. Provo charged around $30 per month to get access to the retail customers. This means that Provo had to build the fiber network throughout town and also then had to supply electronics and a fiber drop to each customer that was added onto the network. In total Provo was spending $3,500 per customer and at $30 per month in revenue it takes ten years just to recover the cost of the network, without considering covering operating expenses.

Provo had 'borrowed' the money from the Electric Utility to finance the fiber network, and they had to eat a lot of that investment when they sold the network at a big loss. It likely that they will lose most of the rest of that investment if they are successful of divesting themselves of the network a second time.

Chelan County PUD, Washington. Chelan County Public Utility District (PUD) is the electric and water company for Chelan County, Washington Their history as much like Provo in that they 'borrowed' the funds to build the network from the electric utility. Like Provo, they also had to build a cable TV headend and had to assist some small service providers to supply retail services on the network.

Last year Provo undertook an effort to make the wholesale fiber business self-sufficient. In doing so, they had to write off the entire cost of the network, around $90 million as they recognized that wholesale revenues were never going to generate enough cash to pay back the electric company for the network. Chelan is now operating the business such that revenues cover expenses, but they are not going to ever generate enough cash to pay back the electric company or self-fund any future expansion of the network.

Provo encountered two other problems of note that is a cautionary tale to others contemplating getting into the wholesale business. First, they experienced a lot of churn, meaning that households and businesses are constantly dropping off of their network. This has resulted in a very large inventory of nearly 1/3 of the locations they have built that are generating no revenue. Every fiber system has this situation to some degree, but the Chelan situation is the most drastic example.

Second, Chelan never finished building the network and there are still significant parts of the County. This has resulted in fiber haves and have-nots. The households and businesses without fiber are irate that their electric rates have been used to subsidize building fiber to others but not to them.

Utopia, Utah. Utopia is a wholesale fiber network that has been built collectively by a number of small rural towns. Utopia has experience the same sorts of problems as seen by Provo and Chelan. Utopia has been recapitalized several times in an attempt to find a financial model that can pay for itself.

Danville, Virginia. Danville is an example of a City that has taken a very different approach to that taken by Provo, Chelan and Utopia. Danville build a fiber backbone system through the town for purposes to serve the City and the electric utility. However, rather than infuse large dollars to build all of the residential areas of the town at once, Danville is building out the fiber network in small lots of 100 – 150 homes at a time.

At least initially, Danville will be voiding the problems of the other larger towns who have tried the wholesale model in that they will only be building to small numbers of homes as they get the cash from earlier homes built. However, this model has two obvious problems in the long run. First, it is creating a clear set of fiber haves and have-nots in the town and it is hard to see how politicians won't eventually have to say yes to building to everybody in the City.

Secondly, as the number of homes increase, the cost to operate the network increases. Further, there will be churn in Danville just as in all of the other towns who have tried this. There will come a time when the costs are higher per served household than today and I would predict that at some size the revenues will no longer cover costs. Whether you get to the full network slowly or all at once, it looks very difficult for a wholesale model to cover costs over time.

Various small Washington PUDs. There are several rural PUDs that are close to Chelan who have taken an even harder approach than Danville. These PUDs have elected to charge a significant installation charge to the retail providers of between $500 and $1,000 per household. The practical consequence of this is that in these towns the network is only adding dozens of new homes per year instead of hundreds. However, by having part of the cost of building to a customer covered by the install fee the PUDs are making it easier to break even.

Conclusion of the Pros and Cons. There are several conclusions that I can generalize on from the experience of the Cities and Counties that have already tried the wholesale model, as follows:

- First, it takes a really long time to pay for the cost of building fiber if you are only charging $20 to $30 per month to the retail providers to use the network.
- Churn is really deadly in a wholesale network since every location that churns goes to zero revenue and the revenue from other customers has to somehow make up for the lost customer investments.
- You can charge a significant installation fee to the retail service providers, but this will greatly reduce the number of customers who ever get added to the fiber. In this situation the service provider will cherry-pick and only agree to sell to customers who agree to sign a contract to buy a lot of products for a long period of time. Customers who only want to buy one product, like high-speed data, tend to not be added to wholesale networks.
- If you build slowly to make sure that costs are covered you end up with a slowly growing network and a City made up of fiber haves and have-nots. That is a very uncomfortable strategy to take for most politicians and City governments.
- The choice seems for wholesale seems to be either build everywhere and then eat the build cost and subsidize the network, or build slowly and end up with fiber haves and have-nots. I have not seen or modeled a wholesale network that can afford to build to all homes and businesses in any City.

Next Steps

These study results do not mean that the City should instantly jump ahead and build fiber. In hiring us to look at these issues you have basically gathered the facts. The City is now armed with some key facts – you know how much it will roughly cost to build fiber and you know roughly how many customers you need to get onto the network to make it the business pay for itself. But there should be a lot more discussion on the pros and cons of doing this in Martinsville.

One of my recommendations is to form a Citizen's Committee to help the City Council look t this issue. In the Cities that have been successful with fiber the public has been involved in the process, and in some communities even drove the process. They survey indicates a lot of interest in getting competition for communications services, but the City should kick the tires a bit more to really understand the breadth and depth of that support.

This kind of Committee should be made up of several types of people. It would be good to have few people that understand financial forecasts, be that bankers or business men. It ought to have a few technical people who understand computers and networks at the local level (not necessary that anybody intimately know the technology involved, but rather than understand networks more generically). Other than that you should have a few more interested citizens who the City Council trusts to give them a fair assessment of the pros and cons.

A Citizen's Committee should not include anybody who stands to gain or lose money as a result of building a fiber network. This means you should not put incumbent service providers, fiber contractors and construction companies, or potential wholesale providers on the Committee, because they are going to only generate ideas that benefit them. However, the City Council will want to hear from all of these types of parties in some forum such as public hearings, if the idea goes that far.

F. Financing Options

The design, construction and initial start-up costs for the establishment of a City-wide fiber optic telecommunications system will be significant. The City cannot fund this from reserves and will therefore need to borrow the money necessary to finance the entire system. If you are like most cities, the intent would be that any money borrowed for the establishment of the new telecommunications system would be repaid entirely from revenues of the new system. Following is a discussion of some of primary ways the City could consider funding this sort of venture. These funding mechanisms apply equally to any business model and would cover all of the investment in a sole venture or the City's share of a partnership venture.

Municipal Bonds

The primary historic source of money to finance this sort of telecommunications system is through the issuance of municipal tax-exempt bonds. There are several types of bonds that have been used to finance these types of networks. Most cities would prefer to use revenue bonds for this type of venture. With a revenue bond the backing of the bonds would be the fiber network and the business associated with the venture. Ideally there would be no additional pledge with a revenue bond other than having the system as collateral for the bonds. However, some recent revenue bonds for municipal ventures have required a debt service reserve fund in which the City pledges to make the annual payments of the bond. If you are facing this kind of pledge, it is worth instead considering general obligation bonds.

The biggest issue of using revenue bonds will be the willingness of the market to accept them. Since the market meltdowns in late 2008 there have been only a few successful revenue bonds issued for any municipal venture, not just for telecom ventures. Currently the market is still a little leery about taking the extra risk associated with revenue bonds. However, these markets change over time and there will certainly come a time again when revenue bonds will be more easily marketable.

If you can't use revenue bonds, then the next typical alternative is general obligation bonds. In Virginia the use of general obligation bonds requires a referendum approval by voters. General Obligation bonds would put the tax revenues of the City at risk should the telecom venture fail. While the intent would be for the project to pay for itself, there are no guarantees of success. Some telecom ventures have been built using general obligation bonds. Typically in the market there is a lower interest rate available for general obligation bonds compared to revenue bonds, and when this spread becomes large enough cities have elected to use the general obligation bond option. As this report is being written the going rate for a revenue bond for this kind of

project is running at about 5% interest while the interest rate for general obligation bonds are as low as a little under 2% interest.

One thing that the business plan models shows is that the venture in Martinsville is expected to lose money for the first few years until it ramps up customers. Most bonds allow for the borrowing of interest payments that would be made in the first few years as a way to make sure the project can make the payments to bondholders. This is known as capitalized interest. The various financial models used in this study assume capitalized interest for the first three to five years of the new business.

There are other financing mechanisms that have been used by other municipalities to fund revenue generating projects. These include:

A Combination Construction Loan and Fixed-rate (Serial) Bonds

A different way to start this kind of projects is to begin with a bank construction loan that is then taken out and replaced by bonds. This scenario can be more attractive to bondholders since they don't get involved in the project until after the assets have been built. This removes the risk of going over budget on construction and speeds up the revenues in the project since the bondholders avoid the buildout phase. The best way to do this would be to work with one financial firm that would handle both parts of the transaction. You would want somebody who could acquire the bank loan and who could then make the conversion to bonds at the appropriate time. CCG worked with a project in 2007 that was able to do this transaction using Bank of America.

There are risks to the City and benefits with this type of financing. One of the benefits is that there probably is no voter approval needed to secure a bank loan, so the City could proceed to get the network built without a referendum. The downside to the City might be the unknown nature of the interest rates in the future when it was time to swap the construction loan to a bond.

A construction loan typically capitalizes the interest during the construction period, so the City could avoid having to pay interest while the project was being built. These costs could then be rolled into the bond.

Other Short-term Borrowing Options

Line of credit with a bank. Cities can sometimes get a line of credit with a bank that could be large enough to fund construction. In effect, the line of credit would be used in the same way as the construction loan in the above example. One problem with a line of credit is that interest is usually not deferred.

Commercial paper. Commercial paper is a short-term, unsecured promissory note with a maturity ranging from one to 270 days. The loan can be tax-exempt, but banks often treat commercial paper as a construction loan and charge a corresponding higher interest rate. Since the term cannot exceed 270 days, this poses interest rate risk to the City when it has

to renew the commercial paper during construction. Interest can be compounded and paid when the commercial paper is taken out with long-term bonds. The short nature of this funding method makes it harder to use for a City.

Other Long-term Borrowing Options

Variable Rate Demand Obligations (VRDO's). VRDO's are a bond where the principal is paid in a lump sum at maturity. However, the borrower has the right to redeem bonds in whole or in part at any time (upon an agreed upon notice). VRDO's are very effective in circumstances when the borrower wants to match the repayment of the bonds to a revenue stream that varies year to year or a revenue stream that can vary from initial estimates and changes over time. In the case of the new telecommunications system for Martinsville, this type of financing would provide the flexibility to make bond payments that match the actual revenues received. If revenues are slower than anticipated principal payments do not need to be made. If revenues come in faster than anticipated repayment of the bonds can be accelerated without penalty.

VRDO's are most commonly structured as 7-day floating rate bonds. Interest rates are reset each week. Interest payments are made on the first day of each month. There is a lot of interest rate risk in times with low interest rates since the interest rate is reset each week. Unlike fixed-rate bonds the borrower does not know what the interest rate will be on the VRDO's over the life of the issue. Interest rates on VRDO's are on the short end of the yield curve and have therefore historically been lower than interest rates on fixed-rate bonds even with the additional ongoing costs for a liquidity provider and a remarketing agent. There is typically a maximum rate stated which the VRDO's cannot exceed.

The size of the borrowing and the term of the bonds contemplated by the City of Martinsville for its new telecommunications system make VRDO's a viable financing option for the City. The legal structure and the financing participants of VRDO's make this type of issue significantly different than other types of borrowing. However, VRDO's are not an uncommon type of financing and the legal structure is very standardized and well known to the national credit rating agencies, such as Moody's Investors Service. The City is advised to work with their financial advisor to further explore the advantages and risks associated with VRDO's.

Capital Appreciation (zero coupon) Bonds (CAB's). CAB's are bonds that are issued at a deep discount and which do not bear any stated interest rate. Like a Series E savings bond, CAB's are bought at a price that implies a stated return calculated on a basis of the bond being payable at par at maturity. With no stated interest rate there is no interest paid until maturity, at which time all of the compounded accreted interest is paid. With no interest payments required in the beginning years of the bonds, this would enhance the cash flow in the beginning years of the business case model for the City of Martinsville telecommunications system.

CAB's do however have several drawbacks over other types of available financing for the City of Martinsville telecommunications project. First, the interest rates on CAB's are typically higher than both the fixed-rate and VRDO's. Second, investors prefer not to have a prepayment option on CAB's, which limits the flexibility of the City to call the bonds early if revenue collections are better than anticipated or if a restructuring of the debt is needed.

USDA Rural Development Rural Utilities Program (RDUP)

The Rural Utility Service (RUS), an arm of the department of Agriculture administers a loan program referred to as RDUP. At the last funding this plan had over $1 billion in funds available for a combination of loans and grants for deployment of broadband and telecommunications services in rural communities. The loans can be used for the construction, improvement and acquisition of facilities and equipment for broadband service.

There are several features of these loans that make them difficult for cities to use. To date, no municipality has ever successfully received an RDUP loan.

RDUP application process is lengthy and the requirements are rigid. To date a city has never been the recipient of a RDUP loan, which based on the loan requirements, is not surprising. All loans have gone to telecommunications companies. The RDUP requirements that raise concerns for the City of Martinsville fiber project are as follows:

- The borrower requires a 20% equity contribution. The equity contribution does not need to be cash. Very few cities are willing to contribute 20% of funds toward this type of project. Some of the network you have already built might be able to count as equity, but that would have to be negotiated and it probably would not equate to 20% of the project.
- RDUP determines the number of years over which the loan must be repaid. This poses a risk to the City of Martinsville that the loan duration will almost certainly be shorter than desired, which results in higher annual loan payments. Most RDUP loans are for 12 to 15 years which is far less than the 25 to 30 year terms you can get with a bond.
- RDUP requires no more than one-year delay in the payment of principal on the loan and will not allow the borrower to capitalized interest on the loan to cover interest payments in the first few years. This would mean that there would not be sufficient cash flow in the first few years of the business to make principal and interest payments on the loan.
- There is a long time frame from the beginning the application process to the approval of the loan in Washington DC. It is normal for the entire process to take in excess of twelve months. The application must include a market study, an engineering plan and a finance plan. Even though we just did a market study (survey), you would have to do another one since the survey cannot be more than six months old at the time the application is submitted. The business plan prepared for this report would be sufficient for application purposes. The RUS would require more detailed engineering than was done in this preliminary feasibility study. The City would incur the cost of the application process and the extra engineering with no assurance the loan would be approved.

There are some factors that are positive for the City of Martinsville in regards to RDUP loans. These factors are as follows:

- RDUP has the authority to make part of the award a grant instead of a loan. To some extent this could offset some of the other problems with these loans.
- RDUP has significant money available to borrow to projects; enough to fully finance the City of Martinsville fiber project.
- RDUP has attractive borrowing rates that would most likely be lower than revenue bonds. Current interest rates are around 4%.

In contrast to the RDUP loan, the City could issue bonds to finance 100% of the project costs. Furthermore, City issued bonds offer the flexibility to structure the debt to meet the specific requirements and needs of the City and the new telecommunications system. The City has no ability to negotiate the terms and structure of the RDUP loan.

G. Implementation Time Line

The RFP asked CCG to look at a possible time line for implementing a FTTH project. Obviously there are many different possible paths such a project might take and very different time frames possible depending upon circumstances

Following we will discuss one potential time line. In this example, we look at a time line that looks at the assumption that the City will partner with a commercial partner to provide cable TV service but the City will directly serve retail data and telephone service. This time line is for the City-only build and not for the whole County. A whole-County build would take longer to complete construction but could still have a first customer at the same date.

This timeline predicts that it takes about 18 months to get the first customer from the date that the project is funded. It is very hard to predict how long it might take to get funded. First the Council will need to approve the project. From there, if everything goes well it usually takes about six months to get bond funding. In your case, since you are already in the business serving a few business customers it is possible that you could trim the 18-month implementation period by a few months, but probably not by more than that.

In Attachment II to this report we have prepared a list of many of the major tasks that are required to implement a FTTP project. This is a somewhat abbreviated list in that many of the tasks listed include many sub-tasks. At CCG we strongly recommend that a City use a Gantt chart process when implementing a project of this complexity. A Gantt chart is a document that lists each task to be performed in a project. It estimates the time required for each task and assigns the responsibility of each task to a specific individual. Most importantly, the tasks in a Gantt chart are linked. For example, if a given task cannot be started until some other task is completed, these tasks are linked in the Gantt chart so that if the first task finishes early or late the impact can be seen on the second task and on the whole time line. We have found that projects that use Gantt charts tend to finish on time while projects that don’t rarely finish on time. As you can imagine, keeping track of a few thousand tasks and trying to manage the whole

process with a deadline is exceedingly difficult. A Gantt chart gives the project manger a tool to keep a perspective on the overall project.

One can see that the 'short list' of tasks in Attachment II to this report contains over 300 tasks. During an actual implementation it is not unusual to see a Gantt chart with several thousand tasks.

The timeline below looks at some of the critical path steps that are involved in a fiber project. By critical path, I mean tasks that, if delayed, can delay the whole project. Some of the key steps are at the beginning. Obviously the project can't really start until the City Council decides to proceed. The task of finding and negotiating a deal with a cable partner can be quite unpredictable. Additional time might be needed compared what is shown if you want to use general obligation bonds to fund the project and need to hold an election. To further complicate things, any final time line in Virginia must take the construction season into consideration. For example, the whole project can be delayed a year if all of the tasks needed to start network construction are not ready by the start of the spring construction season.

This time line also does not suppose any major external delays to the project. Some possible delays that are impossible to predict might include such things as: a lawsuit by the incumbent such as happened in Monticello, MN and Bristol, VA, or delays in obtaining bond funding for some reason.

With those caveats in mind, following is a sample of a time line that might be achieved by this process. This only includes some of the major milestone tasks from the longer lists of tasks shown in Attachment II.

Possible Time Line for Martinsville FTTP Implementation

CCG Delivers Feasibility Report	October 2012
City Council Elects to Proceed with FTTH Project	April 2013
City Seeks and Finds a Commercial CATV Partner	June 2013
Negotiate Deal with Partner	July 2013
Obtain Bond Financing	October 2013
Hire General Manager	November 2013
Begin Engineering of Network	November 2013
Issue RFP for Fiber Construction	March 2014
Begin Fiber Construction	June 2014
Issue RFPs for Electronics	March 2014
Choose other vendors	June 2014
Technical Staff Hired	July 2014
Headend Building/Space Complete	July 2014
Begin Installing Equipment	August 2014
Electronics all Installed	November 2014
Other Staff Hired	November 2014
System Integration and Testing	December 2014
First beta Customers	February 2015

First Retail Customer April 2015

Some notes on this time line:

- Again, this is one of many possibilities.
- This time line assumes some sort of customer pre-sign up program. This would allow the construction crews to install fiber drops and ONT boxes for known customers as the fiber was installed on each street. This process speeds up the construction process and saves costs.
- This time line leaves sufficient time to order needed electronics for voice, video and data services. However, to the extent that the partner is already in these businesses and has equipment that can be used for Martinsville, then such equipment would not be necessary for the project. Already having this equipment could shave time off the time line.

Summary of Time Line

It is possible that if the City decides to go into the business within a few months after the delivery of the feasibility study that the first customers in town could be on the system by the end of 2014. It's even possible if everything goes perfectly that the first customers could be served a few months before that.

We always advise our clients that it is better to take enough time to do things right. Hurrying a project of this complexity is bound to result in problems. We know from experience that the customer experience of the first customers is vital in any deployment. In towns the size of Martinsville, word of mouth is extremely important. If the first customers experience a lot of problems, then the network is going to have to work very hard to gain back customer trust and to get the customers needed for the business to succeed. Thus, doing things right is better than doing things fast.

Attachment I
Residential Survey Results

Total Surveys - 370

1. What City do you live in?

	Number	Percent
Axton	13	4%
Bassett	53	14%
Blackberry	18	5%
Collinsville	31	8%
Fieldale	18	5%
Horsepasture	16	4%
Martinsville	163	44%
Ridgeway	47	13%
Spencer	11	3%

2. What is your zip code?

		Number	Percent
Axton	24054	13	4%
Bassett	24055	53	14%
Blackberry	24055	18	5%
Collinsville	24078	31	8%
Fieldale	24055	1	0%
	24089	17	5%
Horsepasture	24112	16	4%
Martinsville	24089	1	0%
	24112	162	44%
Ridgeway	24148	47	13%
Spencer	24165	11	3%

High Speed Internet

3. If you have access to the Internet at home, what kind of service do you have?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
Don't have Internet	161	44%	77	47%
Dial-up	11	3%	3	2%
Cable modem	82	22%	34	21%
High speed DSL	108	29%	47	29%
Wireless	0	0%	0	0%
Cellphone	7	2%	1	1%
Satellite	0	0%	0	0%
Other	1	0%	1	1%

4. If you use dial-up Internet access today, have you considered changing to high-speed Internet access?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
Yes	11	100%	3	100%
No	0	0%	0	0%

5. How much do you pay for Internet service each month?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
$15 - $25	7	3%	2	2%
$25 - $35	7	3%	1	1%
$35 - $50	9	4%	4	5%
More than $50	33	16%	18	21%
Part of a Bundle	138	66%	56	65%
Don't Know	15	7%	5	6%

6. Please rate your Internet service provider regarding the following from 1 to 5, where one is 'extremely dissatisfied' and five is 'extremely satisfied'

Amount of time it takes to get problems fixed

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
1 – Extremely Dissatisfied	5	2%	0	0%
2 – Somewhat Dissatisfied	22	8%	5	6%
3 – Okay	71	26%	29	34%
4 – Somewhat Satisfied	78	29%	29	34%
5 – Extremely Satisfied	93	34%	22	26%
No Answer	3	1%	0	0%

Download Speed

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
1 – Extremely Dissatisfied	1	0%	0	0%
2 – Somewhat Dissatisfied	15	7%	5	6%
3 – Okay	71	34%	31	36%
4 – Somewhat Satisfied	87	42%	33	38%
5 – Extremely Satisfied	34	16%	17	20%
No Answer	1	0%	0	0%

The value I get compared to the price I pay

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
1 – Extremely Dissatisfied	8	4%	5	6%
2 – Somewhat Dissatisfied	28	13%	17	20%
3 – Okay	108	52%	44	51%
4 – Somewhat Satisfied	49	23%	16	19%
5 – Extremely Satisfied	15	7%	4	5%
No Answer	1	1%	0	0%

7. Would you buy high-speed Internet if the local government can help to bring a competitive solution that will bring you faster upload and download speeds at a lower cost?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
Yes	236	64%	100	61%
No	121	33%	55	34%
Maybe	2	1%	1	1%
No Answer	11	3%	7	4%

Telephone Service

8. Who provides your telephone service?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
CenturyLink	274	74%	121	74%
Netelos	1	0%	1	1%
VOIP like Vonage	7	2%	1	1%
Comcast	88	24%	40	25%

9. How much do you pay for telephone service each month?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
$15 - $25	13	4%	4	2%
$25 - $35	65	18%	28	17%
$35 - $50	68	18%	38	23%
More than $45	53	14%	25	15%
Part of a Bundle	140	38%	58	36%
Don’t Know	31	8%	10	6%

10. In the next year, do you plan to drop your land line and use only cellular service?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
Yes	16	4%	6	4%
No	352	95%	157	96%
Don’t Know	2	1%	0	0%

11. Please rate your telephone service provider regarding the following from 1 to 5, where one is 'extremely dissatisfied' and five is 'extremely satisfied'

Amount of time it takes to get problems fixed

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
1 – Extremely Dissatisfied	11	3%	6	4%
2 – Somewhat Dissatisfied	12	3%	8	5%
3 – Okay	77	21%	32	20%
4 – Somewhat Satisfied	157	42%	64	39%
5 – Extremely Satisfied	113	31%	53	33%

The value I get compared for the price I pay

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
1 – Extremely Dissatisfied	21	6%	11	7%
2 – Somewhat Dissatisfied	26	7%	16	10%
3 – Okay	114	31%	56	34%
4 – Somewhat Satisfied	129	35%	47	29%
5 – Extremely Satisfied	80	22%	33	20%

12. Would you buy telephone service if the local government can help bring telephone service at a lower price?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
Yes	298	81%	132	81%
No	64	17%	28	17%
Maybe	8	2%	3	2%

Cable TV

13. Do you currently subscribe to Cable TV service?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
Yes	332	90%	143	88%
No	29	8%	14	9%
No Answer	9	2%	6	4%

14. If yes, who is Cable TV Provider?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
Comcast	201	59%	111	74%
Satellite	131	39%	39	26%
Other	8	2%	1	1%

15. How many televisions are used in your home?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
0	10	3%	3	2%
1	45	12%	19	12%
2	111	31%	51	32%
3	121	34%	54	34%
4 or more	73	20%	32	20%

16. How much do you pay for Cable TV service each month?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
$15 - $29	3	1%	3	2%
$30 - $49	9	3%	3	2%
$50 - $69	34	10%	22	15%
$70 - $89	50	15%	26	17%
$90 or more	77	23%	33	22%
Bundle	141	42%	57	38%
Don't Know	20	6%	6	4%

17. Please rate your cable service provider regarding the following from 1 to 5, where one is 'extremely dissatisfied' and five is 'extremely satisfied'

Amount of time it takes to get problems fixed

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
1 – Extremely Dissatisfied	8	2%	4	3%
2 – Somewhat Dissatisfied	7	2%	4	3%
3 – Okay	80	24%	38	26%
4 – Somewhat Satisfied	164	50%	75	50%
5 – Extremely Satisfied	72	22%	28	19%

Picture Quality

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
1 – Extremely Dissatisfied	12	4%	6	4%
2 – Somewhat Satisfied	3	1%	1	1%
3 – Okay	52	16%	28	19%
4 – Somewhat Satisfied	135	41%	66	44%
5 – Extremely Satisfied	129	39%	44	32%

The value I get compared for the price I pay

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
1 – Extremely Dissatisfied	25	8%	16	11%
2 – Somewhat Dissatisfied	29	9%	18	12%
3 – Okay	144	43%	68	46%
4 – Somewhat Satisfied	99	30%	37	25%
5 – Extremely Satisfied	35	10%	10	7%

18. Would you buy cable service if the local government can help bring cable service at a lower price?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
Yes	298	81%	139	85%
No	58	16%	22	13%
Maybe	9	2%	2	1%
No Answer	5	1%	0	0%

19. Is it important to you for the cable TV company to have a local business office in the area?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
Yes	148	40%	60	37%
No	219	59%	103	63%
No Answer	3	1%	0	0%

20. Do you work at home?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
Always	0	0%	0	0%
Often	2	1%	0	0%
Occasionally	32	9%	11	7%
Never	335	91%	152	93%
No Answer	1	0%	0	0%

21. If you had faster Internet access at home would you work at home more often?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
Yes	6	2%	0	0%
No	362	98%	161	99%
Maybe	1	0%	1	1%
No Answer	1	0%	1	1%

22. Should the local government partner with a commercial provider to offer cable TV, telephone and data service?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
Yes	309	84%	136	83%
No	56	15%	25	15%
Don't Know	5	1%	2	1%

23. Should the local government consider directly offering telephone and data service to households and businesses?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
Yes	305	82%	136	83%
No	63	17%	25	15%
Don't Know	2	1%	2	1%

24. If not, why not?

- Government should not get involved
- Conflict of interest
- Government needs to say out of private sector
- Don’t Care
- Government doesn't need to provide us with every thing
- If it’s setup with a subsidy
- Need more information
- Government needs to focus on government issues

25. How do feel about the possibility of the local government constructing a fiber network to go to every home and business?

	Total Survey		Martinsville	
	Number	Percent	Number	Percent
For it	265	72%	122	75%
Against it	54	15%	19	12%
Don't know	51	14%	22	13%

Attachment II – Tasks Required for FTTH Implementation

CCG Feasibility Report Delivered
City Chooses to Proceed
- Staff Recommendations
- Educate Council
- Council Vote

Negotiations with CATV Partner
- Determine price for Network Access
- Negotiate Partnership Agreement

Bond Financing
- Choose Bond Advisor
- Choose Bond Seller
- Choose Bond Attorney
- Referendum of using General Obligation Bond
- Prepare POS
- Get Rating if Needed
- Sell Bonds

Organizational Readiness
- Create Enterprise Fund
- Create Org Chart
- Create Budget
- Create Logo

Human Resources Readiness
- Complete Job Descriptions
- Determine Salaries
- Determine Benefits
- Hire General Manager
  - Job Description
  - Salary
  - Advertise

Procurement Readiness
- Equipment to Buy
  - Vehicles
  - Computers
  - Data Routers
  - Furniture
  - Office Equipment
  - Test Equipment
  - Software
- Provide Specs
- Prepare RFP / Competitive bid ad Appropriate
- Purchase Equipment

Contract Readiness
- Interconnection Agreement
  - Get CenturyLink Account Rep
  - Execute New Interconnection Agreement
  - File Interconnection Agreement with State Commission
- NPAC Agreement
- Operator Services/Directory Assistance
- Long Distance Agreement
- CALEA Readiness
- Network Neutrality Compliance
- SS7/LIDB/CNAM Agreements
- RAO/CMDS Hosting
- Internet Transport Agreement
- Terminating Traffic Agreement

Headend Building
- Determine Location
- Buy, Build or Upgrade Existing Space
- Hire Architect
- Design Building
  - Determine Power Requirements
  - Determine Grounding
  - Determine parking
  - Determine Office Space Needs
  - Determine Warehousing Needs
- Issue RFP for Contractor
- Choose Contractor
- Prepare Building Site
  - Site Work-Clearing, Earthwork, Drainage
  - Concrete Work (Foundation)
  - Mechanical (Waste Water Connection-Plumbing)
  - Electrical (Commercial Power)
  - Fiber Entrance
  - Roads
  - Security
  - Parking
  - Trees and Shrubs
- Build Building
- Inspections

Industry Code Administration Readiness
- Select AOCN
- Obtain OCN(s)
- Obtain ICSC
- Obtain ACNA/IAC

- Obtain ECC
- Obtain Non-host RAO
- Obtain Switch and POI CLLIs
- Establish CLLI's in CLONES
- Establish CLLI in BIRRDS
- File Initial NRUF
- Request NXX Code to Establish LRN for Switch
- NXX Codes Established in BIRRDS
- LRN Establish in BIRRDS
- Determine Number Assignment Policy

Tariff Readiness

- Create Local Tariff
- Create State Toll Tariff
- Create State Access Tariff
- Create International Tariff
- Create Interstate Access Tariff
- Create Interstate Toll Tariff

Business Office Readiness

- Determine Location
- Build, Buy or Lease space
- Secure Space
- Evaluate Phone System
- Remodel Space as needed
- Walk In Center-Payments, Sales, Equipment
- Plan Customer Experience and Sales Optimization
- Location Plan-Central, Multiple, Kiosks

Settlement Readiness

- Identify Annual Regulatory Fees
    - At VA PUC
    - At FCC
- Establish CenturyLink Reporting
- USF Settlement Process

Accounting Readiness

- Establish Chart of Accounts
- Bond Accounting
- Establish Revenue Accounting Procedures
- Define Managements Report Requirements
- Create Management Reports
- Asset Accounting
- Hire Auditor

Technical Workforce Readiness

- Establish Job Descriptions
- Advertise for Jobs

- Hire Supervisor
- Hire Internal Technicians
- Hire Installers
- Hire Help Desk technicians
- Training

Voice Switch Readiness

- RFP for Switch Vendor
- Choose vendor
- Interconnection Agreement
- SS7 Trunks
- Trunks to CenturyLink
- Collocation at CenturyLink?
- Local Interconnection Trunks
- 911 Trunks
- Long Distance Trunks
- Establish Relationship with NENA
- Establish 911 Relationship with Local PSAPs
- Determine Address Validation Process
- MSAG Validation
- Integrate switch into OSS software
- Call Testing Plan
- Integrate Long Distance

FTTH Equipment Readiness

- Active or Passive Network?
- Establish Specs
- Issue RFP for Equipment vendor
- Choose FTTH Vendor
- Order Equipment
- Install Equipment
- Test Equipment

Data Equipment Readiness

- Will Company Be Own ISP?
- If Not, Find ISP Partner
- If yes, Prepare to be ISP
    - Assigning Email Addresses
    - Creating VPNs
    - Assigning IP Addresses
    - Virus Checking
    - Network Security Procedures
- Write RFP for data Routers and Switches
- Order Equipment
- Install Equipment
- Use Share Ware ISP Software?

- Create Customer terms of Service
- Determine Customer Data Usage Policies

Network Security Readiness

- Evaluate EDI Requirements
- Evaluate HIPAA Requirements
- Evaluate Other Security Requirements
- Implement Security Plan
- Disaster Recovery Plan
- Create Emergency Operations Manual

Long Distance Readiness

- Obtain CIC Code
- Order Connection to Vendor
- Provide Tax Exempt Certificate to CenturyLink
- Prepare Billing System
- Implement Long Distance

Customer Service Readiness

- Establish CSR Responsibilities
- Hire Customer Service Supervisor
- Hire Customer Service Reps
- Establish Pre-Order Procedures
- Coordinate with Sales
- Establish Hand Off Process
- Determine and Document Work Flow
- Test Internal Process
- Establish Order Activities
- Test Internal Process
- Establish Trouble/Maintenance Activities
- Determine White Page Directory Procedures
- Determine Customer Verification Processes
- Establish Number Porting Processes
    - Select SMS Interface
    - Complete Testing with NPAC
- Installation and Repair Activities
- Establish Toll Free Number
- Trouble Call Handling
- After Hours Service
- Credit and Collections Activities
- Fraud
- Drop Box Locations
- Long Distance PIC Activities
- Equal Access Notification to Carriers
- Learn Tariff Requirements
- Deposits

- Credit Checks
- Delinquent Customer Handling
- Disconnection Policies
- Partial Payment Policies
- Reconnection Policies
- BNA Authorization
- Customer Privacy Policy
- Red-Flag Policy and Manual

Sales and Marketing Readiness

- Pre-sales Campaign
- Determine Marketing Budget
- Determine Residential Marketing Plan
- Determine Business Sales Plan
- Establish pay and commission structure
- Hire salespeople
- Establish external marketing partner
- Prepare marketing literature

Build Fiber Network

- RFP for Network Engineers
- Hire Network Engineers
    - System Walk-Out
    - Engineer System
    - Determine Construction Units
- Make Ready needed for Poles?
    - Contact pole owner
    - Establish process
- Issue RFP for Construction Company
- Hire Construction Company
- Determine Warehousing of Materials
- Order Fiber
- Order Construction Materials
- Obtain Rights-of-Way
- Establish Process for Locating Existing Utilities
- Determine Process for Inspection
- Obtain Needed Permits
- Construct Network
- Build Huts as Needed
- Test Network

Customer Site Readiness

- Determine Installation Procedures
- Hire External Installers as Needed
- Train Installers
- Obtain Fiber Drops

- Determine How to Power ONTs
- Order ONTs
- Obtain Minor Materials
- Use Spliced or Connectorized Drops?
- Customer Training material
- Processes for Building Buried Drops
- Processes For Aerial Drops
- Safety Training
- Install First Customer Drop

Billing Readiness

- Prepare OSS-BSS RFP
- Choose OSS Vendor
- Purchase OSS System
- Determine Products & Prices
- Determine Data Speeds
- Determine Customer Payment options
    - Checks
    - Live payments
    - Cash
    - Credit Cards
    - Bank Drafts
    - Payments Taken in Banks and Grocery Stores
- Determine Bill Format
- Determine CABs Billing Processes
- Determine Billing Cycles
- Determine Delinquency Rules
- Implement OSS
- Test Billing

System Integration

- Implement Internet Backbone Connection
- Test Voice, Video and Data with ONTs
- Test Middleware
- Test Provisioning Software
- Test OSS Integration
- Test Network Security
- Test Voice Products
- Test Data Products
- Test Wholesale Video Products

Customer Launch

- Select Beta Customers
- Install Beta Customers
- Beta Test
- Ready for Normal Customers

Begin marketing
Install First Customer