Leveraging for Growth, Northampton Municipal Network Strategy and Plan

Prepared for:

City of Northampton
Massachusetts

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1 - Executive Summary

The City of Northampton ("the City") leadership has recognized the importance of encouraging the development of a reliable, affordable, and secure broadband infrastructure to serve the municipality and students of Northampton; as well as an economic development tool to foster economic growth.

The City’s has an existing investment in a municipally-owned fiber optic network that connects all the public schools, libraries, and municipal buildings in Northampton – a total of twenty-six buildings. Each of the twenty-six buildings that are served over the municipal network have a router installed that enables connectivity on the network.

If the City were to expand the network by connecting additional buildings, or through access technologies such as WiFi, the benefit to the community may increase significantly. But, as affirmed in Section 1.1, Goals, the intent of this plan is largely to address the benefits of enabling more services on the current municipal infrastructure to the locations that are already connected to the network.

Cities need to be “smarter.” A robust, affordable infrastructure is a critical component of being smarter. Long-standing challenges are being confronted almost daily with new business models resulting in the creation of radical new efficiencies for long-standing challenges. Uber and Lyft are examples for new efficiencies in transportation. Google and Facebook are examples for advertising. Cities are now taking advantage of the most advanced technologies to become smart cities. Well-designed municipal networks provide the foundation for cognitive solutions. Like businesses, local, state, and federal governments are using networks to access data. That data is being converted to information to provide the bases for better administration, planning, and operations for service delivery, safety, security, and general information about the health of the communities that they serve.

Like electricity, water, and efficient roadways, broadband is a critical utility. In fact, while we are able to go “off the grid” for electricity and water, the broadband “grid”, which includes connectivity with the world wide web, cannot be replaced through off-the-grid solutions. You either have access to broadband, which the FCC has now defined as 25 Mbps downloads and 3 Mbps uploads during the peak hours for 95% of your end users, or you do not. (See the February 4, 2015 release on the 2015 Broadband Progress Report at https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2015-broadband-progress-report). This definition is what the FCC considers to be the minimum acceptable speed for consumers and enterprises to connect to the Internet.

And, beyond the local solution of a broadband local area network that connects locations such as the twenty-six buildings on the City’s municipal network, the true utility of what we commonly refer to as “my broadband connection” includes reliable, affordable, and secure high-speed access to the Internet, which is the global network of interconnected networks.
Through these dedicated local networks and through the Internet, end users have access to Internet Protocol Enabled Services (“IPES”) such as Voice Over Internet Protocol (VoIP) and streaming video.

Reliable broadband connectivity includes a local network that is designed to support the required speed to access the Internet during peak usage times, through management of the Internet connection with acceptable contention ratios, with high quality providers of Dedicated Internet Access. Through scale, a network can include cost effective network diversity that will provide path and nodal diversity to access key network points such as carrier hotels where connectivity to the Internet is available from these providers of direct connections to the Internet. These direct connections are commonly described or referenced as Dedicated Internet Access (DIA).

Simply stated, to be affordable, the required investment for the initial and ongoing construction or replacement of network elements must be recovered through an adequate level of revenues from a defined level of demand with an acceptable ongoing cost structure. Revenues are the result of a fee structure that supports the required level of demand for the addressable market.

The cost to provide broadband services is daunting. Several years ago, Google built fiber-to-the-premise (FTTP) to locations throughout Kansas City, Kansas and Kansas City, Missouri. The cost was $84M to pass 149,000 locations. $84M is a significant investment in any community. The cost per location passed was $546. Northampton does not have 149,000 locations, and the cost per home passed would probably exceed $546 per location to pass all of the locations in the entire City of Northampton. Google’s focus, like Verizon’s and other major investors in fiber-based infrastructure, is on major metropolitan areas or clusters. Northampton is not a location that has been considered by these and other similarly situated companies for significant infrastructure investment.

Northampton commissioned Percipio Industries LLC (Percipio) to examine the opportunity to leverage the municipality’s existing fiber optic network and other infrastructure to bring secure, reliable, affordable, and secure high-speed broadband to the City. Fundamentally, what role should the City play in this region to bring reliable, affordable, and secure high-speed broadband to non-municipal locations?

1.1 - Goals
The City’s primary goal is to maximize the efficiency, value, and usefulness of their existing municipal network. This includes, but is not limited to, increases in the services or utility of the municipal network provided to the Northampton Public Schools, Smith Vocational and Agricultural School District, Northampton libraries, and the municipality itself.

Use of the Five College Network fiber strands, that are currently under agreement for the City’s use until January 2019, are an important factor for consideration. These fibers may enable access to more reliable and affordable connectivity to the Internet. As such, the fibers may be
complementary to the goal of maximizing efficiency, value, and usefulness of the existing municipal network.

A second goal is affirming, through critical review, the feasibility of leveraging the existing network as an economic development tool. Can the City’s existing municipal network provide a foundation or a basis for providing reliable, affordable and secure Internet access to business customers in the Northampton community either directly or by developing a public-private partnership with one or more private sector companies?

The third goal is to understand how the municipal network can enable Smart City applications that will benefit the community. It is anticipated that the improved scale of operations and improvements in the cost to provide service will enable the adoption of such technologies much sooner.

To accomplish these goals, revisions to the business and/or operational models of the municipal fiber network will be considered and, where appropriate, recommendations shall be made on changes to the business and/or operational models. The outcome from this effort will be that the City shall be better situated to utilize existing assets, maximize efficiencies, and realize economies of scale. Recommendations will also be made for revisions to the business and operational models between the City and school districts and libraries that will be mutually beneficial. Initial examples are: i) provide cash flow to the City to offset operational costs and to provide a reserve for asset maintenance, and, ultimately, asset replacement; ii) improve the quality of the school districts’ and libraries’ Internet access performance and, ideally to provide that improved quality at a reduced cost. The Modernization of the E-Rate system several years ago has provided opportunities to reduce the cost of services to the school districts and libraries while improving the quality of the services received, or simply to provide an improvement in the services being received through the provision of more available bandwidth at a comparable cost; iii) enable the schools and libraries to access Internet enabled services that will improve the quality of their operations at an affordable rate; and iv) improve access to City information that benefits the community.

1.2 - Guiding Principles
Using the City leadership’s goals as a framework, this analysis has identified the following principles to guide the City towards its objectives:

- The City will maximize efficiencies on the existing, publicly funded municipal fiber network, by revising the business relationship with the school districts and the libraries and the use of the Five College Network.
- The City will consider leveraging the municipal fiber network as a tool to foster economic growth by offering robust Internet access at affordable prices to large and enterprise businesses, either directly or through a public-private partnership.
The City will not get into the Internet access business simply as an attempt to compete with the private sector. The principle is to leverage the existing publicly financed infrastructure to provide services that will provide an economic “toolbox”, to attract new businesses and to retain growing local businesses that require access to reliable, affordable, and secure broadband and broadband-enabled services.

The City shall consider how improved access to advanced technologies may enable the City to improve the quality and level of government services for the community. In essence, the City shall include such access in their Smart City planning.

The City will not, at this point in time, consider a ubiquitous fiber deployment to all Northampton premises. The City will approach the issue of expansion and repurposing of their existing broadband infrastructure with caution to minimize risk.

The City will maintain full control and ownership of their existing fiber network and any additional network elements, including fiber cable, installed in the City’s attachments in the communications space of the utility poles and within any conduit that the City may have occupancy rights.

These guiding principles pertain to the City’s existing municipal fiber infrastructure and any plans to expand that infrastructure in the future. Expansion of the municipal fiber network to private enterprise customers would require several preparatory steps to be taken by the City, described in this analysis, and would require the City to either act as retail ISP directly or establish a public-private partnership with an entity (or entities) willing to utilize the existing municipal fiber network as an access network, with extensions built to new end users, under the terms required by the City to ensure a competitively neutral, nondiscriminatory service that provides the required rate of return on the public funds.

One of those terms must be the private partner will rely on the City and the City’s subcontractors to maintain and service the municipal fiber optic network, even those parts the private partner is utilizing to serve business customers. The City will have to consider whether any new fiber installations outside the current municipal fiber network footprint will be owned and controlled by the City, the City’s private partner, or reviewed and approved on a case-by-case basis.

If private partners want to construct and own fiber extensions that will be physically interconnected into the City’s municipal fiber network, methods to establish “Meet-Me” or other formal Points of Interconnect demarcation points can be established. One beneficial result of the 1996 Telecom Act is that the communications sector has established numerous processes and procedures for enabling such interconnection between parties.

In addition to the issues of the construction, funding, and ownership of extensions to the fiber network that may be interconnected with the City’s network, control of network integrity,
which includes ongoing reliability and survivability, will need to be addressed with clear delineation of responsibilities and best practices.

While the City will not, at this time, formally consider the feasibility of a ubiquitous fiber-to-the-premises (FTTP) network throughout Northampton, it is possible that a private partner may choose to use the existing municipal fiber network to provide access to a particular neighborhood where they can then construct a small-scale FTTP system. But there is no guarantee that providing access to the municipal fiber network to a private partner will produce this result or that any private partner who may employ such access through an FTTP extension will generate an adequate return on investment to support the initial and ongoing costs of such an extension.

1.3 - Current State of the Municipal Fiber Optic Network
The City has an existing investment in a municipally-owned network that connects the public schools, libraries, and municipal buildings – a total of twenty-six buildings. Each of the twenty-six buildings that are served over the municipal fiber has a core switch installed that enables connectivity on the network.

This investment may enable the City to provide reliable, affordable, and secure broadband-enabled services to the Northampton community that they are currently connected:

- Six schools in the Northampton Public Schools
- Two Northampton libraries - Lilly and Forbes
- One school that is the Smith Vocational and Agricultural School District
- Seventeen municipal buildings

For the seventeen municipal buildings, the City provides and supports local area network connectivity, network security, Internet connectivity, and Internet Protocol Enabled Services such as VoIP. For the six schools in the Northampton Public Schools, the City supports local area network connectivity, network security, and Internet Protocol Enabled Services such as VoIP. Internet Connectivity at the schools is provided by a third party vendor to each individual building.

For the two libraries, and Smith Vocational and Agricultural School, the City currently provides and supports local area network connectivity and distributes the VoIP services that are purchased in bulk and routed over the City’s municipal network. IT support and network management responsibilities for the two libraries and Smith Vocational and Agricultural School lie outside the City’s Information Technology Services Department.

The City’s network has a central hub location at the Puchalski Municipal Building that is connected to each of the twenty-five other locations that are connected to the municipal network. As a hub, the City’s network hub location is the primary Point of Interconnection to
the locations that are accessible through the Northampton municipal network. This hub is also the location that is used by the municipal network to access the Internet.

Internet access, or Internet Transit for the City, is purchased from Comcast and provided to the municipal building hub by Comcast over coaxial cable as part of Comcast’s commercial network. The Internet access being purchased is for the needs of the City for municipal functions only in the seventeen on-net municipal buildings.

As part of the new VoIP System deployment and to address network reliability, the City is currently in the final stages of implementation to deploy a second hub on the municipal fiber network. When completed, the FD (Fire and Dispatch) Data Center shall serve as the primary hub and, for network reliability purposes, the City will replicate data between the FD and DPW in accordance with the City’s Disaster Recovery Plan.

The existing municipal network footprint has the potential to put reliable, affordable, and secure broadband Internet access within reach of many areas of the City that extend beyond the municipal functions of the City.

In addition to the public investment the City has already made in the City’s municipal network, the City is also allowed to use four strands of dedicated fiber on the Five College Network for non-commercial purposes. This is a result of the Five College Network having been built through Northampton; municipalities the Five College Network traverses obtained use of strands of fiber from that network that go from each city or town into the Springfield Data Center (“SDC”) located at Springfield Tech Center, STCC Technology Park, 1 Federal Street, Springfield, MA. The current Agreement for use of the four strands expires in February 2019. The use of the four strands of the Five College Network fiber is for ten years from the execution of the original Agreement which was February, 2009. The SDC is the region’s primary telecommunications facility, with numerous tier 1 Internet Transit providers selling Dedicated Internet Access in a wholesale, competitive environment.

Through the connection in the SDC, these four strands of fiber have the ability to provide the City, school districts, and libraries with a second option for cost-effective access to the Internet and Internet-enabled services. The three fibers that are not in use currently were tested during a scheduled maintenance event this spring. No issues were identified with any of the three fibers that were tested.

Currently, one strand of the Five College Network fiber is being used for a 20 Mbps connection that is used for all municipal departments to access the City’s cloud-based applications. The other three fibers are available for use by the City to: i) reduce their cost of Internet access, ii) improve the quality of the Internet access, or iii) to reduce the cost and improve the quality of the Internet access for the City, the school districts, and libraries. Subject to further review, it has been contemplated that the 20 Mbps connection that is routed through the SDC could be groomed onto this new connection as well.
Today, both school districts, the libraries, and the City are paying retail prices for retail Internet access service for connections in Northampton. The Northampton Public Schools procure Internet access primarily from Comcast, with a single circuit provided by Crocker Communications using the MB123 network. Smith Vocational uses Comcast and the libraries procure Internet access through the library consortia CW MARS which resells retail Internet access. As a retail Internet service, the physical connection to the location or address being served and the Internet Transit are bundled together for a single service.

“The City will not, at this point in time, consider a ubiquitous fiber deployment to all Northampton premises. The City will approach the issue of expansion and repurposing of their existing broadband infrastructure with caution to minimize risk.”

The cost and quality of Internet access are exacerbated due to the fact that each of these entities are buying their Internet access separately. Through the aggregation of the demand for all of these entities into a single location, such as the Northampton Hub or the SDC, the individual purchases of bandwidth can be aggregated into a larger bandwidth purchase. The use of a larger “pipe” to the Internet will improve the quality of the service simply due to the lower contention of many small bandwidth connections versus one, or a few, large bandwidth connections. Additional efficiencies to reduce the cost and improve the quality of the Internet access or, more specifically, the end user Quality of Experience, are possible with the extension of the Dedicated Internet Access connection from the Northampton hub to the SDC. Issues such as network survivability need to be considered as services are aggregated in fewer locations with higher bandwidth per location.

2 - Use of the Five College Network Fiber Strands

2.1 - Current Status
When the 53 mile Five College Network was constructed, each town that it traversed received use of four strands of fiber connecting the town (or city) to the carrier-neutral data center located at 1 Federal Street, Springfield, MA (“SDC”). Many of the towns that have use of the fiber strands from the Five College Network are utilizing the fibers to procure Dedicated Internet Access directly at the SDC. The City entered into an Agreement with the Five College Net, LLC in February, 2009 that allowed the City to use four strands of the FCN network for a five-year term, that term renewed automatically for a second five-year term which expires in January 2019. The Five College Network, LLC has indicated that it intends to continue to renew its current Agreements with municipalities as long as the fiber network is viable. The current Agreement prohibits the use of the FCN strands for commercial or for-profit purposes.

Though the City has the right to use four (4) fiber strands of the Five College Network connecting the municipal network hub with the SDC, the infrastructure is currently dedicated to...
provide a single 20 Mbps circuit over a single fiber. Through the connection in the SDC, this circuit is used for all City departments to access the City’s cloud-based applications.

During a scheduled maintenance event this spring, the remaining three fiber strands were tested for readiness of operation. No issues were identified during the testing. If issues are identified during future maintenance events, they shall be brought to the attention of the Five College Network. The Five College Network is responsible for the ongoing maintenance of these City-controlled fiber strands.

2.2 - Recommendations for Revised Use of the Five College Network Fiber Strands
The City should obtain and compare pricing for the purchase of Dedicated Internet Access at a single node in both Northampton and the SDC. Given the efficiencies of providing service over as few connections as practicable, the pricing for the aggregated demand should provide the optimum price point. Reduced network contention on large network connections relative to many small connections will dramatically improve the Quality of Experience by the end users.

The capital expense (CAPEX) required to light and the operating expense (OPEX) to maintain the network between the Northampton hub and the SDC need to be identified. The CAPEX will include a bill of materials for this intercity segment. These costs will be compared against the cost of purchasing Dedicated Internet Access in Northampton. Based on the services available in Northampton and the services available in Springfield, decisions on the type of interface or port size will need to be determined. Generally, the most cost-effective ports are 1 Gbps or 10 Gbps. But 40 Gbps and 100 Gbps ports are now being deployed in many markets. A fundamental consideration should be the level of demand during the peak or “busy hours” of the day.

The costs to obtain Dedicated Internet Access in the Northampton hub and the SDC hub need to be identified and the bill of materials for the equipment and systems in each colocation to support the scope of service needs to be completed. The assessment will include the current and forecast cost of collocation space, power, cross connect fees and other related recurring and non-recurring cost to connect to Internet Transit in each location. These costs are incremental to the network costs noted in the previous paragraph.

3.0 – Network Design Considerations

In addition to the capital and operational expenses for the network and the recurring cost of Internet access, network reliability and survivability will be reviewed and comparisons of the current service, with aggregation in Northampton and aggregation in Springfield, shall be completed. Options to establish more than one path or connection to the Internet shall be identified and the cost to establish and maintain such additional network paths shall be identified and incorporated into recommendations for consideration by the City. The use of the Five College Network can be an integral element in this process.
In accordance with public procurement policy, it is envisioned that the issuance of one or more competitive RFPs may be required. Vendors who provide services in the SDC include Level (3), Sprint, Comcast, CenturyLink, Lightower, and Verizon. If purchased in sufficient quantity, Dedicated Internet Access is available at the SDC for below $1/Mbps/month. For example, estimates were recently obtained for a 10 Gbps port with a commit of 10 Gbps, the cost was $7,000 per month or $0.70 per Mbps. For a 10 Gbps port with a commit of 1 Gbps, the cost was $2,500 or $2.50 per Mbps. At a commit of 3 Gbps, the cost of Dedicated Internet Access (i.e., Internet connectivity) justifies the 10 Gbps commit rate. This crossover rate is central to the recommendation to aggregate demand at the highest level that is practicable and prudent. Prudence requires an understanding of the network being employed to access the aggregation node and the network being employed by the Dedicated Internet Access carriers to connect to one or more IP routers on the IP network used by each carrier.

Costs for a comparable carrier class service in Northampton can be quoted by Verizon, Comcast and Lightower and certain providers on the MB123 network. These would be costs for carrier class, Dedicated Internet Access with service level agreements that allow for the Dedicated Internet Access to be oversubscribed based upon industry standard oversubscription ratios and best practices. These oversubscription ratios are also known as contention ratios.

With adequate requirements for Dedicated Internet Access, a second "northern" route that would include Northampton going north to Cambridge for Dedicated Internet Access versus sending all of the traffic "south" through Springfield to Boston.

4 - Use of the municipal fiber network by the Northampton School Districts and Libraries, Analysis and Recommendations

4.1 - Current Status
Currently, even though every one of the schools in the Northampton Public Schools, the Northampton libraries, and the Smith Vocational and Agricultural School District are connected to the municipal fiber network and every location has a core network switch owned and managed by the City, the schools in both districts and the Northampton libraries use the fiber network only for voice services and local area network connections. The school districts do not use the municipal fiber network for Internet access. Instead, all of the schools in both school districts and the Northampton libraries procure Internet access from retail service providers, who sell Internet access bandwidth services to each location individually. In most markets, this approach generally results in the highest actual and effective cost for the services being purchased and the quality of the end user experience, which is also known as the “Quality of Experience”, is less than ideal due to the fact that the network capacity is limited to the individual bandwidth provided to each location versus the benefit of shared bandwidth for the aggregated bandwidth of all users.
The actual cost of the service is the price or amount paid for the service each month. The effective cost is the cost per Mbps of bandwidth received during the end users’ peak usage during a day. If the end user’s peak usage is coincidental with the peak usage when the oversubscription or contention ratio is in effect, then the Quality of Experience for the end user will be lower as the effective bandwidth is lower for each end user.

This contention ratio limits the units of bandwidth that each user has access to during the peak usage period due to the fact that the bandwidth connection to the Internet is shared. Service providers are generally not willing to reveal the contention ratios they have established in their networks and when they are willing to share the ratios, issues such as special events, time of day, or day of week can affect the ratios at any given time.

Oversubscription ratios of 50:1 for residential and 20:1 for business end users are not unusual. If the oversubscription ratio is 50:1 and every end user has a 10 Mbps connection with the service provider, the service provider will have a 200 Mbps connection to the Internet for every 1,000 customers who will be online during the peak access to the Internet. In essence, a total of 10 Gbps of demand will be routed through 200 Mbps of connectivity to the Internet. During the peak period or periods, end users will experience delay for many of the applications being used by the end users if the available bandwidth is less than the bandwidth required by the end users. The end users’ broadband speed, as measured with an Internet speed test with applications like speedtest.net, may be recorded at a slower rate than the rate provisioned to the end user location during a peak period. Ultimately, the end user will receive a lower Quality of Experience during peak periods when the service provider has a high contention ratio. The key point is that connectivity during peak periods with a service that has a high contention ratio will generally result in a poor Quality of Experience.

Speed tests can be manipulated. Through the use of some form of "burst" mode that many ISPs enable for a short period of increased bandwidth, a speed test can result in a higher bandwidth speed than the actual speed being received over a longer, normal use interval. And, if the ISP peers with the speed test websites or hosts the speed test servers within their network or choose to route speed test traffic over a more favorable route than “normal” Internet traffic, the results of speed test to identify normal usage may be distorted to record a higher bandwidth speed.

Based on the FY 2015 eligibility criteria, the Northampton Public Schools and Northampton libraries were eligible for a 50% E-Rate discount from the federal E-Rate system for Internet access and local area networking. Correspondingly the Smith Vocational and Agricultural District was eligible for a 60% E-Rate discount (see Table 1 below). That means that for every thousand dollars the school district pays a service provider for approved charges, the E-Rate system reimburses the district $500 with a 50% discount and $600 with a 60% discount. There are two beneficiaries to this arrangement, the school district (or libraries within the school district), which gets a significant discount, and the eligible service provider – who gets the business and 100% of the revenue. The City receives no financial benefit and the City’s
municipal fiber network receives no additional usage for Dedicated Internet Access to help with sustainability even though the City’s municipal network is present at each and every school.

As the E-Rate program moves to a data-centric model, the reimbursement for voice services is being reduced each year by an absolute reduction of 20%. The goal is to reduce the reimbursement for voice services to zero by the FY 2020 funding period. That is why the discount for service provided by Verizon are rated at 30 and 40%, respectively for the two school districts in Table 1, FY2015 E-Rate Program Committed Amounts.

It is anticipated that the enhanced connectivity of the City’s municipal network will enable both school districts and the Northampton libraries to access IP Enabled Services (IPES) such as VoIP at prices which will allow all of the recipients of the E-Rate discounts to continue to receive these required services even as the E-Rate program reduces and eventually eliminates discounts for those services. Access to IPES services such as VoIP should provide all of the schools and the libraries with affordable options for voice services.

These discounts are based on the participation in the Federal School Lunch program and the discounts are subject to affirmation each fiscal year. But, as a rule, they have been relatively consistent over periods of several years.

The City is encouraged to begin recovering their operational and capital costs through charges to the end user entities for the ongoing operational costs and the CAPEX reserves for the costs required to light and provide lit optical services. And the school districts are encouraged to leverage the municipal network to maintain or lower their actual cost of service and to improve the match between the effective cost for their services and the effective level of services that they require and purchase to support the education of the students in the community during all periods of usage.

And, while discussion is oriented to the schools, it should be recognized that the E-Rate program includes services for libraries at the same reimbursement level as the schools are able to document. The Northampton libraries, which are subject to the same discount as the Northampton Public Schools, were not listed as recipients of E-Rate support in FY-2015. If this is an oversight, the addition of the requirements for the libraries should be included in future E-Rate reimbursement requests.
The City can either register for E-Rate and bill services accordingly directly to the district, or the City can work with private partners who will participate in the E-Rate competitive bidding system using the resources of the City’s municipal network – the physical network, ongoing maintenance, Dedicated Internet Access, and, possibly, volume purchases of Internet Protocol Enabled Services such as VoIP. (Note, Internet Protocol Enabled Services, or IPES, is the designation that the FCC has provided for this category of services).

4.2 - Recommendations for Revised Relationship with Northampton Public Schools, Smith Vocational and Agricultural School District, and the Northampton Libraries to Leverage the Five College Network Fiber

The relationship between the City and the schools and libraries, as it pertains to use of the municipal fiber network, can be revised in a way that is mutually beneficial, allowing the school districts, libraries, and the City to aggregate their common requirements to obtain more robust Internet access at a lower cost and allowing the City to realize revenue from its municipal fiber network to contribute to the network’s ongoing sustainability.

The network components are already in place for every public school in the Northampton Public Schools, the libraries, and the Smith Vocational and Agricultural School District, to be able to utilize the existing municipal fiber network, as well as the existing City-owned core network switching gear, for Dedicated Internet Access. Additional VLANs can be added to the schools’ existing core switching gear to accommodate Internet connectivity provided by the City.

A single, large Internet connection should be less expensive on a per Mbps basis. In addition, the schools, libraries, and City are currently paying retail pricing for end user locations in Northampton. The City has use of four strands of fiber from the Five College Network that connect the City’s municipal network with the carrier neutral telecom facility in Springfield, MA, the SDC. Since this is a wholesale facility for carriers, Internet Transit, which is Dedicated Internet Access, should be available at the SDC at a significantly lower pricing per Mbps than retail pricing in Northampton.

The City should consider the benefits of aggregating the needs of the schools and the libraries and the City to achieve lower costs and improved quality of service by providing the school districts and libraries Internet access, intra-school district connectivity, bandwidth, and other IPES. This will provide a more reliable, affordable, and secure solution for the school districts, libraries, and City on a going-forward basis. It will also provide the City with a source of funds to offset the cost of the services that the schools and libraries are purchasing currently from Comcast and CW MARS or that the City is providing at no charge. These funds will contribute to the sustainability of the municipal network.
To provide enhanced network reliability, a redundant Dedicated Internet Access connection can be established using a path and nodal diverse service going north from Northampton to Cambridge on the MB123 middle mile network or the Lightower network.

4.2.1 - City as Managed Lit Fiber Services Provider to Northampton Public Schools and Libraries and Smith Vocational and Agricultural School District

Lit Services will enable intra-community connectivity between the schools and libraries as well as Internet access over network connections that are shared by each school district, libraries, and the City through the routers that are maintained by the City. While the intra-school connectivity is in place, this solution is distinctly different from the service that the schools and libraries are currently receiving from Comcast and CW MARS.

The City would either need the personnel on staff to directly support these managed lit services, or hire a subcontractor to support them. The municipal network’s architecture of a fiber ring with working and protect paths would allow for a very robust service offering. For the locations that are not on the physically diverse ring, a collapsed ring with a working and protect path in the same fiber path will be used. This is the approach that is currently in place.

In this scenario the City or its subcontractor could utilize the existing core switching electronics already installed at each school or library to furnish Internet access as well as local area network connectivity. Additional VLANs can be added to furnish Internet access, and access switches can be added at each location if needed and can be managed by either the City or the end user depending on the specific arrangement reached.

It is important to note that the City is basically already providing and supporting most of the services the two school districts and the libraries require. The City currently provides and supports local area network functionality to each school and each library, point-to-point connections between the Northampton Public Schools, and does so using the same managed lit service platform it uses to distribute VoIP service and other services to the schools and libraries. The same infrastructure can be leveraged to provide and support Internet access as well.

The current network utilization by the Northampton Public Schools includes local area networking for file sharing at no cost, however such local area network circuits typically have a cost associated with them as they do require network resources, and they should help to contribute to the sustainability of the municipal fiber network. Also, the E-Rate program has a specific prohibition of the provision of free services, requiring that the applicant pay the full undiscounted portion of any eligible service provided by the service provider who is providing the E-Rate services. Paragraph 41 of the FCC’s December 23, 2003 Report and Order on the Schools and Libraries Program (FCC 03-323) states:

“We also take this opportunity to clarify and amend our rules to codify a prohibition on the provision of free services to an eligible entity by a service provider that is also providing discounted services to the entity. The Commission requires that an entity must pay the entire
undiscounted portion of the cost of any services it receives through the schools and libraries program. For the purpose of this program, the provision of unrelated free services by the service provider to the entity constitutes a rebate of the undiscounted portion of the costs, a violation of the Commission’s rules.”

Since the City is not currently providing the E-Rate services, the schools and libraries are not in violation of the Commission’s rules. But, should the City become the provider of E-Rate services, it will be important to properly categorize and account for wide area network services, Internet access, local area network services and voice services so as to be fully compliant with the FCC’s E-Rate Program.

Also, it is important to note that the E-Rate reimbursement system, which has historically supported reimbursement for voice services, is currently phasing out all financial support for voice, to be completely phased out by 2020. Recent modifications to the E-Rate system will phase out the district’s reimbursement for voice services by an absolute reduction of 20 percentage points a year beginning in 2015. According to the E-Rate Modernization order of 2014: “This phase down will apply to all costs incurred for the provision of telephone services and circuit capacity dedicated to providing voice services, including: local phone service, long distance service, plain old telephone services, radio loop, 800 service, satellite telephone, shared telephone service, Centrex, wireless telephone service such as cellular, and interconnected VoIP.”

In order to be able to offer the most robust, future-proofed services available at the most affordable cost, the City would install and manage electronics at 1 Federal Street, Springfield, MA, the SDC, and also at the City’s network hub locations in Northampton to utilize the Five College Network fiber strands to transport Dedicated Internet Access the City purchases in Springfield into Northampton. The City will utilize a portion of that Dedicated Internet Access connection for its own municipal use and allocate a portion of Dedicated Internet Access for the managed lit services for the schools and the libraries. The City can continue to utilize the core network electronics to deliver and manage VoIP, as well as other existing applications.

This scenario would require the City to participate in the E-Rate reimbursement system, part of the Schools and Libraries Program, administered by Universal Service Administrative Company under direction of the FCC. The City would be able to participate directly by obtaining a 498 ID (formally known as a SPIN number) from the Universal Service Administrative Company, discussed further below in section 4.3.

4.2.2 - City as Dark Fiber Service Provider and Internet Access for the School Districts and the Libraries

It should first be noted that any dark fiber service would be limited to within Northampton, on the existing municipal fiber network, and would not include any of the Five College Network fiber between Northampton and Springfield.
In addition to a dark fiber solution, procurement of Internet access from the City by the school districts and libraries could also be provided either in tandem with the dark fiber or as a separate service. The Internet access will be purchased by the City at wholesale rates at the SDC, and made available to the school districts and libraries in Northampton, either at each school individually or at a central hub location if the school districts and libraries prefer that architecture. The Northampton Public School District and the Smith Vocational and Agricultural School District can procure services individually or as a consortium.

Recent changes to the E-Rate system allow the school districts to purchase electronics for dark fiber as a Category 1 reimbursement (previously this was Priority 2), and a dark fiber network allows the school district a future proof, scalable solution. The 50% and 60% E-Rate reimbursement would apply to a dark fiber lease between the City and the Northampton and Smith Vocational and Agricultural School District’s, respectively.

In this scenario there would be two services the City would be providing the school district: a dark fiber lease for strands on the existing municipal fiber network within Northampton, and Internet access delivered to the municipal fiber network from Springfield over the Five College Network fiber strands; and possibly over a redundant Internet connection going north to Cambridge. The Internet access service is a Priority 1 E-Rate filing as well and also subject to 50% and 60% reimbursement for each school district, respectively.

In this scenario the City and their subcontractor would manage the dark fiber infrastructure. The City’s responsibility would be for repairs of the physical fiber infrastructure only. The school districts would be responsible for managing the lit services and the network electronics they install on the dark fiber, including core and access switches, using the platform for LAN connections and WAN connectivity. The City would remain responsible to manage the lit service on the Five College Network fiber connection between Northampton and Springfield.

In accordance with the E-Rate program, the proposals from the school districts could include the purchase of the electronics in each school and library. Staff salaries and labor costs for personnel of the applicant or underlying beneficiary are not E-rate eligible.

This scenario would also require the City to participate in the E-Rate reimbursement system.

4.2.3 - City as Lit Service Provider to ISP of the School District’s Choosing
The school districts and libraries can also purchase lit services from an established ISP as a service provider using the City’s municipal network. In this role, the City would provide a wholesale lit service to an ISP of the school district’s choosing. This scenario would allow the school districts to utilize the municipal fiber network for Internet access while working with a third party ISP that is awarded the services contract in accordance with competitive service requests issued by each school district. In this scenario, based on an award from the competitive service request issued by each school district, the City would provide the third
party ISP a wholesale managed lit service that the ISP would use as a platform to provide the school districts with the services specified in the E-Rate competitive service request.

If the requested services included Internet access and the City is awarded the service request from the competitive bid, the City would bundle the managed lit service platform with Internet access. The proposals should note where the Internet access is to be delivered to the ISP.

In this scenario the City must have the staff in place, or utilize a subcontractor, to manage lit services on behalf of an ISP. The ISP would essentially be reselling the lit service platform to the school district. In accordance with the services proposal issued by each respective school district, the ISP would interconnect the other services being purchased by each school district.

The City or its subcontractor would be responsible to operate and manage the electronics necessary to provide the lit service platform in Northampton, as well as the Internet access service from Springfield, if Internet access was included in the services proposal. This scenario would also allow the school district to utilize more than one ISP if they defined such an approach in their services proposal.

This scenario would allow the school district to work with a third party ISP.

For the City, lit services enable a more efficient utilization of the individual fiber strand assets.

As a dark fiber service, specific fiber strands would have to be allocated or dedicated for that use and could not be utilized for any other purpose.

By providing a managed lit service to either the district or an ISP, the lit service can be multiplexed or added into the traffic on a fiber that is being utilized for other purposes. A single fiber can be used for local area networking, Internet access, VoIP and other services, all broken out as discrete, individual services at the electronics managed by the City or its subcontractor. In addition, all existing core networking infrastructure is already in place to furnish this solution.

This scenario would not require the City to participate in the E-Rate reimbursement system. The ISP(s) the district chooses to work with would have that responsibility.

4.2.4 - City as Dark Fiber Provider to the ISP of the School District’s Choosing
If the school districts, individually or collectively, choose to work with a third party ISP, the City can also address this by providing a managed dark fiber service to the ISP that is awarded the competitive services proposal.

The service provider who bids with the City’s network must win the competitive services proposal for dark fiber. Recognizing the City is the only provider with fiber connectivity to the schools and libraries, it is highly probable that the City municipal network would win any award
that required a dark fiber optic network but, other interested parties could bid to deploy dark fiber to the locations cited in the proposal for services.

If the services proposal includes a requirement for Internet access, the City should bundle this dark fiber service with an Internet access service as a package deal to the ISP to further network utilization and sustainability.

Similar to the scenario above the City would be responsible for operation and maintenance of the physical dark fiber infrastructure only within Northampton, and the ISP would be responsible for managing the lit services provided to the school district. However, the City or its subcontractor would be responsible for managing the lit service between Northampton and Springfield, if Internet access was included in the award and the City’s dark fiber or Internet access services were selected by the service provider who is awarded the services proposal.

This scenario would not require the City to obtain a 498 ID as an E-Rate service provider and the City would not have to participate in the E-Rate reimbursement system. In this scenario the ISP, or ISPs, who is awarded the competitive service proposal or proposals, must have a 498 ID.

4.3 - Steps Necessary for the City to Participate in the E-Rate System
Prior to 2011, schools and libraries could purchase E-Rate eligible services only from regulated telecommunications carriers, which excluded many public service providers. However, starting in 2011, the FCC modified the E-Rate program to allow schools and libraries to purchase E-Rate qualified telecommunications services and Internet access from any entity, including municipalities.

The E-Rate program is part of the Schools and Libraries Program administered by the Universal Service Administration Company (“USAC”), under direction of the FCC. Typically, USAC programs require an entity to obtain Eligible Telecommunications Carrier (ETC) designation in order to participate. For the Schools and Libraries Program (“E-Rate”), ETC designation is not a requirement, but service providers are required to obtain a 498 ID (formally a SPIN number) in order to receive approved disbursements from USAC for services that are supported through the E-Rate program.

Typically, participants in the E-Rate reimbursement system are required to contribute to the Universal Service Fund (USF). However, the City, as a service provider only to itself and the school districts and possibly libraries, would be considered a non-common-carrier entity. A non-common-carrier entity providing interstate telecommunications exclusively to public safety or government entities that do not offer services to others is explicitly exempted from contributing directly to the universal service support mechanisms.

Contributions to the USF would be required on revenue from services provided to any non-municipal entity, above a certain threshold, and participation in the USF, even only to make contributions, also requires ETC designation.
To apply for a 498 ID (formerly a Service Provider Identification Number) an applicant must first obtain a Dun & Bradstreet (DUNS) number and register with the FCC’s Commission Registration System (CORES), upon registration the City will be issued a FCC Registration Number (FRN).

The first category of supported services, Category One, includes the services needed to support broadband connectivity to schools and libraries. Eligible Category One services are listed in the entries for data transmission services and Internet access and voice services. This category consists of the services that provide broadband to eligible locations including data links that connect multiple points, services used to connect eligible locations to the Internet, and services that provide basic access to the Internet. With the exception of dark fiber and self-provisioned broadband networks, maintenance and technical support appropriate to maintain reliable operation are only eligible for support when provided as a component of these services.

4.4 - Regulatory Requirements

The Communications Act of 1934, as amended, requires that the Federal Communications Commission establish mechanisms to fund universal service (USF), interstate telecommunications relay services (TRS), the administration of the North American Numbering Plan (NANPA), and the shared costs of local number portability administration (LNPA). To accomplish these congressionally directed objectives, the Commission requires telecommunications carriers and certain other providers of telecommunications (including Voice-over-Internet-Protocol (VoIP) service providers) to report each year on the Telecommunications Reporting Worksheet the revenues they receive from offering service. The administrators of each of these programs use the revenues reported on this Worksheet to calculate and assess any necessary contributions. The Commission also uses the revenue data reported on this Worksheet to calculate and assess Interstate Telecommunications Service Provider (ITSP) regulatory fees.

With very limited exceptions, all intrastate, interstate, and international providers of telecommunications in the United States must file a 499A for (annual filing) and 499Q (quarterly filing). In addition to filing this form most filers must contribute to the universal service, TRS, NANPA, and LNPA funding mechanisms.

Exception for government, broadcasters, schools, and libraries:
The following non-common-carrier entities are explicitly exempted from contributing directly to the universal service support mechanisms and need not file this Worksheet unless they contribute to TRS, LNP, or NANPA:

- Government entities that purchase telecommunications services in bulk on behalf of themselves, such as state networks for schools and libraries.
• Public safety and local governmental entities licensed under Subpart B of Part 90 of the
Commission’s rules or any entity providing interstate telecommunications exclusively to
public safety or government entities that do not offer services to others.

• Broadcasters, non-profit schools, non-profit libraries, non-profit colleges, non-profit
universities, and non-profit health care providers.

Exception for USF de minimis telecommunications providers:
Telecommunications providers are not required to contribute to the universal service support
mechanisms for a given year if their contribution for that year is less than $10,000.

• Providers that offer telecommunications for a fee exclusively on a non-common carrier
basis need not file this Worksheet if their contribution to the universal service support
mechanisms would be de minimis under the universal service rules. Note that entities
providing solely private line service may nevertheless be considered common carriers if
they offer their services directly to the public or to such classes of users as to be
effectively available directly to the public.

Summary: if the City limits its telecommunications services to municipal locations, which
includes schools and libraries, the City would qualify as a non-common-carrier as a government
entity (and likely as a de minimus telecommunications provider as well) and would be exempt
from ITSP fees and exempt from quarterly filing requirements. These regulatory requirements
are discussed further as it pertains to the possibility of the City providing telecommunications
services to non-municipal entities in section 6.1.4.

If the City were to expand their services to include offering services to the public as a common
carrier, the de minimis exception would need to considered.

At this time, based on the fact that the scope of review is focused on expanding the services to
include E-Rate for schools and libraries, the de minimis exception has not been considered
further.

4.5 - Relevance of the Municipal Light Plant statute to This Relationship
The formation of a Municipal Light Plant under Massachusetts General Law is not required for
the City to obtain a 498 ID and participate in the E-Rate system. The general purpose of the
Municipal Light Plant statute is to allow a municipality to form an entity that will be legally
recognized as a utility within Massachusetts, and subject to regulation as a utility only in those
areas where the Commonwealth has jurisdiction.

The primary advantage to forming a Municipal Light Plant would be to allow the city to use its
fiber optic network to serve locations that are not public locations. The City’s current
agreements with the utility pole owners (National Grid and Verizon) and the conduit owner
(Verizon) for the placement of the municipally owned fiber network allows for only municipal
use. And this arrangement is perfectly satisfactory even if the City chooses to become the E-Rate eligible service provider to both school districts and libraries.

However, if the City decides to expand the reach of the municipal fiber network to non-municipal end users, such as business customers, a portion of the City’s pole attachment agreements would have to be transferred from municipal-only agreements to utility agreements, and new pole attachments necessary to serve new non-municipal end users would have to be utility agreements. Municipalities by themselves cannot enter into utility agreements, but Municipal Light Plants can.

The formation of a Municipal Light Plant need only be considered by the City to serve non-municipal customers using the municipal fiber network.

The creation of a Municipal Light Plant is discussed further below in section 6.1.1.

5 - Broadband Assessment for Potential Commercial Use of Municipal Fiber Network

While the City should consider leveraging its existing municipal fiber network to provide high bandwidth, low cost services as an economic development tool, extending the City’s municipal network beyond the current locations of the schools, libraries, and municipal buildings will result in many changes to the cost structure of the City’s municipal network.

As noted in sections 4.5 and 6.1.1, the cost for pole attachments will be subject to an increase in the annual cost. Also, as noted in section 2.1, the City is currently prohibited from using the four FCN strands between Northampton and the SDC for commercial or for-profit use and they could not be leveraged for this purpose based on the existing agreement between the City and Five College Net, LLC.

The City should limit their risk or financial exposure through an incremental approach. The first increment was to reduce the cost of leased communications services by building the municipal network. The second increment is to expand the scale of the network by expanding the scope of services for the schools and libraries. Part of the expansion to include schools and libraries is a complementary requirement to begin charging schools and libraries for the services that they receive. Most of those services are subject to a discount from the E-Rate program. The third increment is to expand to include users of broadband and broadband-enabled services that are on or near the municipal network. The cost to extend the network and the time to recover the cost through the monthly fees will determine the focus.

Typically, end users who have the largest bandwidth requirements will be the customers who justify the cost for extending the network.
But, as the City plans capital projects such as road repairs, traffic signals, and water mains, expansion of the network should be considered. Public and private requirements for fiber networks should also be considered. Many communities embrace a “dig once” public policy where if there is a project in the municipality that requires trenching, a municipal requirement to install conduit for fiber optics will be included. This can be one of the attributes of a Smart City plan. In essence, a Northampton Municipal Network Master Plan that will incorporate outside plant projects and the fiber needs of the public and private sectors should be developed and maintained as a living document. The Master Plan will need to address locations, complementary capital projects, timelines, costs, preferred technology, and potential revenues.

If the City does proceed with plans to leverage its existing municipal fiber network to business customers, one of the first steps to be taken, especially given the long lead times involved, would be to start the process of voting to form a Municipal Light Plant (MLP). A MLP will give the City an entity that is legally recognized as a utility in Massachusetts with the legal right to attach to third party utility poles for commercial purposes. The municipality itself does not have this right, a MLP as a utility does. The formation of a MLP is discussed in detail below in section 6.1.1.

In practical terms, as Northampton has a competitive telecommunications market with multiple ISPs, if the City were to form an MLP to act as an ISP, the lit services offered by the City’s MLP should start at 1Gbps symmetrical and scale up to 10Gbps symmetrical, and these services will be classified as carrier class service, with dedicated bandwidth and service level agreements suitable for enterprise level customers. Dedicated bandwidth means that service performance will not be affected by other network users, as it is with residential and small business grade service offerings. This is the market the City’s MLP can consider addressing using an incremental approach.

**5.1 - Incumbent Services and Pricing**

In addition to their residential, small and medium business services, Comcast provides enterprise level, fiber based services including Dedicated Internet Access and Metro Ethernet services such as Ethernet Private Line and Virtual Private Line. Comcast can provide Internet access circuits and transport circuits up to 10Gbps.

In the enterprise marketplace, Verizon also offers services such as Ethernet Virtual Private Line, LAN Extension Service as well as Optical Wave Service (wavelengths), Transparent LAN Service, point-to-point Ethernet and Dedicated Internet Access. Verizon can provide up to 10Gbps Dedicated Internet Access.

Lightower owns fiber in Northampton that was part of the Fibertech network acquisition. The fiber is the northern tip of a fiber ring extending into the SDC at 1 Federal Street, Springfield. Below aerial fiber is in purple and fiber in conduit is in light blue.
Lightower offers dark fiber on a case-by-case basis, Metro Ethernet compliant services including MetroE Advanced Private Line, Ethernet Virtual Private Line and Ethernet Private LAN, Wavelength service and business class Dedicated Internet Access.

DSCI also offers a complete set of Metro Ethernet services, MPLS VPN service, business class Dedicated Internet Access and SIP trunking, but they do so by reselling the Verizon wholesale access platform. DSCI generally does not offer dark fiber.

Carriers utilizing the MB123 wholesale, open access network can provide Ethernet Private Line, Ethernet Private LAN, Dedicated Internet Access and wavelength services. The more limited footprint of the MB123, compared to Verizon or Comcast, creates the probability of high construction costs associated with serving new customers. However, the MB123 currently represents the most cost effective delivery platform for carrier class, enterprise level services, and therefore represents the competitive benchmark pricing level the City’s MLP would need to beat in order to successfully utilize its existing municipal fiber network to serve non-municipal end users. The MB123 is also the more directly comparable to the City’s existing municipal fiber network because of its limited footprint. Built to connect only public-use buildings originally (Community Anchor Institutions) connecting any new end user to the network requires construction, including utility pole and conduit make ready, and including splicing that new fiber extension into the existing network fiber. These construction costs can be amortized over the contract term or paid as a lump sum. New connections to the Northampton fiber network would have similar requirements.

5.2 - Competitive Landscape
While most carriers providing service in the Northampton market are large incumbents with extensive network footprints throughout the commonwealth and beyond, the reach of the Northampton fiber network is considerably more local. While companies such as Verizon and Comcast can offer point-to-point services between locations almost anywhere in the region, the Northampton network will be limited to offering point-to-point connections only within Northampton, unless arrangements are made with third party providers to complete circuits, most likely with a handoff or interconnection at the SDC located at 1 Federal Street, Springfield.
Given the localized aspect of the Northampton municipal fiber network, and unless third party networks are used to complete non-local point-to-point circuits, the primary service offerings of the Northampton MLP will be enterprise class, Dedicated Internet Access and point-to-point (or point-to-multipoint) circuits within Northampton. It should be noted that if the City decides to pursue a public private partnership approach to retail services, discussed below, that private partner can be the entity utilizing third party networks in order to complete point-to-point circuits where one party is not within Northampton.

Enterprise class services, as we are defining them here, include 1Gbps symmetrical connections, either as a point-to-point circuit between end users or as an Internet access circuit, and go up to 10Gbps symmetrical circuits. If the City’s MLP receives a qualified request for a larger bandwidth service, they can be evaluated on a case by case basis. Both Ethernet and wavelength hardware have 40Gbps and 100Gbps options, though far more expensive than 10Gbps hardware.

“A carrier utilizing the MB123 wholesale open access network to provide service to a business customer in Northampton would charge approximately $4,000-$5,000/mo for a 1Gbps symmetrical Dedicated Internet Access service. This represents costs of $1,200/mo for the MB123 circuit between Northampton and 1 Federal Street, Springfield, and between $2,500 and $3,000/mo for carrier class Internet access in 1 Federal Street, Springfield, plus retail markup. Costs can vary depending on the specific amount of oversubscription allowed on the Internet access. The Dedicated Internet Access available in 1 Federal Street, Springfield comes with a robust service level agreement suitable for carrier customers. Only the largest enterprise customers will require similar service level agreements, and 1Gbps of Internet access from a tier 1 Internet transit provider such as Level (3) can be resold by the Northampton MLP to multiple customers whose total aggregate service obligation is more than 1Gbps. This oversubscription is industry standard and there are standard oversubscription ratios and best practices that can be followed.

6 - Feasibility of the Municipal Fiber Network Being Leveraged to Serve Business and Enterprise Customers

It is not uncommon for a municipal network, built originally for the purpose of serving only municipal locations, to grow sufficiently in reach and services such that it can be utilized to provide service to non-municipal locations.
Once prominent example is the City of Santa Monica, CA. As noted in Community Broadband Networks review: [https://muninetworks.org/reports/santa-monica-city-net-case-study](https://muninetworks.org/reports/santa-monica-city-net-case-study). Starting in early 1989, Santa Monica created the first municipally owned and operated Public Electronic Network (PEN). The PEN featured e-mail, schedules of city events, and a discussion board that were accessed using public terminals in public locations. The success of this service was the catalyst for the municipal network that Santa Monica operates today.

From the Community Broadband Networks link:

“The first goal of the network was to save public dollars by eliminating leased lines from private providers. The first $530,000 investment in fiber infrastructure ultimately resulted in an ongoing savings of $700,000 per year. As part of their long-term strategy, the City reinvested those savings in expanding the network. Over the past ten years, the network has expanded to offer dark fiber and services of 100 Mbps to 10 Gbps to area businesses as well as free Wi-Fi to the public in many areas.

Money that could have been spent on leasing slower, less reliable connections from existing providers has instead been used to expand public infrastructure and other public amenities. Free Wi-Fi, public safety video cameras, and real-time parking info are just a few niceties that enhance the quality of life in Santa Monica.”

Santa Monica has leveraged investment that was recovered through reduced costs to incrementally grow network capabilities throughout their city.

The City of Northampton has already made an investment to construct, operate and maintain the municipal fiber network. With a small increase in those existing operating costs, and some reorganization, that investment can be leveraged to increase revenue from the network, reduce the effective costs, and more importantly, provide a foundation for economic development growth within the City.

The determination about what business and operational model to follow when transitioning from a municipal only network to one that serves private enterprise is the most important consideration for the City. Options for the city range from an infrastructure provider offering only dark fiber, to a wholesale only provider to retail ISPs who in turn serves end users, to a retail ISP serving end users directly.

Since the City has been operating their fiber network as a purely municipal network to date, several changes would be required in order to operate as anything other than a municipal only network, including but not limited to an infrastructure provider, wholesaler or direct retailer. Some of these changes will require a capital outlay and some will require assuming monthly recurring costs the City is not currently obligated to pay, but the ability to monetize the existing municipal fiber network may allow the City to cover any additional costs and produce revenue in excess of any additional costs. The profit, or funds left after paying the expenses, will enable the City to use broadband as an economic development tool.
### 6.1 - Steps Necessary for the City to Use the Fiber Network for Non-Municipal Purposes

In 2015 the FCC classified Internet Service Providers ("ISPs") as common carriers for the purpose of enforcing net neutrality. To provide telecommunications services to non-municipal entities the City will need to form a separate legal entity that could be considered a common carrier. While it is possible there may be more than one way to achieve this, Massachusetts General Law Chapter 164 allows the City to create a Municipal Light Plant, originally intended for the creation of municipal electric utilities and expanded to include telecommunications utilities. Creation of a Municipal Light Plant would unambiguously give the City the separate legal entity required.

A certain number of the City’s pole attachment licenses and conduit occupancy agreements that are currently specifically for municipal-only use of the network would need to be transferred to licenses and agreements allowing for both municipal and commercial use. The formation of an MLP would also satisfy this requirement as MLPs have the legal right to attach to utility poles for commercial use.

As the existing Agreement for the City’s use of the four FCN fiber strands prohibits commercial and for-profit use, alternate transport to the SDC would have to be utilized, or Dedicated Internet access would have to be procured in Northampton, or the City would need to request approval from Five College Net, LLC.

### 6.1.1 - Municipal Light Plant Creation

Massachusetts General Law Chapter 164, Section 47C, allows the City to create a Municipal Light Plant (MLP) which would be allowed to form a cooperative public corporation for the purposes of furnishing utility services. Utility services can be limited to telecommunications services.

A Municipal Light Plant is a not-for-profit, citizen-owned utility corporation. Municipal Light Plants are authorized under MA General Law and certified by the MA Secretary of State to provide telecommunications, electricity and energy services. MLP designation is not granted by or up to the discretion of the Massachusetts Department of Telecommunications and Cable (MDTC), rather it is achieved with compliance to Massachusetts General Law Chapter 164, Section 35.

Once MLPs are formed, they are then subject to regulation by the MDTC, where applicable.

Massachusetts General Law Chapter 164, Section 35 states: “A city shall not acquire such a plant until authorized by a two thirds vote of its city council, or of a majority of the commissioners if the city government consists of a commission, passed in each of two consecutive municipal years and thereafter ratified by a majority of the voters at an annual or special city election. If such a vote is not ratified, no similar vote shall be submitted for
ratification within one year thereafter. “ The wording “shall not acquire such a plant” refers to MLP creation, and in the case of the City, creation of a MLP including the assets of the existing municipal fiber network.

The City can create a MLP from scratch, or utilize their IT Services Department and its existing resources to form the MLP. For example, when nearby Greenfield formed their MLP in 2015/2016 they chose to utilize the existing Greenfield Technology Department and transition it into the newly formed MLP, incorporating the existing responsibilities of the Technology Department and expanding those responsibilities, and resources, to accommodate the duties of the MLP.

Though the Massachusetts Municipal Light Plant legislation was originally intended to address electric generation and distribution, it has since been amended to include telecommunications networks and services. Massachusetts General Law Chapter 164, Section 47E states: “A municipal lighting plant or a cooperative public corporation and any municipal lighting plant member thereof, established pursuant to this chapter or any general or special law may construct, purchase or lease, and maintain such facilities as may be necessary for the distribution or the operation of a telecommunications system for municipal use or for the use of its customers. Such municipal lighting plant may incur debt for such facilities by a vote taken in the manner prescribed pursuant to section 8 of chapter 44. Such cooperative may incur debt for such facilities pursuant to the provisions of section 47C. Such facilities may include suitable land, structure, machinery, other apparatus and appliances for operating a telecommunications system. Such cooperative or municipal lighting plant, which is engaged in the business of operating a telecommunications system, may, as a part of such business, if an appropriation is made therefor, rent, lease, or sell for cash or credit at prevailing retail prices, install and service, within the territory served by such business, merchandise, equipment, utensils and chattels of any description which are incidental or auxiliary to the operation of said telecommunications system or the use of its customers or are necessary or expedient in the protection or management of its property used in such business. Wherever apt, the provisions of this chapter and chapter 44, which apply to the operation and maintenance of a municipal lighting plant, shall apply also to the operation and maintenance of such telecommunications system.”

It is worth noting that recently a small western Massachusetts town, Mount Washington, which plans to deploy and own (but not operate) its own last mile broadband network, was successful in a home rule petition filed by State Sen. Downing and State Rep. Pignatelli, and enacted as S. 1978, authorizing the town to own, operate and borrow for up to twenty years to construct a broadband last mile system without establishing a municipal light plant. However, it remains unclear how Mount Washington will be able to successfully obtain non-municipal attachment agreements from the utility pole owner(s) without a MLP utility.

Google has been pursuing pole attachments and conduit occupancy agreements without a utility authorization. While municipalities and electric utility companies have supported such attachments and occupancy with commercial agreements, poles and conduits owned by
telecommunications carriers have provided Google with quite a bit of difficulty in the timely completion of commercial agreements.

6.1.2 - Pole Attachment and Conduit Occupancy License Transfers and Fees
The City currently has pole attachment agreements with the utility pole owners (National Grid and Verizon) that are defined as for municipal use only. As such, the City does not have to pay the pole owners any monthly recurring fee to have their fiber attached to the utility poles or placed inside Verizon conduit. In order to utilize the fiber network for purposes other than municipal, the City would need to have at least a portion their pole attachment agreements and conduit occupancy licenses transferred from municipal-only use to standard carrier attachment agreements.

MLPs have the legal authority to enter into agreements with utility pole and conduit owners to attach as a carrier offering commercial services available to non-municipal locations. To continue serving only municipal locations, including schools and libraries, the City’s existing municipal use only pole attachment agreements, which limit network use to only specific municipal locations, are sufficient. The existing municipal use only attachment agreements have no recurring fees associated with them, the attachment agreements allowing for commercial use of the network would have recurring fees associated with them of approximately $14/pole/year. This fee is determined and regulated by the Massachusetts Department of Telecommunications and Cable.

It is possible only a limited subset of utility poles the existing municipal network is attached to would need to have their licenses transferred in this manner. For example, if a new business customer was to be served, a fiber strand would be employed between the customer’s location and the Municipal network hub. The MLP should attempt to relicense only the utility poles involved with this fiber route, limiting the additional recurring costs of carrier pole attachments. The MLP should attempt to limit license transfers to these limited, case-by-case scenarios, and not ubiquitously transfer all licenses. Percipio cannot guarantee that the utility pole owners will be completely cooperative with this process but, the April 2011 Federal Pole Attachment Report and Order and Order on Reconsideration, FCC 11-50, provided statutory requirements on access, enforcement, and pricing for pole attachments and conduit occupancy.

In the case of requests for commercial agreements by service providers who do not have access to poles or conduits in accordance with the Communications Act, as amended or in accordance with state law as mandated by the Massachusetts MLP, history has established that telecommunications carrier pole owners have not traditionally provided much cooperation in the timely completion of mutually agreeable commercial agreements.

The process to transfer attachment agreements and conduit licenses will involve filing the necessary paperwork with the pole and conduit owners and navigating the ensuing processes to ensure there is no actual make-ready work required on the utility poles. Theoretically the agreement and license transfer should not trigger any actual make-ready work, but it does
trigger a review process for the pole owners and their response to the transfer requests, and
the costs involved for their review and any work involved, should be monitored and even
handled by a specialty subcontractor.

6.1.3 - Regulatory Requirements
As discussed above in section 4.4, the Communications Act of 1934, as amended, requires that
the Federal Communications Commission establish mechanisms to fund universal service (USF),
interstate telecommunications relay services (TRS), the administration of the North American
Numbering Plan (NANPA), and the shared costs of local number portability administration
(LNPA). To accomplish these congressionally directed objectives, the Commission requires
telecommunications carriers and certain other providers of telecommunications (including
Voice-over-Internet-Protocol (VoIP) service providers) to report each year on the
Telecommunications Reporting Worksheet the revenues they receive from offering service.
The administrators of each of these programs use the revenues reported on this Worksheet to
calculate and assess any necessary contributions. The Commission also uses the revenue data
reported on this Worksheet to calculate and assess Interstate Telecommunications Service
Provider (ITSP) regulatory fees.

With very limited exceptions, all intrastate, interstate, and international providers of
telecommunications in the United States must file a 499A for (annual filing) and 499Q
(quarterly filing). In addition to filing this form most filers must contribute to the universal
service, TRS, NANPA, and LNPA funding mechanisms:

1. Federal Universal Service Fund — Entities that provide interstate telecommunications to the
public for a fee as well as certain other providers of interstate telecommunications must
contribute to the universal service support mechanisms. See 47 C.F.R. § 54.706

2. Telecommunications Relay Services — Every common carrier providing interstate
telecommunications services and every VoIP provider (including interconnected and non-
interconnected) must contribute to the TRS Fund. See 47 C.F.R. § 64.601(b), 64.604

3. Non-Interconnected VoIP Service Providers — All providers of “non-interconnected VoIP
service” (as defined in section 64.601(a) of the Commission’s rules) with interstate end-user
revenues subject to TRS contributions must file this Worksheet in order to register with the
Commission and report their revenues for purposes of calculating TRS contributions.

4. North American Numbering Plan Administration — All telecommunications carriers and
interconnected VoIP providers in the United States shall contribute to meet the costs of
establishing numbering administration. See 47 CFR § 52.17

5. Shared Costs of Local Number Portability — The shared costs of long-term number
portability attributable to a regional database shall be recovered from all telecommunications
carriers and interconnected VoIP providers providing service in that region. See 47 CFR § 52.32
6. ITSP Regulatory Fees – Congress requires the Commission to assess and collect regulatory fees “to recover the costs of ...enforcement activities, policy and rulemaking activities, user information services, and international activities.” See 47 C.F.R 159(a)

Entities that provide interstate telecommunications to the public for a fee as well as certain other providers of interstate telecommunications must contribute to the universal service support mechanisms.

**Exception for USF de minimis telecommunications providers:**
Telecommunications providers are not required to contribute to the universal service support mechanisms for a given year if their contribution for that year is less than $10,000. Telecommunications carriers providing telecommunications services on a common-carriage basis and interconnected VoIP providers need not contribute to the universal service support mechanism if they meet the *de minimis* standard. However, they must file this Worksheet because they must contribute to other support mechanisms (TRS, NANPA or LNPA). Such providers need not file an FCC Form 499-Q.

If the City chooses to act as an ISP and offer service to non-municipal entities, the City should adopt business practices that limit their cost of regulatory oversight. For example, providers of interconnected VoIP are subject to many of the regulatory fees discussed above, but if the City works with an interconnected VoIP provider who can verify they are fully compliant with all relevant regulatory fees, the City’s activities could then be limited to data which is not considered a regulated service for the purpose of the above listed funding mechanisms. The City could also continue to provide VoIP, through their vendor, to only municipal end users, and offer a data only service offering to non-municipal end users. As a data-only service provider, the City would be able to limit the amount of regulatory oversight and regulatory fees they are subject to.

With respect to certification as service provider and as an Eligible Telecommunications Carrier (ETC), the FCC has been very prominent in asserting their primacy in the regulation of IP Networks and IP-Enabled Services. This primacy includes the issuance of certification as an IPES and ETC when the services being provided are not subject to the jurisdiction of a state commission. For IPES such as VoIP, the FCC has also authorized providers of Interconnected VoIP to obtain access to their own telephone numbers. The MLP’s retail service offerings and operational model will largely determine its regulatory requirements.

**6.2 - Business and Operational Model Options for Non-Municipal Service Offerings**
The City must decide which business model and operational model to pursue prior to taking any substantive steps forward. Each option has unique features and requirements, and each has a unique timeline in order to be fully executed.
For each business and operational model, the City will need to understand how the cost and means to attach to poles and occupy conduit if they do not complete an MLP. For the purposes of section 6.2, it is assumed that the City will become a Municipal Light Plan in accordance with Massachusetts law or the City will have identified other options for pole attachments or conduit occupancy.

With respect to conduit, many municipalities, in accordance with Rights-of-Way, have implemented “Dig Once” requirements that include the addition of conduit or conduit and fiber that the City has ownership, in lieu of ROW fees or for a reduction of ROW fees. But, if the municipality is in an area where request to install conduit are limited, this is not a viable immediate term option.

6.2.1 - Infrastructure Provider

Being an infrastructure provider means the City would provide only passive network elements to its customers, and not any managed lit services. Dark fiber is the primary product of infrastructure providers. Occasionally conduit space, colocation space or other discreet network elements are also made commercially available by infrastructure providers. Dark fiber is most commonly leased for a term with a monthly recurring charge, or a long term Indefeasible Right of Use (IRU) can be used, which is a capital lease of dark fiber. Generally dark fiber leases and IRUs are priced with respect to distance, on a per strand mile basis. Since there is virtually no provider of dark fiber currently within Northampton, it is challenging to determine an appropriate market price based on competition.

There are many municipalities deploying fiber optic cable for the purpose of economic development currently. These municipalities can be reviewed to determine if a market price can be determined. But many of these municipalities are building their fiber optic networks because the incumbent providers of communications services are not willing to invest the funds required for a ubiquitous fiber network deployment throughout the municipality. As such pricing based on similar market conditions may not be appropriate.

In this scenario, the City’s MLP would essentially be dark fiber provided to end users, and/or to ISPs using the dark fiber to serve end users.

Should the City embrace the development and maintenance of a Municipal Network Master Plan, as discussed in section 6, network expansion will be completed in accordance with the Master Plan. Whether in accordance with the Master Plan or on a case-by-case basis, a typical build scenario would involve identifying a new area, obtaining a construction quote to build a new fiber extension to that area, including all third party make ready costs, and after approvals, splicing the new area into the existing municipal fiber network.

The lack of dark fiber capacity outside of Northampton would be a challenge for the City as a dark fiber provider. It may be more prudent to include dark fiber as an available service, on a case-by-case basis, while offering managed lit services including Internet access as a primary
service. Both lit and dark fiber services is commonplace, and dark fiber is often relegated for use by only very large enterprise customers, priced in such a way so as not to cannibalize the market for lit services which are much more economical for the City to provide. Also, the use of dark fiber from the existing municipal dark fiber network must be approached carefully and an engineering plan for the availability and proper allocation of dark fiber per network segment must be developed. Once a strand of fiber is in use as a dark fiber service for a customer, that fiber strand cannot be utilized by any other customer.

The City can also consider offering wavelength service, often considered a substitute to a dark fiber service. While multiple customers can have individual wavelengths, usually 10 Gbps up to 40 Gbps, on a single strand of fiber, the wavelengths remain completely independent throughout the circuit, never multiplexed together. The City can offer this service from Northampton all the way to the SDC if the City leases a dark fiber strand into the SDC that it can use for commercial purposes, or requests and is granted approval from Five College Net, LLC to utilize the FCN strands for commercial purposes. Wavelength service would be considered a managed lit service but is mentioned in this section because it is often considered a dark fiber alternative.

6.2.2 - Municipal Retail Provider
The City currently is the operator of a managed lit service network, where the City’s IT Services Department manages multiple services for multiple locations using a shared infrastructure. This is the most economical use of fiber and other network resources, and the most economical way to grow the network. The City can offer a suite of managed lit services to non-municipal end users using the same underlying technologies, hardware platforms, subcontractors and other resources already being utilized to operate the municipal network. The City can offer managed lit services, including Internet access and point-to-point local circuits, directly to the end user as a retail services provider.

Under the retail model, the City’s MLP acts in very much the same way municipal utilities have always acted when providing electricity to end users. The City’s MLP will connect new end user locations and provide telecommunication as a utility. In this scenario the City will offer Internet access, local area point-to-point connections and VoIP service, and would have to arrange for a method to bill customers, arrange for all customer care functionality including a Network Operations Center, and support the services in the field with on-site tech support as needed and physical maintenance and repair of the fiber network.

Any business function or operation that the City would not perform in-house could be performed through outsourcing. Where practical, the City should simplify the services or processes. One example is the use of flat-rate billing for services on a monthly or other time-based frequency.

Since each new end user location will require some degree of construction, the cost of that new connection must be evaluated and incorporated into the proposal to the customer. While some
customers may choose to pay for the cost of construction in a lump sum at the beginning of the initial service term, other end users may prefer to have the cost of construction amortized over the length of the service term and included in their monthly recurring costs. Service adoption will likely be improved if the City can offer to amortize construction costs over a normal term, for example one to five years.

6.2.3 – Public-Private Partnership
When long established municipal electric utilities decide to leverage their existing assets and deploy fiber throughout their utility footprint to offer broadband as a service, they have a deep well of resources already in place to draw on. An existing billing platform, an existing call center and customer care platform, an existing customer relationship including a marketing relationship, and existing field service resources. Granted, some of the existing resources will need to be augmented to address the new service offerings, but the operational structure of a municipal utility is already in place.

For a newly formed Municipal Light Plant, purpose-built to offer IP-Enabled Services, much of that infrastructure may not exist. The City’s IT Services Department may very well play a key role in creating the MLP, but the MLP may require resources in addition to the Department’s existing resources. Some tasks required to support and properly operate the MLP may best be performed internally and some tasks may be best performed by outside contractors or private firms.

The extent of tasks that may be performed by outside contractors can extend into the retail space, and the City can choose to rely on a private enterprise partner for functionality including but not limited to marketing, sales, billing, customer care, Network Operations Center and the provision and support of VoIP service.

A public-private partnership can also take the form of a co-branded retail service, where the retail service partner provides the lion’s share of service and support discussed above, but incorporates a certain amount of co-branding in their marketing, sales and customer support services. Customer awareness that the service delivery platform is a fiber network provided by a municipal telecommunications utility may have positive effects on customer adoption and subscription rates, especially in a politically progressive community such as Northampton.

In this scenario the City can provide their private enterprise partner(s) with either a dark fiber service or a managed lit service to access the end user.

6.2.4 - Open Access Provider
A variation to the public private partnership model, and a variation to the managed services provider model, would be for the City’s MLP to act as the operator of an open access network where multiple retail service providers are all allowed access to wholesale services provided by the MLP in order to provide retail service to end users. In this scenario the wholesale services
would be managed lit services including Internet access, point-to-point circuits, wavelength service and, on a case-by-case basis, dark fiber.

Generally, Percipio does not recommend the open access model as it requires the management of relationships with multiple parties, and it divides an already rather small marketplace between too many competitors, leaving slices of the pie too small for any one service provider to bother putting in the required marketing and sales effort.

6.3 - Who’s Doing This
In Massachusetts several municipalities offer retail Internet service directly to business and residential end users through their Municipal Light Plants. It is important to note that most of the MLPs currently offering Internet service are pre-existing MLPs, initially formed for the purpose of providing electricity, having added Internet service later. These MLPs generally own or co-own the utility poles and some conduit in their service delivery area, making deployment of fiber within the community easier and less costly than it would be for a telecommunications-only MLP that does not own or co-own the utility poles. MLPs offering electric service that have added Internet service also have the benefit of a pre-existing relationship with their customers, providing customer service, billing and marketing.

Municipalities currently offering retail Internet service directly to end users through their MLPs include Concord, Taunton, Braintree, Norwood, Shrewsbury, South Hadley, Westfield, Chicopee, Holyoke and last year Wellesley formed an Internet Exploratory Committee made up of MLP staff, board members and residents to look at offering Internet service in addition to electric service. In December 2014 the Wellesley MLP purchased Verizon’s share of all jointly-owned poles, making fiber deployment even less onerous for the MLP. Many of these MLPs currently provide Internet access to their school districts.

The best example of a Massachusetts MLP that was formed for the sole purpose of offering Internet access, that does not have any history of offering electricity and does not own or co-own any utility poles or conduit, is that of the town of Leverett. Leverett formed their MLP a few years ago in response to the construction of the MB123 fiber optic network that was built into town connecting community anchor institutions such as the police and fire stations. Previously there was no other network present in Leverett suitable to connect an FTTP network to the Internet. The town took this opportunity to form a MLP, vote to approve borrowing to construct an active Ethernet fiber to the home network, voted to raise property taxes to cover the debt service on the borrowing, and connected their newly constructed FTTP network to the Commonwealth’s MB123 network.

Leverett, being a small town with few municipal employees and no IT Department, decided to take the public-private partnership approach and work with two private partners to operate and provide service on the network, issuing separate RFPs for a Network Operator and for Internet Service Provider. The Network Operator role is being performed by Holyoke Gas & Electric and they are responsible for fiber network maintenance and repair, and the ISP role is
filled by Crocker Communications and they are responsible for providing Internet access, email, customer care and billing. The Leverett MLP board personnel handle administrative responsibilities such as recurring insurance and pole attachment fees.

7 - Summary Recommendations

Recommendation #1: Proceed with E-Rate participation. Work with the school districts and libraries to develop competitive service proposals that will best employ fiber-based networks to serve the needs of the schools and libraries.

Recommendation #2: Employ an incremental approach to expanding the municipal network. Integrate municipal capital project planning projects like road improvements, traffic signal modernization, and water main replacements or repairs with requirements for fiber buildout. Such plans should be documented in the Municipal Network Master Plan.

8 - Conclusion

The City of Northampton has all the pieces in place to provide the Northampton Public Schools, the Smith Vocational School, both libraries and all municipal buildings with robust, carrier class Internet access and networking.

Like Santa Monica, CA, Northampton has the basis for an incremental deployment of their network.

Through participation in the E-Rate program, either as a service provider directly to the schools and libraries or a wholesale service provider, the City can increase their funds from network operations, reduce network costs, and improve the quality of services for the schools, libraries, and for the City.

The FCC specifically allows municipalities to participate in the E-Rate system, and for a municipality that owns a fiber network connecting all E-Rate eligible locations within their jurisdiction, as well as controls fiber from the municipality into a regional carrier hotel facility, participation as an E-Rate provider is highly recommended for several reasons.

First, rather than purchase oversubscribed retail Internet access from retailers such as Comcast at each school in Northampton, Dedicated Internet Access is available at the SDC and can easily be delivered over the FCN fiber and over the municipal fiber network to all schools and libraries. Control over oversubscription would then be the City’s, and the demand for increased speeds over time can be more easily met by the City, school districts and libraries. Bandwidth can be purchased in a larger, more cost effective block at the SDC and can even be dynamically
allocated among school locations as needed. If needed, bandwidth can be allocated for specific testing requirements, or to increase WiFi backhaul at certain locations or for any other reason.

Second, the school districts and libraries can experience this increase in service performance at no additional expense to their current budgets while the City will see revenue related to the increased use of the network by the schools as their E-Rate provider. Instead of those dollars going to Comcast, those dollars can go back into supporting the municipal fiber network as a future-proofed networking platform for the schools for generations to come. The municipal fiber network was built to all E-Rate eligible locations within Northampton at great expense, only by the City becoming an E-Rate provider can that infrastructure investment be most efficiently utilized.

And E-Rate eligible services that are being provided by the City to the schools and libraries at no cost should be included in the E-Rate request for funding by each school district.

Through an incremental approach to network expansion that is guided by a Municipal Network Master Plan, the financial risk to the City can be better addressed.

While all important pieces are in place for the City to become an E-Rate provider, the pieces that would need to be put in place for the city to serve non-municipal customers come with costs and overhead and no real guarantee the City can ultimately successfully operate as an ISP in a competitive marketplace. The formation of an MLP as a common carrier ISP, ongoing compliance with the required regulatory regime, pole attachment agreements for commercial use with the pole owners, customer service of non-municipal customers, construction of fiber extensions within Northampton, all of these tasks require human resources and financial resources. While there are success stories of municipalities in Massachusetts offering Internet access as an ISP, those are limited to long standing electric MLPs with far more experience installing and maintaining cable networks, let alone the fact they are usually also the local utility pole owner or co-owner.

Our recommendation concerning leveraging the existing municipal fiber network to serve non-municipal customers is to proceed with caution and to only enter the commercial, competitive marketplace for specific, well-defined opportunities.

One example to consider: if a new customer was identified for the City’s MLP to serve as an ISP, a fiber extension would need to be constructed to that new location and spliced into the existing network. Because this fiber placement would not be for municipal use, all utility poles involved in carrying that fiber from the new location to the City’s network hub would be licensed or re-licensed as non-municipal attachments and pole attachment fees would apply. These pole attachment fees are the same whether the City is serving one customer or one thousand, and the new fiber cable installed on that route can also serve a very large number of customers, but until the City’s non-municipal customer base grows sufficiently the City won’t be able to realize those economies of scale. However, if the first project for the City as ISP involves
a well-developed project, an anchor tenant of sufficient size, those economies of scale can be achieved quicker.

Although entry into this competitive marketplace should be approached with caution, the initial first incremental step, the development of an E-Rate service proposal that will include all of the services being used by the school districts and the libraries, should be approached enthusiastically. With the E-Rate submission, the City will have the basis to reduce their effective costs while increasing funding for the municipal network.

The formation of a MLP does have a long lead time, but should be perused only after careful consideration and approval by the Mayor and City Council that the expansion of the metropolitan network beyond the schools, libraries, and municipal buildings is a prudent consideration with City Council support that conforms to the MLP statute.

9- Glossary of Used and Related Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Aggregation</td>
<td>The process of combining multiple services or communication circuits into a higher-capacity service or system.</td>
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<tr>
<td>Bandwidth</td>
<td>The term refers to the rate of data transfers a network interface is designed to support, measured in units of bits per second.</td>
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<tr>
<td>Bit</td>
<td>The basic unit of information in computing and digital communications. In binary systems a bit can be a 1 or a 0.</td>
</tr>
<tr>
<td>Byte</td>
<td>A unit used to measure digital volume. There are eight bits in a byte.</td>
</tr>
<tr>
<td>Broadband</td>
<td>The FCC has defined broadband as 25Mbps downstream and 3Mbps upstream.</td>
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<tr>
<td>CAI - Community Anchor Institution</td>
<td>Includes such entities as schools, libraries, hospitals and other medical providers, public safety entities, institutions of higher education, and community support organizations.</td>
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<tr>
<td>Carrier Hotel</td>
<td>Also called a colocation center, a secure physical site or building where data communications converge and are interconnected, and where Dedicated Internet Access is available.</td>
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<tr>
<td>Cellular</td>
<td>A wireless network where a land area, or cell, is served by an antenna and the signal can be distributed from one cell to another.</td>
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<tr>
<td>CLEC - Competitive Local Exchange Carrier</td>
<td>A telephone service company that provides local telephone service that competes with the incumbent local exchange carrier (ILEC).</td>
</tr>
<tr>
<td>CO - Central Office</td>
<td>The name commonly used in North America to identify the switch in a telephone network that connects local customers. CO actual refers to the building that contains switching and interconnection equipment.</td>
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<tr>
<td>Coaxial Cable</td>
<td>A type of cable comprising a central wire conductor surrounded by a hollow cylindrical insulating space of air, or solid insulation, or mostly air with spaced insulating disks, finally surrounded by a hollow cylindrical outer conductor.</td>
</tr>
<tr>
<td>Colocation</td>
<td>Also co-location, is the placement of equipment (such as multiple antennas) at a common physical site to reduce environmental impact and real estate costs and speed zoning approvals and network deployment.</td>
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<tr>
<td>Term</td>
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<tr>
<td>Common Carrier</td>
<td>A company that provides communications services and to the public for a fee.</td>
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<tr>
<td>Contention</td>
<td>the number of users sharing the same data capacity during the period of peak usage.</td>
</tr>
<tr>
<td>CPE - Customer Premise Equipment</td>
<td>All telecommunications equipment located on the customer’s premises, including telephones, modems and any device used by a telephone company or ISP to deliver their service at the customer premise.</td>
</tr>
<tr>
<td>Diversity</td>
<td>A method for improving the reliability of a message signal by using two or more communication channels with different characteristics.</td>
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<tr>
<td>Downstream</td>
<td>The direction of transmission from the source to the destination (such as from a network to an end customer).</td>
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<tr>
<td>DSL - Digital Subscriber Line</td>
<td>A technology for bringing high-bandwidth information to homes and small businesses over ordinary copper telephone lines.</td>
</tr>
<tr>
<td>E-Rate</td>
<td>The commonly used name for the Schools and Libraries Program of the Universal Service Fund, which is administered by the Universal Service Administrative Company (USAC) under the direction of the Federal Communications Commission (FCC).</td>
</tr>
<tr>
<td>FCC - Federal Communications</td>
<td>An independent agency of the United States government, created by Congressional statute to regulate interstate communications by radio, television, wire, satellite, and cable in all 50 states, the District of Columbia and U.S. territories.</td>
</tr>
<tr>
<td>Fiber Optics</td>
<td>A flexible, transparent fiber made by drawing glass (silica) or plastic to a diameter slightly thicker than that of a human hair. Optical fibers are used most often as a means to transmit light between the two ends of the fiber and find wide usage in fiber-optic communications, where they permit transmission over longer distances and at higher bandwidths (data rates) than wire cables.</td>
</tr>
<tr>
<td>Five College Network</td>
<td>In 2007 the Five College consortium of Amherst, Hampshire, Mount Holyoke and Smith Colleges and the University of Massachusetts Amherst completed a fiber optic network stretching from Springfield, MA, up and around the five campuses.</td>
</tr>
<tr>
<td>FTTP - Fiber to the Premise</td>
<td>Also called Fiber to the Home (FTTH) is a pure fiber-optic cable connection running from an Internet Service Provider (ISP) directly to the user’s home or business.</td>
</tr>
<tr>
<td>ILEC - Incumbent Local Exchange Carrier</td>
<td>A telephone company that provided local service prior to the Telecommunications Act of 1996 which owns most of the local loops and facilities in a serving area.</td>
</tr>
<tr>
<td>Internet Protocol - IP</td>
<td>The Internet Protocol (IP) is the method or protocol by which data is sent from one computer to another on the Internet.</td>
</tr>
<tr>
<td>IPES - Internet Protocol Enabled Services</td>
<td>A regulatory designation by the FCC for the purposes of regulating separately services provided using the Internet Protocol. VOIP is an IPES.</td>
</tr>
<tr>
<td>ISP - Internet Service Provider</td>
<td>An organization that provides services for accessing and using the Internet. Internet service providers may be organized in various forms, such as commercial, community-owned, non-profit, or otherwise privately owned.</td>
</tr>
<tr>
<td>LAN - Local Area Network</td>
<td>A computer network that interconnects computers within a limited area such as a residence, school, laboratory, university campus.</td>
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<td>Term</td>
<td>Description</td>
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<tr>
<td>Local Loop</td>
<td>The physical link or circuit that connects from the demarcation point of the customer premises to the edge of the common carrier or telecommunications service provider’s network.</td>
</tr>
<tr>
<td>MAN - Metropolitan Area Network</td>
<td>A network that interconnects users with computer resources in a geographic area or region larger than that covered by even a large local area network (LAN) but smaller than the area covered by a wide area network (WAN).</td>
</tr>
<tr>
<td>Make Ready</td>
<td>The process required to prepare utility poles and conduit to receive new attachments or installations. Cable may need to be relocated on existing poles to maintain required clearances, and sometimes new taller utility poles need to be installed to accommodate new installations.</td>
</tr>
<tr>
<td>Mbps - Megabits per second</td>
<td>A measure of data transfer speed (a megabit is equal to one million bits).</td>
</tr>
<tr>
<td>Metro Ethernet</td>
<td>The use of Carrier Ethernet technology in metropolitan area networks (MANs).</td>
</tr>
<tr>
<td>Municipal Light Plant - MLP</td>
<td>A not-for-profit, citizen-owned utility corporation. Municipal Light Plants are authorized under MA General Law and certified by the MA Secretary of State to provide telecommunications, electricity and energy services.</td>
</tr>
<tr>
<td>Net Neutrality</td>
<td>The principle that Internet service providers should enable access to all content and applications regardless of the source, and without favoring or blocking particular products or websites.</td>
</tr>
<tr>
<td>Network Hub</td>
<td>A common connection point for devices in a network.</td>
</tr>
<tr>
<td>Node</td>
<td>In communication networks, a node (Latin nodus, ‘knot’) is either a connection point, a redistribution point (e.g. data communications equipment), or an endpoint.</td>
</tr>
<tr>
<td>Overbuilding</td>
<td>The installation of telecommunications infrastructure on the same utility poles and in the same service area as other already exiting telecommunications infrastructure that offers competitive services.</td>
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<tr>
<td>Oversubscription</td>
<td>A situation that occurs when a service provider sells more capacity to end customers than a communications network can provide at a specific time period. This provides a benefit of reduced network equipment and operational (reduced leased line) cost. Over-subscription is a common practice in communications networks as customers do not continuously use the maximum capacity assigned to them and customers access the networks at different time periods. Unfortunately, over-subscription in telecommunications can cause problems when customers do attempt to access the network at the same time.</td>
</tr>
<tr>
<td>PPP – Public-Private Partnership</td>
<td>A government service or private business venture that is funded and operated through a partnership of a government entity and one or more private sector companies.</td>
</tr>
<tr>
<td>QoE - Quality of Experience</td>
<td>A measure of the overall level of customer satisfaction with a vendor. QoE is related to but differs from Quality of Service (QoS), which embodies the notion that hardware and software characteristics can be measured, improved and perhaps guaranteed.</td>
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<tr>
<td>QOS - Quality of Service</td>
<td>The overall performance of a telephony or computer network, particularly the performance seen by the users of the network.</td>
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<tr>
<td>Right-of-Way</td>
<td>The legal right, established by usage or grant, to pass along a specific route through grounds or property belonging to another.</td>
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<tr>
<td>Term</td>
<td>Description</td>
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<tr>
<td>Smart City</td>
<td>An urban development vision to integrate multiple information and communication technology (ICT) and Internet of Things (IoT) solutions in a secure fashion to manage a city's assets – the city's assets include, but are not limited to, local departments information systems, schools, libraries, transportation systems, hospitals, power plants, water supply networks, waste management, law enforcement, and other community services.</td>
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<tr>
<td>SDC - Springfield Data Center</td>
<td>The region's primary carrier hotel and colocation facility.</td>
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<tr>
<td>Universal Service Fund</td>
<td>A system of telecommunications subsidies and fees managed by the United States Federal Communications Commission (FCC) intended to promote universal access to telecommunications services in the United States.</td>
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<tr>
<td>Upstream</td>
<td>A term used in fixed telecommunications to denote the data flow from the end-user into the network.</td>
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<tr>
<td>USAC - Universal Service Administrative Company</td>
<td>An independent, not-for-profit corporation designated by the Federal Communications Commission (FCC) as the administrator of universal service.</td>
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<tr>
<td>VLAN - Virtual Local Area Network</td>
<td>Any broadcast domain that is partitioned and isolated in a computer network at the data link layer (OSI layer 2). LAN is an abbreviation of local area network. To subdivide a network into virtual LANs, one configures a network switch or router.</td>
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