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City of Bloomington Digital Underground

Strategic Planning Report

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Executive Summary

The Bloomington Digital Underground (BDU) is a comprehensive program started over 5 years ago to install fiber-optic cable and conduit throughout the city. The program was created to build an advanced telecommunications infrastructure in the city rights-of-way in order to position Bloomington for economic growth driven by the Internet and electronic commerce. It was stated that the project was executed with the following three benefits in mind:

- "Lowers the barriers to entry for competitive telecommunications carriers"
- "Provides for the City of Bloomington's communications needs"
- "Protects the City's rights-of-way investments and its visual attractiveness"

During its life, little data has been collected regarding the effectiveness of the BDU in realizing the original benefits. This has resulted in stagnation and very little support for growth. This study investigates the to-date impact of the BDU and recommends a strategy for realizing its full potential. Information was obtained from previous experience InfoComm has had with the City of Bloomington, previous experience InfoComm has had with the telecommunications market in the City of Bloomington and the State of Indiana, and interviews conducted by InfoComm as part of this engagement. The list of interviewees was created by the Bloomington Digital Underground Advisory Committee (BDUAC).

SWOT Analysis

From the information obtained a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis was conducted. A SWOT analysis is an effective tool for documenting the relationship between an object of focus (in this case the BDU program) and its surrounding environment. The results of the SWOT analysis revealed that the BDU has had positive impact on the city's telecommunications costs as well as the current telecommunications market. However, the following issues have a very real chance of hurting the future of the BDU:

- The avenue through which the City can justify expanding infrastructure to capitalize on public and economic development opportunities has traditionally been weak.

- The BDU has been highly scrutinized even though the City has saved itself money, gained extreme flexibility, and established a valuable asset through construction of the BDU.
- The City has not been able to show or describe proof that the BDU is a benefit to the community.
- The BDU is in jeopardy of missing out on some very big opportunities due to lack of structure.
- Fears and worry of the City competing with local businesses has forced stagnation of the BDU.
- The BDU has not made its way into the inner working of the City of Bloomington's government structure even though it is a City asset.
- A market for the excess BDU capacity has failed to materialize.

Following the identification of these issues, several goals for this project were established. The purpose of the goals was to ensure that each issue was targeted for abolishment. The goals are as follows:

- Solidify the BDU's position within City of Bloomington government,
- Establish win-win partnerships with both public and private organizations,
- Encourage the utilization of excess BDU capacity,
- Leverage city owned assets to undertake community benefiting projects to expand the BDU, and
- Quantify and publicize community benefits of the BDU.

Strategies

In order to meet the established goals of the project by building on strengths and opportunities and mitigating weaknesses and threats, three strategies were developed. They are governance, pricing, and growth. The governance strategy identified the four jobs related to the BDU and associated responsibilities of each. The pricing strategy developed a model for setting the price of the current as well as future BDU assets. Finally, the growth strategy establishes parameters by which the BDU can and should expand over time.

Initiatives

The final piece of the strategy is a recommended list of initiatives that are actionable items executed as part of one or more strategies. Documented in chronological order, they constitute the migration plan which charts a path from

the current state to a state that realizes the full potential of the BDU asset. They are as follows:

- Amend/change policies to reflect the jobs and authority required as part of each job's description detailed in the governance strategy.
- Set general pricing for current BDU based on documented execution of the pricing model.
- Develop a tiered partnership agreement for eligible participants that protect both the city as well as the end user.
- Accept the HoosierNet agreement with the recommended partnership level and price structure.
- Continue to develop a master plan for BDU growth.
- Establish a partnership with Monroe County that allows the county to utilize the BDU asset.
- Revamp/renew the City's rights-of-way agreement such that it protects the city's investment in the BDU.
- Plan open access network architecture for the Certified Technology Park.
- Facilitate BDU connectivity to PEG channels and Insight.

Conclusion

To conclude, this strategy document has established proof that the BDU is a beneficial asset to the City of Bloomington. Additionally, it provides the actionable steps required to ensure that the city realizes the full potential of the BDU asset.

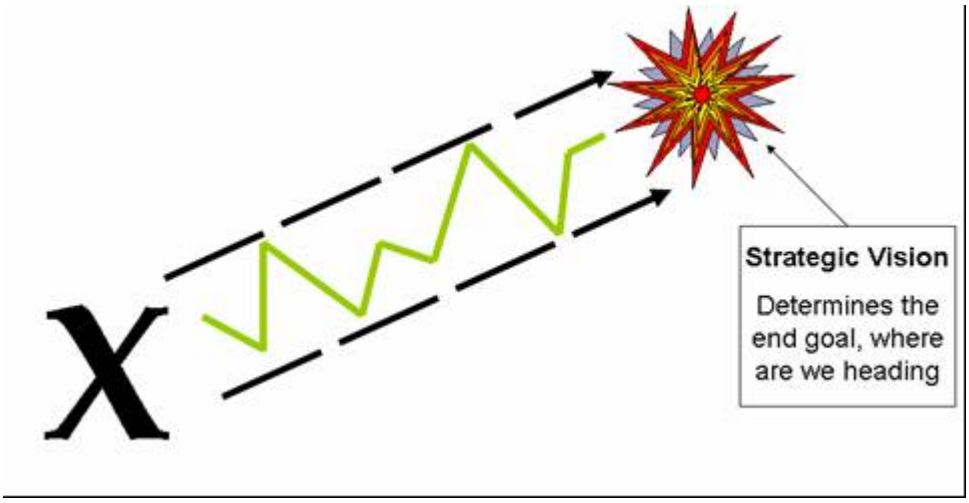
Introduction

InfoComm Systems was hired by the City of Bloomington to provide analysis of the effectiveness of the BDU as well as a strategy for realizing its full potential.

Strategy has been defined as "that which has to do with determining the basic objectives of an organization and allocating resources to their accomplishment." A strategy determines the direction in which an organization needs to move to fulfill its mission. A strategic plan acts as a road map for carrying out the strategy and achieving long-term results.

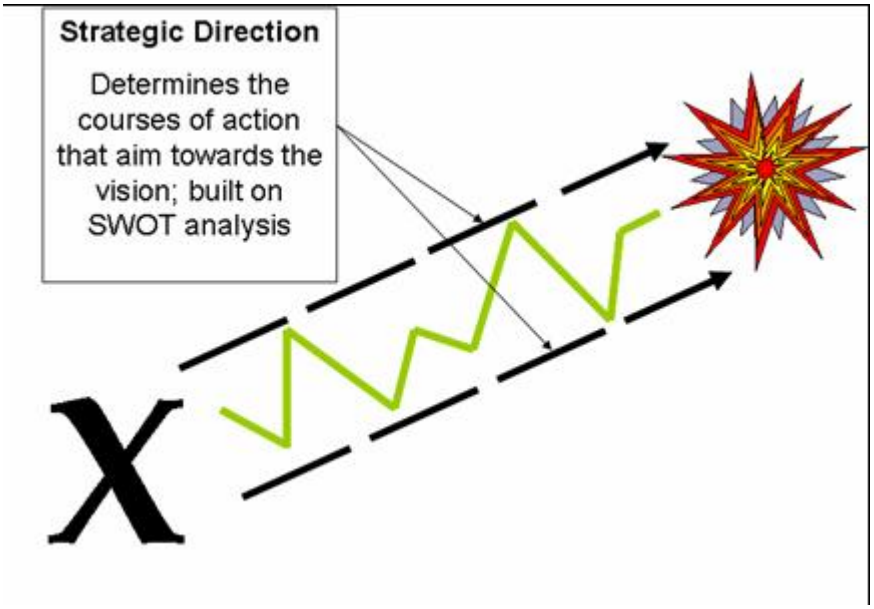
Strategic planning is different from long-range planning. Long-range planning builds on current goals and practices and proposes modifications for the future. Strategic planning, however, considers changes or anticipated changes in the environment that suggest more radical moves away from current practices.
Strategic planning is a very important process critical to the success of many different types of organizations. Essentially, a strategic plan determines where an organization is going over the next year or more, how it's going to get there, and how it'll know if it got there or not. These three key questions are answered throughout three main sections within this document. They are vision, direction, and migration plan.

First, a strategic vision is established. As can be seen in the figure below, a strategic vision determines the end goal of a project.

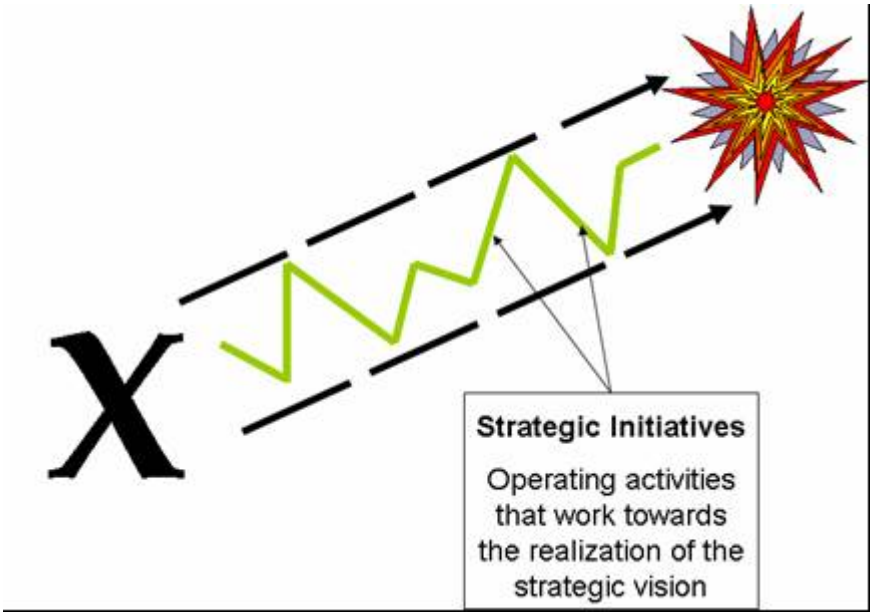


To develop the strategic vision the current state of the BDU and the telecommunications market in the City of Bloomington are documented. Next, the opinions of several community and industry leaders regarding the BDU are obtained and summarized. Finally, the two are used to develop a mission statement and perform a SWOT analysis. The result of the vision section is an end goal depicted in the mission statement, the identification of several issues currently affecting the realization of the mission and vision, and several immediate goals for overcoming each issue.

The next section is the strategic direction. It consists of strategies that define a course of action for reaching the reestablished goals. As seen in the figure below, the strategic direction ensures that activities are directed towards the mission and vision.



The final section is the migration plan. It consists of actionable initiatives within the framework of one of more strategies. As seen in the figure below, these initiatives don't always point directly at the vision; however, they work together to move in that direction.


X
Strategic Initiatives
Operating activities that work towards the realization of the strategic vision

1.0 Vision

The purpose of the Vision section is to establish a set of goals for the future of the BDU project. The goals are extracted as part of a three part process. First, a base state is established in order to document current characteristics related to the BDU. Next, a market needs analysis, proposed city and county initiatives, as well as the opinion of community leaders in regards to the direction of the BDU are documented. Finally, the information from both the Current State and Desired State are compared and analyzed for strengths, weaknesses, opportunities, and threats. This analysis concludes with the establishment of a set of goals used to create a vision for the future of the BDU project.

1.1 Current State

The Current State information presented here is meant to establish a base state upon which to build the vision. A base state is a snapshot that depicts characteristics of a specific place in time. In this case, the characteristics are related to the BDU project and were obtained through previous BDU work conducted by InfoComm, independent research, as well as interviews and meetings conducted as part of this engagement. This information depicted herein is broken into current state information on the BDU and its placement within city government as well as telecommunications infrastructure.

1.1.1 Bloomington Digital Underground[1]

The BDU is a comprehensive program to install fiber-optic cable and conduit throughout the city. The program was created to build an advanced telecommunications infrastructure in the city rights-of-way in order to position Bloomington for economic growth driven by the Internet and electronic commerce. It was stated that the project was executed with the following three benefits in mind:

- "Lowers the barriers to entry for competitive telecommunications carriers"
- "Provides for the City of Bloomington's communications needs"
- "Protects the City's rights-of-way investments and its visual attractiveness"

[1] Volan, Gregory. "Comprehensive Memorandum: Bloomington Digital Underground and Telecom Hotel." September 30, 2004

One component of the program was and continues to be to install telecommunications conduit whenever the City engages in a construction project. The other component was to construct a fiber optic ring consisting of both conduit and fiber optic cable around the center of Bloomington. This ring was constructed and connects to main City buildings – City Hall, Police Headquarters, Fire Station #1, and the Utilities Service Center – as well as the Telecom Hotel (7th and Walnut Street), the Monroe County Community School Corporation (MCCSC) Administration Building, and several schools. The currently installed infrastructure is depicted in *Figure 1* below.

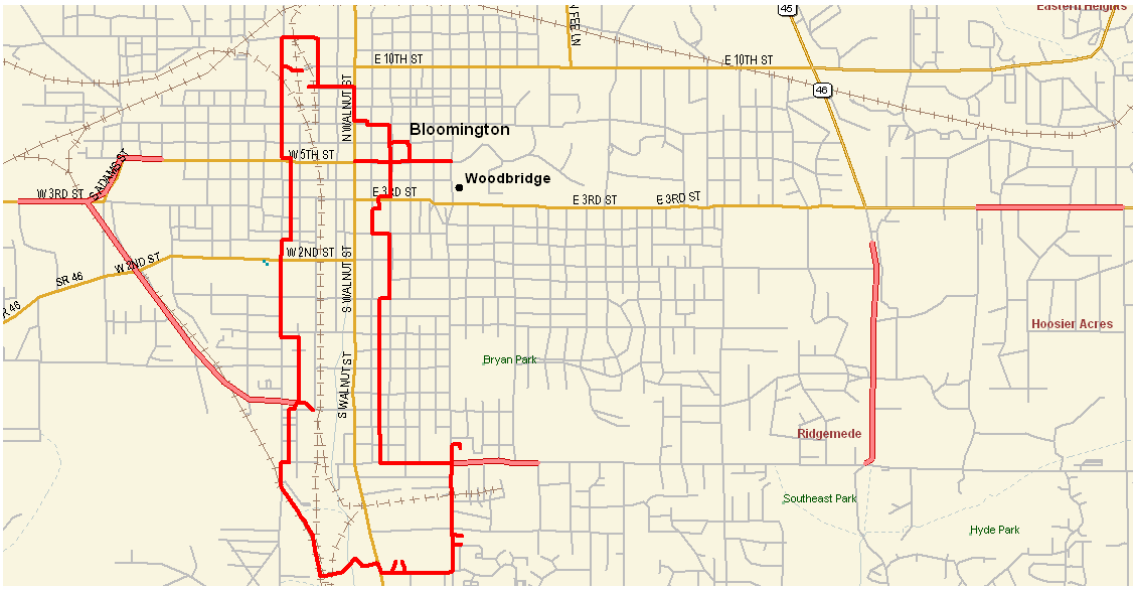


Figure 1 – Current BDU Conduit and Fiber Map

The City deliberately overbuilt the BDU with the intention of making the excess capacity available to private entities. The City installed more conduit and fiber strands than it needed, or will need, for its own use. Currently, the City is using 36 out of the 96 strands of fiber and 1 out of the 6 innerducts in some sections of the network and 1 out of the 3 innerducts in other sections to establish connectivity between the City buildings connected to the fiber. Additionally, MCCSC is using an additional 12 out of the original 96 strands of fiber to meet their needs. Thus, the BDU currently has 48 strands of spare fiber capacity and 2 spare innerducts in some parts of the network and 5 spare innerducts in other parts.

Telecom Hotel

The telecom hotel is a facility located on the City's fiber ring and is designed to be a good environment for locating computer and telecommunications

equipment. Indiana Fiber Works ("IFW"), a regional fiber company based in Indianapolis, operates the telecom hotel. IFW has leased approximately 3,000 square feet from the building owner and has developed approximately one-third of that space into a carrier-grade facility. The City does not own or operate the telecom hotel. The City is a tenant, renting five rack spaces in the facility.

The advantage of a telecom hotel is that any company, by paying for a single connection to the telecom hotel, can connect to every other entity located at the telecom hotel at a negligible cost. If a company is willing to invest in fiber to obtain high-speed Internet service or some other telecommunications service, the company would be better served connecting to the telecom hotel where many providers are located, rather than directly to a single provider. By connecting to the telecom hotel, the company can receive service from any service provider that is located at the telecom hotel and negotiate the best deal among them. The company can easily switch to another provider if its current provider provides bad service, and it has access to the product offerings (e.g., Internet, local telephone, long-distance, and cable TV service) of all the service providers located there. If a company builds fiber directly to a single service provider, the customer is stuck with the pricing, service quality, and product portfolio of that one provider.

Funding

The funding for BDU construction and subsequent equipment and maintenance was obtained by the City from five sources. The largest contributions came from the Telecommunications Non-Reverting Fund (Telecom Fund) which was created from the 5% franchise fee paid by the incumbent cable company Insight to the City. To date nearly $800,000 of the $1.2 million in capital expenditures have been obtained from this fund. Additional funding sources include the Downtown, Adams, and Thomson TIFFs as well as Public Works.

The Telecom Fund was created in November of 1996 by City of Bloomington Ordinance 96-31. The purpose of the fund is to provide a dedicated place for revenue obtained as a result of the cable television franchise agreement. Per the ordinance, 40% of the total money collected shall be dedicated for the planning, design, development and construction of the City's telecommunications infrastructure while the remaining 60% shall be dedicated for public, education, and government access/telecommunications services.

Policies

On October 15, 2003 the City Council passed Resolution 03-28, which adopted a set of policies for the BDU. The policies set forth a general framework for governing the use of the City's fiber optic assets. Generally, the policies state that:

- The City will lease fiber optic conduit and fiber strands only to telecommunications providers, and not directly to end users.
- City Council must approve all pricing decisions related to the use of conduit or fiber by private entities.
- The Board of Public Works is responsible for the day-to-day management of the fiber optic assets.
- The Board of Public Works shall create a standing advisory committee to provide advice and recommendations on the usage, pricing, and management of the fiber optic assets.

As a result of the last bullet point above, on November 18, 2003, the Board of Public Works passed Resolution 2003-45, which created the BDU Advisory Committee (BDUAC). The purpose and duties of this standing committee are "to provide advice, recommendations, and strategic direction to the Board of Public Works and the Common Council on the usage, pricing, and management of the City's fiber optic assets." The committee consists of seven members, five of whom are appointed by the Board of Public Works, and two appointed by City Council. Of the five members appointed by the Board of Public Works, there should be one Indiana University (IU) representative, one economic development representative, and one non-profit representative.

1.1.2 Telecommunications Infrastructure

There are four main types of telecommunications infrastructures installed in the Bloomington area. These are cable television, wireless, fiber optics, and phone company systems. Similar technologies are utilized in each of these infrastructures; however, each has defining characteristics making it unique.

Cable Television

The cable television operator Insight operates a Hybrid Fiber Coax (HFC) transmission system in Bloomington. HFC networks (*Figure 2*) consist of fiber optic infrastructure that connects the headend to centrally located hubs and eventually to fiber optic nodes located in closer proximity to the consumer. The fiber optic signal is converted to RF at these nodes and then sent to the user over coaxial infrastructure. Amplifiers are placed on the coaxial system to ensure that

a strong signal reaches the consumer. Each amplifier is expressed as a cascade. The fewer cascades in a path the lower the amount of signal degradation and the fewer potential failure points within the system. Insights current HFC system consists of 4 cascades.

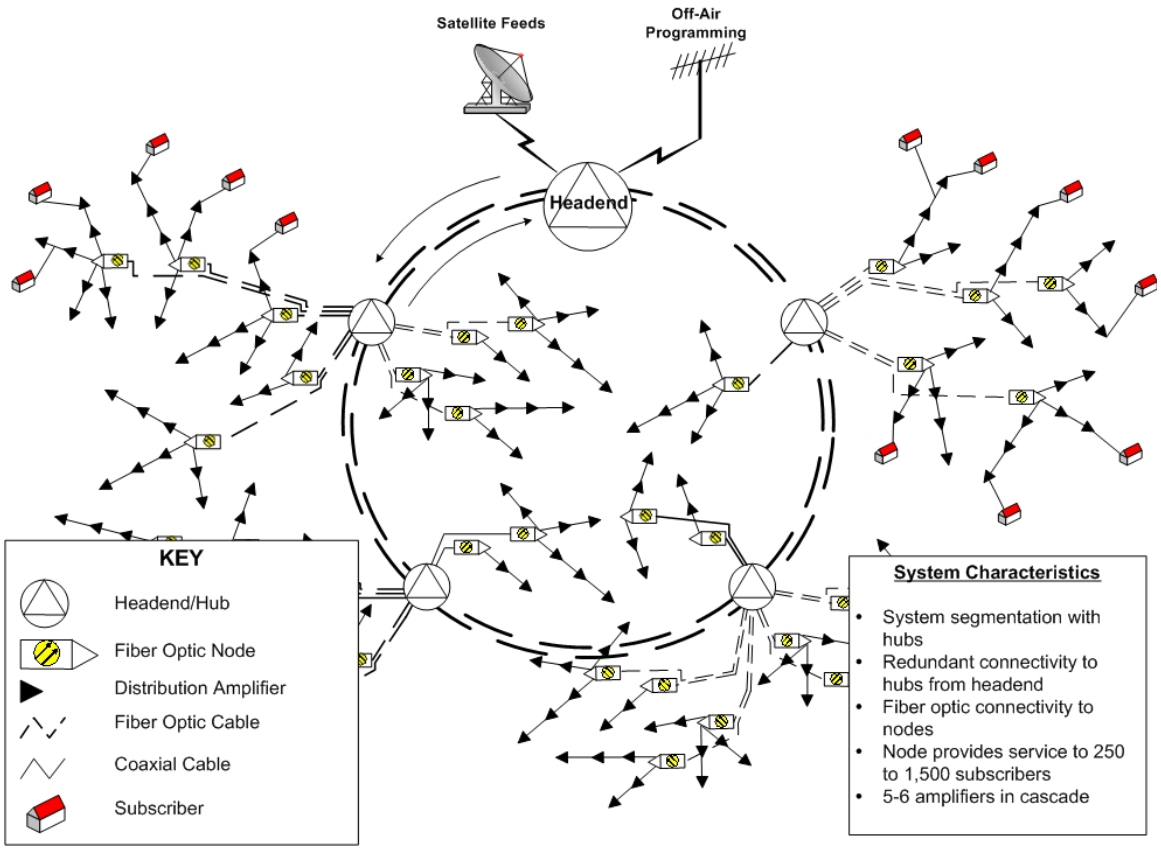


Figure 2 – Hybrid Fiber Coax Cable Television Transmission System[2]

Bandwidth in a HFC cable distribution system is expressed in megahertz (MHz). Most HFC systems have a capacity of 750 – 860 MHz used to support a variety of analog and digital video services, two-way interactive data, and telephony. Traditionally, cable systems have been highly broadcast based with limited bandwidth upstream. However, recent technological advances including the Data Over Cable Service Interface Specification (DOCSIS) 2.0 specification have enabled cable systems to be more symmetrical. The DOCSIS 2.0 standard allows 30.72 Mbps per channel upstream and 42.88 Mbps downstream.

Insight was unwilling to either submit current fiber maps or commit to offering excess capacity for lease or sale. Their system bandwidth capacity and current

[2] Columbia Telecommunications Corporation, "Technology Analysis of Open Access and Cable Television Systems." Prepared for the American Civil Liberties Union, December 2001.

DOCSIS support are also unknown; however, it is most likely that their system has 750 MHz of bandwidth capacity and that they will support DOCSIS 2.0 by the time they roll out VOIP during 4Q2005. Finally, it is highly doubtful that Insight will be interested in utilizing BDU infrastructure as they currently have fiber pushed into most neighborhoods.

Wireless

The Internet Service Provider (ISP) Kiva operates a series of wireless fidelity (Wi-Fi) hot spots in Bloomington. A Wi-Fi hot spot is a high frequency wireless connection that allows many mobile computing devices to connect to the Internet. Currently, Kiva offers this type of access in sixteen locations throughout Bloomington.[3] These Wi-Fi locations utilize phone company circuits to connect back to the Kiva network and the Internet. Under the current arrangement, Kiva and IU have collaborated/partnered on this project and there is potential for the City to build on this partnership. The possibility also exists for Kiva and/or IU to utilize BDU infrastructure to connect to future Wi-Fi locations.

Additionally, several cellular operators have facilities in Bloomington. However, exact equipment and network access point location are unknown due to the number of local and regional resellers.

Fiber Optics

There are two types of pure fiber optic networks available in the Bloomington area, lit and dark. Dark fiber refers to unused fiber-optic cable. The unused cable is leased to individuals or other companies who want to establish optical connections among their own locations. In this case, the fiber is neither controlled by nor connected to the Phone Company or ISP. Instead, the company or individual provides the necessary components to make it functional. This type of infrastructure is appealing to large corporations with in-house technical expertise. Dark fiber optic networks are available in Bloomington from US Signal, ION Communications, and Indiana Fiber Works (IFW). *Figure 3* below depicts US Signal's infrastructure. US Signal has expressed interest in selling this infrastructure at a reduced rate; however, it is mostly aerial. There was speculation of US Signal fiber infrastructure between Bloomington and Louisville; that infrastructure does not exist.

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[3] http://www.kiva.net/services/kivaeverywherefaq.phtml

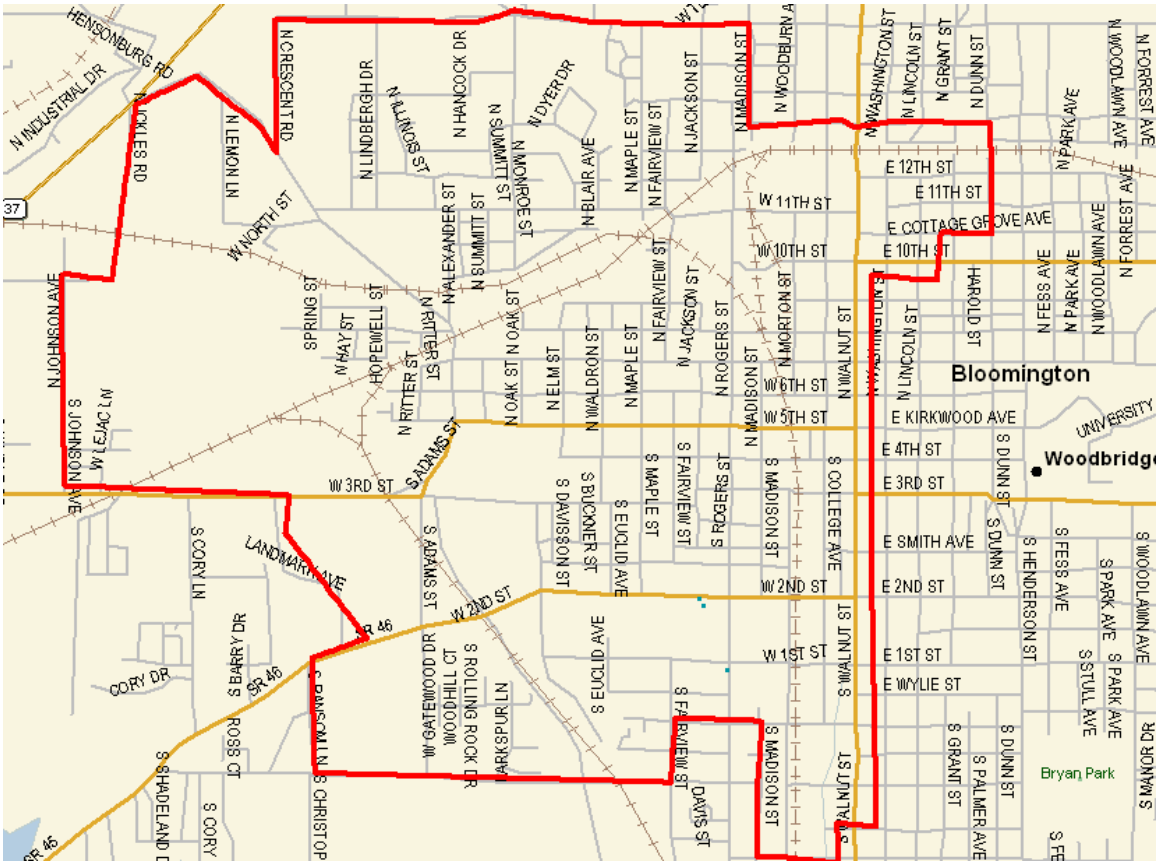

Figure 3 – US Signal Dark Fiber Optic Network

Figure 4 that follows depicts IFW's fiber optic network in and around Bloomington. Their network passing through Bloomington is underground, connects to the telecom hotel, and connects into a larger statewide network with connections to Chicago, Indianapolis, Cincinnati, Louisville, South Bend, and Fort Wayne.

ION's network is a replication of both the city's BDU infrastructure and portions of IFW's regional infrastructure.

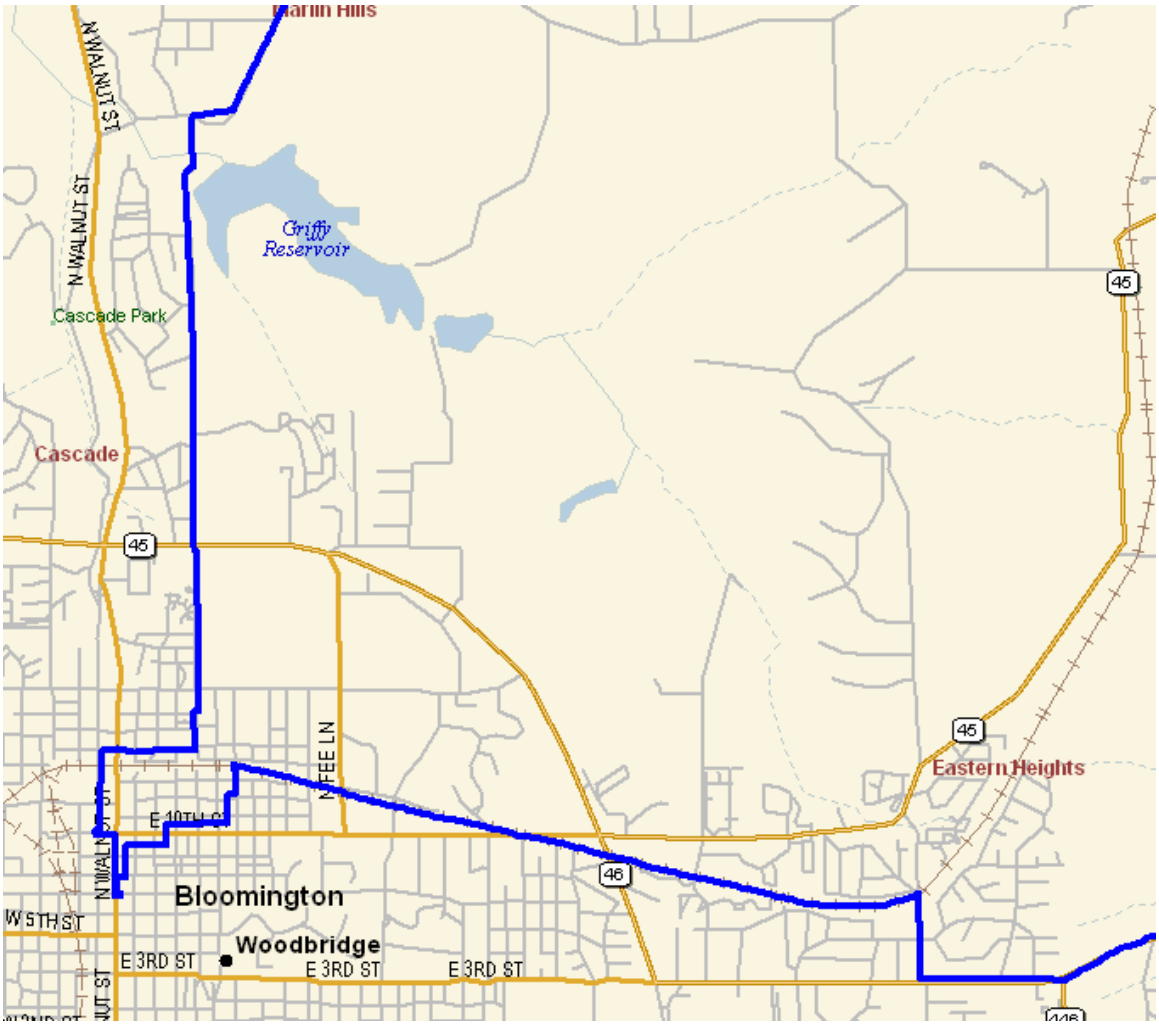

Figure 4 – IFW Fiber Map

Lit fiber refers to fiber optic infrastructure that is leased from the Phone Company or ISP. The fiber is provided to the consumer as a circuit with a pre-determined signaling technology and bandwidth. In most current applications lit fiber is delivered with Gigabit Ethernet or SONET signaling. In Bloomington, lit fiber is provided by SBC, Smithville Digital, and Cinergy. SBC and Cinergy were unwilling to provide their current fiber optic footprints while Smithville Digital's infrastructure is depicted in *Figure 5* below.

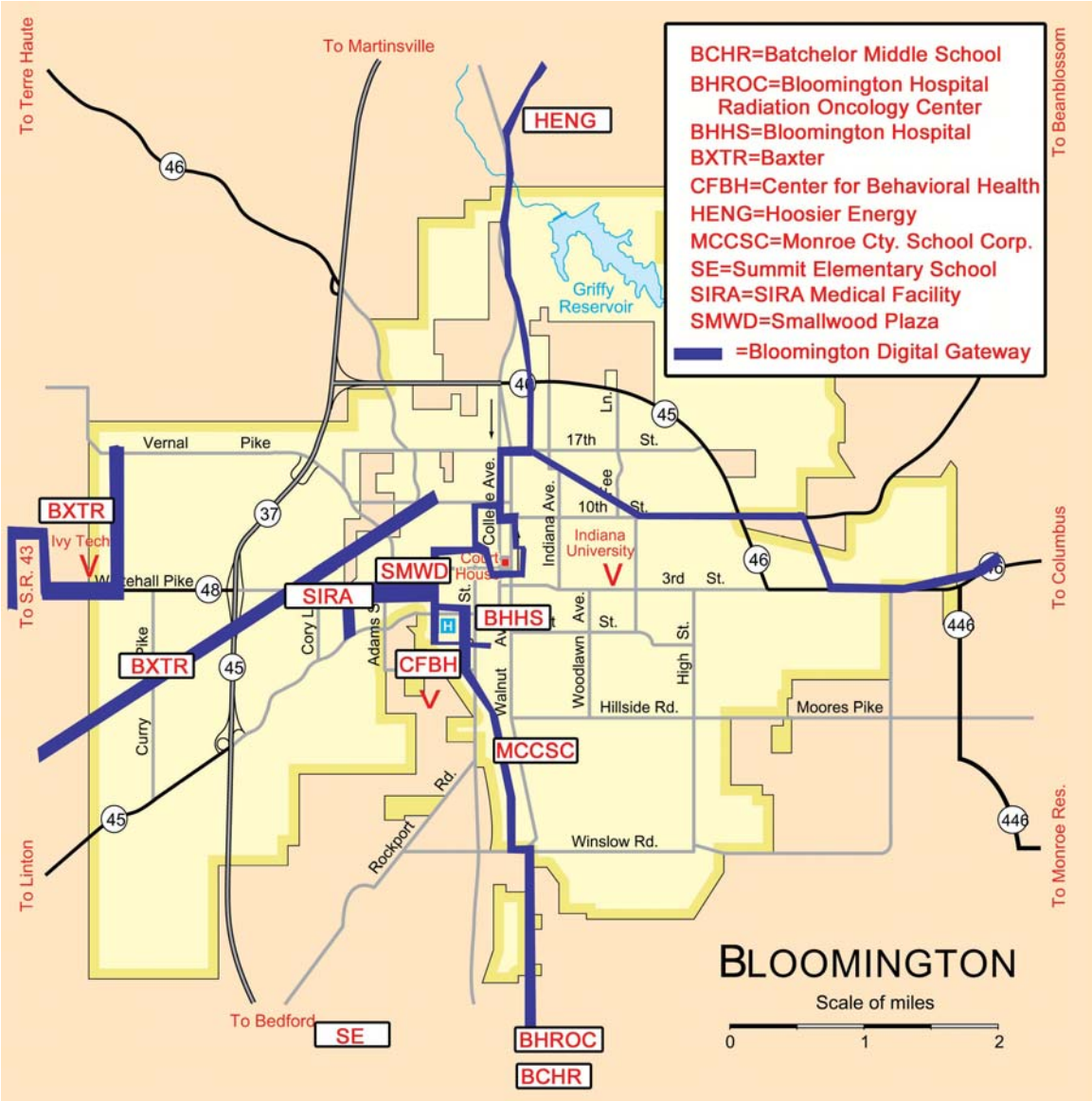

Figure 5 – Smithville Digital's Lit Fiber Optic Network

Smithville Digital has been actively placing fiber optics throughout the Bloomington area. Their business model is focused on building additional infrastructure only when a customer has been identified. It is uncertain whether Smithville Digital will be willing to utilize BDU infrastructure for future expansion.

SBC is currently in the planning process of a fiber to the node (FTTN) / fiber to the premise (FTTP) project named Project Lightspeed. "SBC Communications vowed to dramatically accelerate its plan to build a new fiber-optics network into neighborhoods, following the FCC's ruling clarifying broadband rules. SBC now

aims to provide 18 million households with 'super high-speed data, video and voice services' by year-end 2007 -- rather than five years as previously announced.

Under Project Lightspeed, SBC will provide integrated IP-based television, ultra-high-speed broadband, IP voice and wireless bundles of products and services. Through Project Lightspeed, the company will deploy 38,800 miles of fiber - double the amount used to build out the company's DSL network - at a cost of $4 billion to $6 billion."[4]

It is most certain that SBC will not be willing to utilize BDU infrastructure for Project Lightspeed expansion. However, implementation in Bloomington is assured to be quite some time into the future.

Cinergy does provide fiber optic connectivity for Tri-North, BHSN, Binford/Rogers, and Childs schools. However, due to their unwillingness to participate in the study little is known about the remainder of their current network or their future expansion plans. If interested in network expansion, Cinergy may be compelled to utilize BDU infrastructure.

Phone Company

There are two main phone companies operating in the Bloomington area, SBC, the incumbent local exchange carrier (ILEC) and Southern Hills, the competitive local exchange carrier (CLEC) arm of Smithville Telephone Company. Traditional phone company infrastructure consists of both fiber optic and copper transmission lines. General data services include T-1 (1.544 Mbps), T-3 (45 Mbps), and DSL (bandwidth varies). The base price for a T-1 to the Internet is approximately $500 per month while a point-to-point T-1 that connects two facilities can cost as little as $300. As mentioned in the Fiber Optics section, SBC will most definitely be unwilling to work with the BDU while Southern Hills (Smithville) may be willing to do so as they begin the transition to a fully fiber optic system.

[4] http://www.convergedigest.com/Bandwidth/newnetworksarticle.asp?ID=12617

1.2 Desired State

The Desired State is meant to detail information collected during interviews conducted with various organizations and individuals within the Bloomington community regarding the BDU. The information is presented within three distinct parts including a market needs analysis, proposed city and county initiatives, as well as an opinion section. Each is based purely on interviews conducted by InfoComm. The list of interviewees was created in conjunction with the BDUAC and can be viewed in *Appendix A*. The Desired State then culminates with a mission statement for the BDU based upon the information and opinions collected.

1.2.1 Market Needs Analysis

The current telecommunications market in Bloomington is very similar to markets in several other Indiana communities in which InfoComm has consulted. General consensus supports an interest in increased bandwidth made possible by fiber optic infrastructure. Some of the interest is substantiated while the majority is based upon unsubstantiated claims of cost reduction. This misconstrued focus on cost reduction, along with several other non-local, economic factors, has severely limited the implementation of "advanced" telecommunications networks by infrastructure owners operating in Bloomington. From their point of view, currently it is not economical to incur the capital expense of new technology and infrastructure deployment and reduce prices. Until this current mode of thinking changes, private deployment of "advanced" telecommunications networks will focus on those consumers who truly understand the economics and are willing to pay for the service. Information detailed herein is broken into views of the current market from several different perspectives.

Private Telecommunications Consumers

The major difference between consumers can be directly attributed to their level of telecommunications sophistication and understanding. In the current market there are two types of telecommunications consumers, those who view telecommunications as an expense and those who view telecommunications as an enabling piece of their business strategy. During the interview process, a very interesting discrepancy emerged between these two types of users. Users viewing telecommunications as an expense expressed interest in and a need for fiber optics. Conversely, users viewing telecommunications as an enabling piece of business strategy had a very good understanding of their bandwidth needs

and generally expressed that these needs were currently being met with existing services. Additionally, these users understood that more bandwidth was available, that it would cost more, and that their volume or business model would have to change before increased bandwidth was needed and could be substantiated economically. Thus, the discrepancy was caused by perceived need versus actual need which is a very big problem in the telecommunications industry today.

The businesses in Bloomington who view telecommunications as an enabling piece of their business strategy include members of the following segments, high-tech (Bloomington Information Technology Sector [BITS] members), large businesses with multiple local/regional facilities, and ISPs. Members of each of these segments were interviewed.

Interview results showed that there are very few large high-tech firms in Bloomington, most are small, local companies who feel that their bandwidth needs are being adequately met. There was no sign of a major bandwidth shortage among this segment. For example, CACI has been able to support 32 employees working on remote projects in Washington, DC with a single T-1. Nor was there any indication that increased bandwidth would drastically change the business model or competitive advantage of these businesses. While discussing the ability of the small business community to band together and aggregate their bandwidth needs, it was stated that ISPs were created for that very purpose.

While interviewing larger businesses in the Bloomington area it became apparent that there was a need for increased bandwidth and fiber optic infrastructure. These businesses were requiring faster and faster connections between their various facilities. However, according to these organizations, current telecommunications providers are working hand-in-hand with them to ensure that their needs are met. Additionally, they are doing so at increasingly better prices. This is especially true of Smithville; the price for Smithville's gigabit Ethernet service is the same as the price for 100 megabits from SBC, ten times slower.

The final group, ISPs, turns the focus to organizations deeply dependent upon bandwidth and infrastructure as core to their business. Changes in bandwidth price and supply go straight to their bottom line. Even so, those ISPs interviewed expressed little concern over bandwidth availability and pricing. Combining this lack of concern with the fact that the majority of their main

customers showed little need for increased bandwidth, the needs of most ISPs should stay relatively level. One caveat is the fact that several ISP expressed concern over the movement in the industry for infrastructure owners to also offer ISP services. This trend has made it increasingly difficult for ISPs to compete with infrastructure owners for DSL customers. Thus, successful ISPs are diversifying into wireless data and service/support.

Socially Benefiting Telecommunications Consumers

Major differences in description appears when focus shifts from profit driven private sector companies to the telecommunications needs of socially benefiting companies. Socially benefiting companies operate to provide a service to the general population. Return on investment (ROI) for these services is not measured in profit but rather in public value add, a very hard metric to measure. Thus, when focusing on telecommunications it is nearly impossible to gauge the ROI potential of investments in additional bandwidth and new technology. However, it is suffice to say that additional bandwidth and new technology, coupled with execution expertise, should provide added value through increased access to social services for the community.

Most of the socially benefiting entities that were interviewed expressed little need for increased telecommunications capacity. MCCSC is currently working with Insight and Smithville to connect the remainder of their facilities into their current fiber optic network. Their connection to the Internet is provided by a T-1 from Indiana Higher Education Telecommunication System (IHETS) and one from HoosierNet. Combined, these circuits are providing adequate Internet bandwidth to meet their current needs. Bloomington Hospital and the Center for Behavioral Health have both recently completed fiber projects with Smithville. Bloomington Hospital however, is constantly looking for new ways in which to provide better access to resources for their physicians. One example, the digitization of patient records, creates substantial bandwidth requirements above and beyond what is currently available. These projects push the envelope of what is currently being offered by private sector telecommunications providers yet are critical to the wellbeing of the community as a whole.

City/County Telecommunications Consumers

The City of Bloomington and Monroe County are by far the largest telecommunications consumers in the Bloomington area. There are numerous City organizations spread throughout the Bloomington area in disparate facilities. The City has and would like to continue to meet the

telecommunications needs of these facilities and their employees through the creation and expansion of the BDU.

The County, on the other hand, has not participated in the BDU, but would very much like to. Currently, the County would like to connect the Sheriff, Justice, Health, and Courthouse buildings together with fiber and connect them all to the telecom hotel. Additionally, the County would like to collaborate with the City by connecting its infrastructure with the BDU as well as coordinating with the City on future fiber optic projects.

In addition to core City and County function, there are several peripheral organizations the City and County must account for. One of those is CATS (Community Access Television Services). CATS works with the City and County to manage PEG channels. One important component of PEG management is the broadcasting of City Council meetings. During an interview, CATs explained that because bi-directional functionality is not built into Insight's system between the Showers building and the library where CATs is located, it is very inefficient to broadcast the meetings. Fiber optic connectivity between the CATs facility at the library and council chambers would drastically reduce this inefficiency. CATs is also currently talking with the County about broadcasting some trials and other justice matters. Fiber optics between the Courthouse/Justice building and the library could enable such a project.

Other peripheral organizations to the County include the library and convention center. The needs of the main library branch are attached to the needs of HoosierNet, as expressed above, while the needs of the Ellettsville branch are currently being met by Smithville. The needs of the convention center, on the other hand, are currently not being met. The convention center has not been able to support the Internet access, videoconferencing, and other technical requirements of its customers. This presents a problem as the convention center is the primary interface between the City/County and many visitors. Thus, fiber from the BDU is desired.

Infrastructure Providers

Of the providers who own infrastructure in Bloomington, Smithville was the most cooperative and voiced the strongest opinion of its needs. Smithville expressed strong resistance to the City's push to install more infrastructure as part of the BDU. Smithville continued without stating whether they would be willing to utilize City infrastructure as part of their fiber expansion strategy. However, Smithville did state that they thought the City should concentrate on

educating local companies to the competitive advantages that can be achieved by harnessing increased bandwidth and fiber optics as a new platform on which to build a strategy. Smithville is currently moving very aggressively to meet the demands of the sophisticated telecom users in Bloomington.

The only request from the other providers was expressed by Insight. They simply stated that they would like to be a part of telecommunications conversations instigated by the City as this project moves forward.

1.2.2 Proposed City and County Initiatives

During the interview process several proposed city and county initiatives relating to telecommunications and the current and/or future use of the BDU were discovered. These initiatives come from many different sources and may or may not be feasible.

- City-wide wireless project that consists of partnerships between IU, City of Bloomington, Monroe County, Bloomington Hospital, and other private ISPs.
- Utilize BDU to market the City of Bloomington as a high-tech city in order to encourage business relocation.
- Partner with the hospital to better enable the medical community to share patient records.
- Establish a single point of contact for telecommunications issues/needs and then approach providers as a unified market.
- Establish open communications with all providers.
- Provide fiber optic access as a tool for downtown/tech park development.
- Provide a video content distribution network that provides IP multicasting, streaming PEG channels and city/county meetings.
- Connect with fiber to Insight in order to send video content for distribution.
- Connect the library branches with fiber.
- Encourage local providers to build fiber to all locations in Bloomington.
- Free wireless access for all residents.
- Encourage economic development by offering bandwidth instead of TIF monies, or include as part of TIF.
- Offer subsidized bandwidth for good, high potential entrepreneurial ideas.
- Provide/support education to encourage the incorporation of high capacity bandwidth into competitive strategies.

- Install interspersed conduit road crossings including diagonal crossing at intersections.
- Create a master plan that describes how utilities, highway, planning are to include BDU – this includes financial details as well as specs – attach to Title 20 zoning policy.
- Coordinate builds with city and county road/highway projects.
- Utilize BDU to strengthen E911
- Prioritize city/county building build out and substantiate with ROI
- Fiber deployment as means of economic development

1.2.3 Opinions on BDU Direction

Similar to Section 1.2.2 above, several opinions relating to telecommunications and the current and/or future use of the BDU were discovered. These opinions come from many different sources and may or may not be valid.

- Utilize BDU as a community resource for both city and county.
- BDU strategy plugs into overall city plan/strategy.
- All costs should be justified for both the government and taxpayers.
- Residential access needs to improve/be offered in more places.
- City needs to be specific about what changes will happen and how it plans to back them.
- BDU should be a benefit for the entire community.
- Government builds infrastructure best – Public Works needs guidance though because market is not mature – Requires government and provider input.
- City should use PEG channels as an institutional network to increase reach.
- Taxpayers need to benefit from the BDU.
- Any earnings need to be reinvested to make a bigger footprint.
- There should be one access account that transfers between all providers.
- City must know where other networks are located.
- BDU shouldn't be harmful to local businesses.
- Current policies don't seem to be limiting.
- Strategy needs official ness – future decisions need to stick.
- Evolving goals built from a strong strategic base.
- Joint city/county committee.
- Tech Park may be too small for growth companies.
- Telecom hotel space is too expensive, need a volume strategy to attract co-location.

- Permitting is a problem for local providers, city needs to manage/facilitate and then get out of the way.
- The perception that the BDU is a low cost/no cost infrastructure needs to be changed.
- Need professional control over BDU construction – past installations were done poorly.
- Definition of broadband would be helpful to set minimum requirements.
- Combine BDUAC with Telecom Council (TCC) and upgrade to be more like plan commission, metro board, or non-profit extension of econ development.
- Government intervention as last resort.
- City needs a better way of locating – takes too long and requires more than one person.
- Re-conceptualize economic development -- as Mayor Kruzan does -- to be much broader in scope than its traditional definition, to essentially be public development.
- Recognize not-for-profits, arts, and culture as economic development engines.
- Recognize quality-of-life as an economic development metric.
- Recognize BDU as a public asset such that its benefit should be public.
- Private benefits should be complementary or components of larger public benefits.
- Tie-in concepts such as sustainability, concurrence, and public benefit.

1.2.4 Mission of the BDU

A mission is the purpose of an organization, in this case the BDU. It describes why the BDU exists by establishing the basic purpose toward which activities are directed. The mission for the BDU toward which this strategy will be built is based on interviews, research, and other information collected as part of this project. It is as follows:

The mission of the BDU is to utilize community resources in a fair and coordinated fashion to enhance, encourage, and facilitate telecommunications advancement for the public and economic benefit of the community.

1.3 Gap Analysis

The third and final part of the Vision section, the Gap Analysis, is meant to bring together, analyze, and make sense of information collected during interview sessions and documented previously in both the Current State and Desired State. This process consists of first performing a SWOT analysis that extracts strengths, weaknesses, opportunities, and threats from the collected information. Once complete, the analysis is used to document a list of issues that are then translated into goals aimed at bridging the gap between current capabilities and the mission of the BDU documented previously in the Desired State. These goals establish a vision for the future of the BDU.

1.3.1 SWOT

A SWOT analysis utilizes internal and external environmental information, as that documented in the Current State and Desired State, to establish the assumptions and facts on which the plan will be based. Analyzing strengths and weaknesses comprises the internal assessment of the BDU while analyzing opportunities and threats comprises the external assessment of the environment in which the BDU operates.

Strengths

The strengths of the BDU within its current capacity are documented herein. Strengths consist of identified areas in which the BDU is distinctive and competent.

1. *Current BDU infrastructure is superior to available alternatives in a number of ways, including:*
    - *Net Present Value (NPV) of initial Investment,*
    - *Ownership versus Leasing, and*
    - *Flexibility.*

There are essentially three different ways in which to obtain the connectivity needed by the City of Bloomington. These include a capital expenditure (build it internally), a capital lease, or an operational lease. Currently, in the City of Bloomington these can be reduced to either a capital expenditure or an operational lease because current providers don't offer capital leasing which requires that the provider hand over ownership of the infrastructure at the end of the lease.

In order to compare the two options, InfoComm has compared past BDU capital expenditures to SBC tariff pricing for operational leases. The most logical comparison, given the fact that the City is currently running a fail safe version of Ethernet technology called Redundant Packet Ring (RPR), is to compare the BDU (1000 Mbps) with SBC's OC-12 (622.08 Mbps) pricing.[5] The analysis, depicted in *Figure 6* below, shows the present value of future payments for both infrastructures in the current 6 node state as well as in various expansion states. The present value of cash outflows for the current BDU infrastructure is about $1.5M (over twenty years) compared to about $2.2M for similar connectivity from SBC. The model and associated assumptions used for this analysis are documented in *Appendix B*.

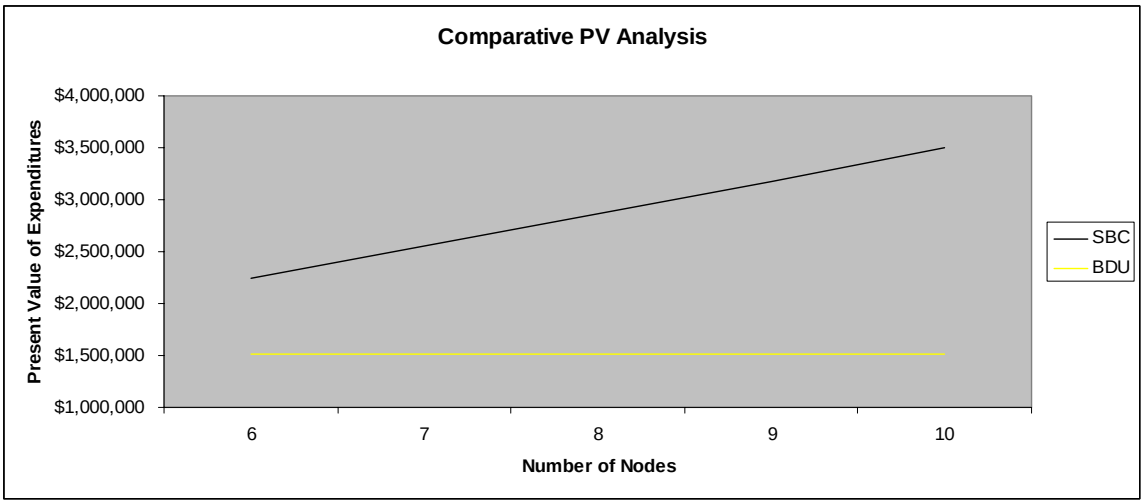

Figure 6 – Comparative PV Analysis

Unfortunately, connectivity options from other local providers were withheld from InfoComm during the interview process. Smithville stated that they price each project independently; Insight stated that they do not have data options available for businesses, and Cinergy did not participate in the project. Regardless of the possible pricing estimates each could have provided, it can be assured that each quote would be in the form of an operational lease. It can also be assured that the lease price would pay for two things, the debt service from the capital used to originally install the infrastructure and the book value of the infrastructure itself. Given that the City has thus far utilized available monies, debt service payments are not required making it more attractive for the City to obtain connectivity through capital expenditures as opposed to leases.

[5] SBC's current Ethernet options only allow Star topologies

The final advantage making the current BDU superior to alternative options is flexibility. Because the City owns its own infrastructure it has several flexibilities not found in offerings from current local providers. First, the City has the ability to leverage its telecommunications expertise within the Information and Technology Services (ITS) Department. Only through a dark fiber lease could the City leverage ITS in a similar manner. US Signal offers the only dark fiber option in the City. Until this project this asset has gone unidentified. The reason for the lack of willingness to provide dark fiber is that dark fiber business plans are based on volume not value add, thus it is very hard to substantiate without a significant number of interested customers.

Second, the City is able to run a superior technology in a fiber preserving, fail safe topology. Given most alternative options, the City would be required to run Gigabit Ethernet technology in a Star topology. This would require a pair of fiber for each new node and would lack 50 ms fail-over (carrier grade). The current technology, RPR, enables a true ring topology and provides automatic network fail-over in the case of equipment failure or fiber cut as well as allows a single fiber pair to connect multiple buildings together as a network. Alternatively, the City could opt for Synchronous Optical Networking (SONET) technology that does operate in a fail safe ring topology. However, SONET equipment is much more expensive than the current RPR equipment being run by the City.

Additionally, the current BDU infrastructure enables the City to quickly and cost effectively add additional nodes to the network. This is imperative as the City works to connect additional buildings and looks to utilize the infrastructure to meet other community telecommunications needs. As can be seen in the comparative analysis diagram in *Figure 6* above, if the City would have obtained connectivity from an alternative provider, each new node added to the existing infrastructure would add to the overall cost of the network. This additional cost is not due to equipment or lateral builds, these amounts are both the same for either option, but rather are attributed to the pricing strategy of providers.

Finally, the fact that the BDU has been built with excess capacity adds greatly to the City's options for meeting other identified needs moving forward.

2. *Telecommunications expertise of the ITS Department*

The ITS Department has very strong telecommunications and various other technical skills that each member has developed through substantial experiences in the public sector. With these skills in house, the City has the ability to service and provide most telecommunications connectivity internally without the additional cost of paying a provider to do so.

3. *Affect on the local telecommunications market*

Although it is nearly impossible to verify, the BDU has had a positive affect on the local telecommunications market. Within the past 6 months alone several large telecommunications projects have been initiated with local providers. This includes the following:

- Hospital chose Smithville to wire 3 locations in Bloomington and 1 in Paoli,
- Center for Behavioral Health has connection from Smithville to telecom hotel and to office in Martinsville,
- Cornerstone is working on a project with ION, and
- Smithville Digital released information about their Bloomington Digital Gateway that includes fiber connectivity for Smallwood Plaza, SIRA Medical Facility, several MCCSC Schools, Hoosier Energy, and Baxter.

Although this activity can't be directly linked to the BDU, it is ironic that these projects have begun while this strategic process has been publicized. Similar results from strategic planning efforts have been seen in other InfoComm engagements.

4. *Cost efficient construction*

One significant ability of the City is that it always has its finger on the pulse of all that is happening from a construction standpoint. Through day-to-day planning and engineering processes the City is constantly aware of current and future projects. This enables the City to construct telecommunications facilities along side other underground projects effectively spreading the capital expenditures across multiple initiatives.

5. *Certified Technology Park (CTP) status*

The City of Bloomington is currently in the process of establishing the downtown area as a CTP. With such a designation, the City will gain the ability to utilize tax increment financing to install telecommunications infrastructure within the area designated.

6. Government owned assets

There are many assets that the City of Bloomington has at its disposal to help further develop the BDU. These include, but are not limited to, the following:

- Rights-of-way
- Abandoned conduit systems
- City employees' expertise and time
- Public, Education, and Government (PEG) channels
- Existing committees

7. Policies

The current policies provide sufficient ability for the BDU to move forward with actions resulting from this strategy. There are little to no changes necessary for this strategy to be put into effect on completion.

Weaknesses

The weaknesses of the BDU within its current capacity are documented herein. Weaknesses consist of identified areas in which the BDU is vulnerable and could be exploited.

1. Lack of mission and vision

As was detailed in the Current State section, the BDU was initially created with three distinct benefits in mind. However, due to the fact that these benefits were not further developed into a mission and vision for the future, the BDU has stagnated. Without a solidly backed mission and vision upon which to build the BDU, the current lack of direction may continue. The result has been no justification for the BDU to do much of anything.

2. Authority

Under the current structure, it is unclear where the ultimate authority over the different aspects of the BDU lies. Several organizations, committees, and

departments are active in the decision process. The Board of Public Works owns the infrastructure asset, City Council makes decisions regarding allocations from the Telecom Fund and connectivity to the BDU, ITS operates the BDU and suggests expansion opportunities, and the BDUAC makes recommendations on a number of BDU related issues. This lack of authority and ultimate accountability could be detrimental to the future of the BDU.

3. *Lack of integration within City Government*

City government is a highly structured organization where assets, projects, and opportunities are shared amongst departments to further benefit the general population. However, the BDU has yet to become embedded in the organizational structure. The result is that the BDU misses many opportunities to benefit from other City projects and initiatives.

4. *Financing*

Financing for the BDU has come from a number of sources in a very piecemeal fashion without documented community benefits. The result is a lack of transparency for the BDU in the minds of many taxpayers. This has been a big sticking point in BDU expansion efforts. A more standardized process would enable the City to collect metrics justifying the BDU and its benefits to the community as a whole.

5. *Construction standards*

It has been expressed during interviews that the City has not done a very good job of monitoring and verifying the work of contractors during BDU construction. Upholding the highest construction standards should be of utmost importance to the City. Establishing a high bar to which others must strive will ensure safety on both the roadways and in the rights-of-way.

6. *Locating*

One concern voiced through the Department of Public Works was that the BDU has added significantly to the work of the Traffic Division. As part of their job the Traffic Division responds to locating requests. These requests have been numerous and the Department of Public Works has requested that this issue be addressed.

7. *Lack of utilization of existing BDU assets*

The BDU was built with excess capacity for the purpose of extending its benefits to other organizations within the community. Up until this point, access to these assets has not been extended beyond city use. As a result, there has been significant scrutiny about the benefit of the BDU.

8. *No community interaction*

The BDU project and the City of Bloomington represent the perfect opportunity for the City to establish a one stop shop for telecommunications information. This is badly needed. Instead of working with each provider independently, the City has the ability to help individual business by taking telecommunications requests, helping new and existing businesses with connectivity issues, and representing the voice of the general population to local providers.

Opportunities

The opportunities in the current environment are documented herein. Opportunities consist of identified characteristics on which the BDU may capitalize.

1. *City/County Collaboration*

The City and County have the potential to combine assets and opportunities to create a telecommunications project in partnership. The County has been following City specifications for all conduit and fiber projects they have undertaken as part of road construction projects completed and currently underway on the west side of Bloomington. Additionally, the County has plans to continue to install conduit with road projects. County officials have expressed interest in collaborating and are anxious to look into utilizing BDU assets to connect a number of County facilities. The County's infrastructure is depicted in *Figure 7* below. The dashed black indicates planned conduit only sections while the solid black indicates installed conduit and fiber.

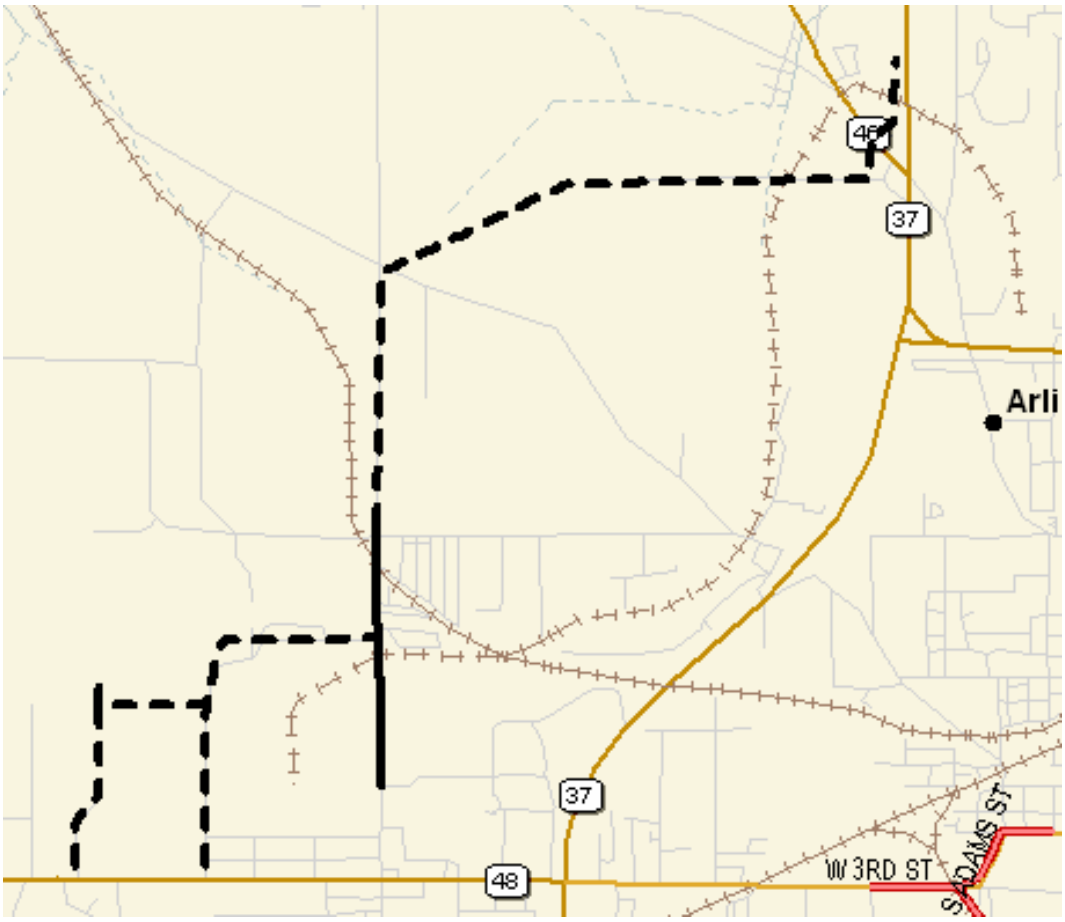

Figure 7 – County Conduit and Fiber Optics

2. *Wireless*

Currently, IU and Kiva Telecom are working in partnership to deploy wireless access throughout Bloomington. Building on this success, the City could join the partnership and potentially create a much larger wireless footprint through the use of new technology such as WiMAX and access to high bandwidth infrastructure provided by the BDU. This could greatly increase data throughput for City employees in the field.

3. *Expanded scope*

Based on the current market analysis small and large businesses are being well served by telecommunications providers. However, there is still a niche that the BDU is perfect to serve. This niche is the non-profit sector. Most non-profits give back to the community, thus, providing subsidized telecommunications services to them will, in effect, benefit the community. Several non-profits are anxious to work with the City, these include:

- IvyTech
- HoosierNet
- Libraries

4. *Education*

BITS consists of a collection of technology based companies within the Bloomington area that sponsor information sessions on various technologies. This organization is in the unique position to offer education to area businesses about how to make the most of the recent activity and availability of fiber in the telecommunications market.

5. *Economic development*

Advanced telecommunications, when obtained for the proper purpose, have the ability to allow the smallest companies in some of the smallest communities to compete globally. By connecting more ubiquitously at faster speeds companies are no longer limited by proximity to their suppliers or their customers. The BDU has the ability to help spread this connectivity all over the City of Bloomington to enable existing industries to grow and new industries to develop.

6. *City planned road construction projects*

The City currently has plans for several road construction projects. These projects have the ability to enable the BDU to expand its reach. Up coming projects include:

- West 3rd Street
- Landmark to 37
- West 2nd Street
- 2nd and Adams (International Data)
- Adams Street Corridor
- Hillside extension (County offices)
- 48 to Park 48
- 46 bypass

7. *Emergency management*

A common telecommunications infrastructure that connects all major city and county areas to a common system would be extremely beneficial for emergency management interoperability. This type of access would enable better dispatching, 911 and E911 services, communications between fire, police, EMS, etc, and fail-over options. Currently, interoperability projects are high on the government's list of Homeland Security best practices and can result in funding support.

8. Smithville

The most progressive telecommunications company in the Bloomington area is Smithville. They have begun increasing their fiber optic assets and offering access to more and more Bloomington organizations. Although their managed services are unattractive to the City of Bloomington, there are several areas in which Smithville and the City can and should collaborate. For one, it makes perfect sense, considering the fact that Smithville's major economic benefit comes from services and provisioning, for the City of Bloomington to lease/sell conduit to Smithville in order that they may offer the end customer fiber optics and managed services over that fiber. Additionally, there is no reason why the City of Bloomington, under an appropriate contract, should not collaborate with the Town of Ellettsville, Monroe County Library, and the Ellettsville Fire and Police to utilize Smithville's current assets to extend the reach of the BDU.

9. Medical Community

In the City of Bloomington outpatient medical facilities have done a nice job of conglomerating in a few major locations. This lends itself nicely to connecting many such facilities with a single investment. Connectivity such as that provided by fiber optic facilities provide numerous returns to the community through enhanced medical services, increased access to highly specialized physicians, and ubiquitous medical record transmission. Add these community benefits to the fact that the hospital is a non-profit entity and it becomes clear that there are opportunities for the BDU to collaborate on medical related projects.

Threats

The threats in the current environment are documented herein. Threats consist of identified characteristics on which the BDU may be negatively affected.

1. *General consensus*

General consensus suggests that many people have written off the BDU's ability to do much more than provide for internal city telecommunications needs. Years of no focus and a lack of tangible benefits have resulted in this perception.

2. *Telecommunications hotel costs*

In a telecommunications hotel environment there are usually a number of providers with a lot of equipment representing a significant amount of invested capital. As a result, each individual tried to squeeze as much margin out of the business they do in the hotel as possible. The current telecommunications hotel is in such a location that the cost per square foot is too high for anyone to squeeze any more margins out of it. Instead, the telecom hotel should be in a relatively inexpensive space in which many providers will be willing to co-locate.

3. *Marketing*

The BDU is a one of a kind infrastructure in the State of Indiana. Many cities in Indiana and elsewhere are undertaking comparable projects that are providing measurable returns for their communities. If the BDU stagnates for much longer all marketing potential that such a project has the ability to create may be lost.

4. *Unwillingness of current providers to utilize spare conduit capacity*

According to local providers, there is little value in the spare conduit owned by the City. In reality, this is not the case. There are several large to medium businesses along the current fiber path that could benefit greatly from fiber installation. Due to the fact that the fiber is already installed and easily accessible for many of these entities, the costs of connection are minimal. It is imperative moving forward that the City concentrate on creating a market for any spare capacity as it is the cheapest way advanced technologies will permeate throughout the community.

5. *State and federal road construction projects*

There are two main road projects currently underway at both the state and federal level that, if left unattended, may cause problems for future BDU expansion. These include the 45/46 bypass expansion and I-69. These projects have the ability to be very beneficial to BDU expansion given proper planning; however, given the current situation, these roads will become more roadblocks than benefits. Planning for and inclusion of these projects is crucial.

6. *Legislative/regulatory threats*

Over the past several years there has been annual legislation proposed to eliminate a municipality's ability to install and own its own infrastructure. It appears as if this trend will continue.

1.3.2 Issues

The following is a list of the major issues currently facing the BDU as extracted from the SWOT analysis:

- The avenue through which the City can justify expanding infrastructure to capitalize on public and economic development opportunities has traditionally been weak.
- The BDU has been highly scrutinized even though the City has saved itself money, gained extreme flexibility, and established a valuable asset through construction of the BDU.
- The City has not been able to show or describe proof that the BDU is a benefit to the community.
- The BDU is in jeopardy of missing out on some very big opportunities due to lack of structure.
- Fears and worry of the City competing with local businesses has forced stagnation of the BDU.
- The BDU has not made its way into the inner working of the City of Bloomington's government structure even though it is a City asset.
- A market for the excess BDU capacity has failed to materialize.

1.3.3 Goals

Strategic goals are developed to bridge the gap between current capabilities and the mission in order to provide a vision of the future. The focus of these goals is on desired changes. Each is worded such that, when reached, they will have addressed an issue as documented above. The goals for the near future of the BDU are as follows:

- Solidify the BDU's position within City of Bloomington government,
- Establish win-win partnerships with both public and private organizations,
- Encourage the utilization of excess BDU capacity,
- Leverage City owned assets to undertake community benefiting projects to expand the BDU, and
- Quantify and publicize community benefits of the BDU.

2.0 Direction

The purpose of the Direction section is to establish courses of action to achieve the long-term goals of the BDU detailed at the end of the Vision section. The courses of action are presented as strategies. There are three main strategies necessary to meet all of the goals. They are Governance, Pricing, and Growth. Within each strategy there are several options focused on the vision, each from a different direction. The direction chosen within each strategy is based upon the internal and external environmental analysis performed as part of the SWOT with focus on the core competencies of the City and the BDU. Ultimately, the strategies determine the current and near future direction of the BDU.

2.1 Governance Strategy

The purpose of the Governance Strategy is to solidify the BDU's position within City of Bloomington government. In the case of this strategy, governance refers to a system and structure for defining policy, providing leadership, and managing and coordinating the procedures and resources of the BDU. This includes a number of roles and responsibilities documented in the following sections.

2.1.1 Oversight

The role of oversight is established to ensure that future initiatives of the BDU adhere to established policies. This role is general in nature, but can be defined by a specific set of responsibilities. Currently, these responsibilities are governed by BDU Policies approved under Resolution 03-28 and the establishment of a Telecommunications Non-Reverting Fund and its appropriations under Ordinances 96-31, 00-45, 03-29, and 04-24. Under these resolutions and ordinances the City of Bloomington fiscal body (City Council) is responsible for the following:

- Approve the rates for leasing the City's fiber optic conduit and fiber strands as well as one-time charges for all related services, such as fiber splices and manhole connections, and
- Expenditures from the Telecommunications Non-Reverting Fund, Road and Traffic Improvement Account, and General Fund for BDU expansion and operating expenses.

Given the SWOT analysis performed, it is recommended that these roles and responsibilities proceed as originally defined.

2.1.2 Ownership

The role of ownership is established to place the BDU asset within a specific department. The purpose for this placement is to ensure that the appropriate measures are taken to maintain the integrity of such an asset. Currently, these responsibilities are governed by BDU Policies approved under Resolution 03-28. Under this resolution the Board of Public Works is responsible for the following:

- Creation of a standing advisory committee to provide advice and recommendations on the usage, pricing, and management of the City's fiber optic asset,
- Management of all construction projects in which City-owned fiber optic assets will be installed, and for supervising the connections of City-owned fiber optic assets to fiber optic conduit and cable that is owned by entities other than the City of Bloomington,
- Determination of an appropriate amount of fiber optic conduit and fiber strands to make available to entities other than the City of Bloomington,
- Approve all contracts used in leasing fiber optic assets to customers,
- Enact safeguards to ensure that no entity be allowed to lease the entire available infrastructure in an attempt to prevent competitors from using it, and
- Establishing rates for leasing the City's fiber optic conduit and fiber strands as well as one-time charges for all related services, such as fiber splices and manhole connections.

There are several alternative options for ownership of this asset. Each option is outlined in *Table 1* that follows. The values listed across the top were extracted from the interview process as well as best practices observed by InfoComm during various strategic planning engagements.

	Flexibility	**Authority**	**Longevity**	**Funding**	**Equal Representation**	**Objectivity**
Board of Public Works	Positive, governed by code, but it is flexible.	Positive, backed by code and City Council.	Negative, no real way to partner and share assets.	Positive, Telecom General Fund.	Negative, all members appointed by the mayor.	Positive, represent the best interest of the City.

	Flexibility	Authority	Longevity	Funding	Equal Representation	Objectivity
Non-profit 501 c (3)	Positive, able to perform whatever duties.	Negative, not a government entity.	Positive, able to sustain as long as financially sound.	Negative, must rely on private grants as funding source.	Positive, makeup of the entity is defined in incorporation and can be changed at will.	Negative, not accountable to any organization through budget and rely on grants from private interests.
Interlocal Agreement (I.C. 36-1-7)	Positive, the duties of the entity is defined in the agreement..	Positive, an interlocal agreement guarantees the power of each entity remains.	Positive, there are no restrictions to length of agreement and the process can be de-politicized.	Positive, a budget is set and expenses above and beyond budget must be approved. Grants can be accepted.	Positive, the makeup of the entity is defined in the agreement.	Positive, accountable to all organizations involved in agreement.
Municipal Utility (I.C. 8-1.5)	Negative, very restrictive of purpose and defined operations.	Positive, authority is granted in the code.	Negative, no real way to de-politicize the organization.	Positive, a budget is set and revenues from the utility become part of the budget.	Positive, utility makeup is determined by those government units served by utility.	Positive, accountable to all organizations served by utility.

Table 1 – Ownership Options

Given the analyses performed, the following recommendations are submitted to the Board of Public Works regarding the ownership role and its responsibilities:

- The Board of Public Works remains the best alternative for the ownership role due to its access to internal information, City employees, and financing through the Telecommunications Non-Reverting Fund.
- If a partnership with Monroe County and/or other entities is forged ownership coordination may become an issue. In the case of Monroe County an Interlocal Agreement is recommended.
- Transfer the responsibility of determining the appropriate amount of fiber optic conduit and fiber strands to make available to entities other than the

City of Bloomington to the day-to-day operations role (Director of ITS as described in section *2.1.4 Day-to-Day Operator* that follows).

- Revise the standing advisory committee specifications established in Resolution 2003-45 per recommendations made in section *2.1.3 Strategic Direction* of this document.
- Work with ITS to establish engineering specifications for subsequent fiber optic installations.
- The Board of Public Works should work to redesign the permitting process and establish a rights-of-way policy with the following goals in mind:
    - It is in the best interest of the City of Bloomington to encourage advanced telecommunications investments,
    - Permitting processes should be as streamlined and efficient as possible,
    - Permitting and rights-of-way fees should not be revenue generating but should instead cover expenses incurred while processing applications and managing rights-of-way,
    - In instances where the BDU exists, policies should highly encourage utilization of the asset instead of new construction. This can be accomplished via stiff fines and taxes for non-compliance, and
    - As-built delivery and verification are required of all utilities operating in the rights-of-way.
- Assign a member of the Engineering Department the role of BDU Engineering Liason. This role shall verify that all construction projects meet BDU specifications pre and post build, present BDU as-builts to GIS, and collect as-builts from local providers per a newly defined rights-of-way policy (see section *3.0 Migration Plan* for more details).
- Work with ITS and City lawyers to draft a standard contract for utilization of the BDU.

2.1.3 Strategic Direction

The role of strategic direction is established to set long-term goals based on the mission of the BDU and recommend appropriate strategies and related initiatives aimed at meeting these goals. This role provides direction to the decisions and actions of both the Board of Public Works and City Council through recommendations justified by a well formulated strategic plan. Currently, these responsibilities are governed by Resolution 2003-45 entitled "To Create the BDU Advisory Committee". Under this resolution the BDUAC is responsible for the following:

- Provide advice, recommendations, and strategic direction to the Board of Public Works and the Common Council on the usage, pricing, and management of the City's fiber optic assets (the BDU),
- Meeting at least quarterly, and
- Establishing its own rules of operating procedure.

There are several alternatives options for the establishment of the role of strategic direction. Each option is outlined in *Table 2* that follows. The values listed across the top were extracted from the interview process as well as best practices observed by InfoComm during various strategic planning engagements.

	Telecom Expertise	**Transparency**	**One-stop Shop**	**Rights**	**Representation**	**Authority**
BDUAC (City resolution 2003-45)	Positive, several telecom savvy individuals with broad experience and exposure.	Negative, not very visable.	Negative, not used to interacting with citizen requests.	Positive, established for this purpose.	Positive, very broad represenatation.	Negative, established by resolution
Telecom Council (TCC) (City code 2.12.060)	Positive, several telecom savvy individuals with broad experience and exposure.	Positive, the TCC is a highly visible council.	Positive, deals with citizen requests and interacts with the cable franchisee.	Positive, City code permits focus on all telecom related matters of the City.	Positive, two members appointed by the mayor and three by common council.	Positive, established by City code.
Economic Development	Negative, no experience in the field.	Positive, highly visible in the community.	Negative, not something economic dev has time to entertain.	Positive, telecom can be included as part of economic dev.	Positive, appointed by mayor and private businesses.	Positive, has good rapport with Mayor as well as industry.

Table 2 – Strategic direction options

Given the environmental and alternative analyses performed, the following recommendations are submitted to the Board of Public Works regarding the strategic direction role and its responsibilities:

- Transfer the role of strategic direction from the BDUAC to the TCC. With the rapid approach of converging technologies in the market the two bodies may begin to overlap. In this case the TCC has a better handle on the technologies and associated issues than does the current BDUAC. Additionally, the BDU does not sit alone in the market. Instead, it is a facilitator of competition sitting in the middle of local telecommunications companies. This requires a highly transparent organization with the ability to negotiate with and influence market players. The TCC fits this role better than the current BDUAC.
- Increase the responsibilities of the strategic direction role to include the following responsibilities:

    - One-stop shop for telecommunications related issues, concerns and needs of the general public as well as the telecommunications providers,
    - Consult with the day-to-day operator regarding strategic decisions not requiring City Council or Board of Public Works authorization, and
    - Provide a yearly progress report to City Council, Board of Public Works, and the Mayor consisting of a rating of the performance of the day-to-day operator.

2.1.4 Day-to-Day Operator

The role of day-to-day operator is established to manage the BDU. This role manages and provides direction to City employees responsible for the day to day operation of the BDU. Currently, these responsibilities are governed by BDU Policies approved under Resolution 03-28. Under this resolution the Chief Information Officer is responsible for the following day-to-day operator tasks:

- Keeping track of the total capital cost of the City's fiber optic assets, operating income, and expenses for using the City's fiber optic assets,
- Allocating BDU related tasks to staff from the ITS Department as needed,
- Allocating ITS resources to BDU related tasks as needed, and
- Recommending to the Board of Public Works the appropriate amount of fiber optic conduit and fiber strands to make available to entities other then the City of Bloomington.

The Chief Information Officer title has been replaced by the Director of ITS. It is recommended that all day-to-day operator roles and responsibilities transfer to

the Director of ITS. It is also recommended that the following additional responsibilities are given to the day-to-day operator role per an amended job description:

- Coordination, alignment, and collaboration of BDU initiatives with Federal, County and State initiatives,
- Collaboration with public and private entities, including economic development, on telecommunications projects (all contracts and non-budgeted expenditure must still be approved),
- Submittal of a budget each year for approval by City Council,
- Collector of BDU related information for discussions with strategic direction role,
- Create favorable ways in which to press local providers into large scale deployments of advanced telecommunications to residents and small businesses (i.e. the way Fort Wayne pressured Verizon into making them one of their pilot cities for Fiber to the Home.),
- Analyze and present to strategic direction role the public/economic/social benefits of potential projects,
- Provide interfacing through the ITS Department for the one-stop shop collector and distributor of information,
- Sit on and/or collaborate with decision making boards within City government, especially planning,
- Become a chain in the planning process,
- Create, update, and own the BDU Master Plan discussed in Growth Strategy,
- Provide metrics and other marketing material to economic development for BDU/Bloomington technology publicity,
- Manage the BDU related tasks assigned to individuals within different departments, and
- Produce an end of the year statement for the BDU.

2.2 Pricing Strategy

The purpose of the Pricing Strategy is to set a course of action for the way BDU pricing decisions are made. Pricing decisions are generally based on the linear regression of a demand function which includes things such as customer income and the status of the current economy. However, in the case of this project a demand function does not exist. This lack of a demand function is a result of several project characteristics including the following:

- Monetary returns are not the only returns associated with this project,
- Both a profit center and a cost center are involved, and
- Current demand for service among private organizations is not likely to develop until services become available (chicken and the egg).

This fundamentally alters the standard process of using the demand function to compare volume and associated margins at different prices in order to make a go/no go decision about proposed growth. Instead, the process must begin by valuing the public benefit associated with current assets and proposed growth. This is then factored into the price and projected value of an investment. As a result, both the Pricing Strategy and Growth Strategy are linked not only to economic benefit but also to public benefit. The inclusion of each type of benefit in these strategies is inline with the stated Mission of the BDU.

2.2.1 Public and Economic Benefit

It is important to begin this process by establishing an understanding of the difference between public and economic benefit.

Economic Benefit – Economic benefit is the measurement of the money and/or services received from an asset over time. It is measured in normal monetary units and is used to determine if the financial results of an investment are favorable. Since the BDU is potentially both a profit and a cost center for the City of Bloomington, economic benefit is calculated by multiplying estimated fiber and conduit demand by the determined price and adding to this value the present value (PV) of the portion that is set aside for City use.

Public Benefit – Public benefit is the measurement of the increased value received by the general population from a community asset over time. For the purposes of this document, it is measured in monetarily equivalent units and is used to determine if increased community value attributed to an investment are favorable. For the purpose of this document, public benefit is assigned a value based on the percentage of invested capital estimated to equal the perceived added value received by the general population over time. It should be noted that public benefit as described herein is largely a subjective estimate of perceived benefit.

Any discussion of the City's investment in assets that are utilized internally yet also benefit the greater good of the community should include both of these elements.

2.2.2 BDU Pricing Model

The BDU pricing model described in this section is meant to provide both a means of setting a price for City owned conduit and fiber as well as the analysis required to input profitability to the growth decision process described in the Growth Strategy section. To begin the price setting process, the City must input several variables into the pricing model, displayed in *Table 3* below.

Variables	Value		Public Benefit Rating Scale	Capital Percent Equivalency
Total Innerducts Installed	3			
Fiber per Innerduct	96			
Fiber Used by City	36		1	5%
Estimated Innerduct Leased/Sold	1		2	10%
Estimated Individual Fiber Leased/Sold	112		3	15%
Public Benefit Rating	8		4	20%
Estimated Inflation	2%		5	25%
Price Volume Discount (per innerduct)	10%		6	30%
Life of Asset (years)	20		7	35%
Public Benefit Opportunity Cost of Funds	2%		8	40%
Capital Cost of Funds	0%		9	45%
Additional Required Return	2%		10	50%

Table 3 – BDU Pricing Model Variables

The variables consist of the following:

- **Total Innerducts Installed** – This is the number of innerducts installed as part of the build. There are generally 3 – 1 ¼ inch innerducts installed inside 1 – 4 inch PVC conduit.
- **Fiber per Innerduct** – This is the number of fiber optic strands installed within each innerduct as part of the build. For the purpose of the model, empty innerducts are assumed to have the same capacity as the number of strands installed by the city within its innerduct. 200+ strands of fiber can fit inside 1 – 1 ¼ inch innerduct.
- **Fiber Used by City** – This is the number of fiber optic strands used by the city. The city has claimed 36 of the 96 initial strands installed in the first phase of the BDU project. Currently, they are using 2, a pair, to connect city buildings.
- **Estimated Innerduct Leased/Sold** – This is the estimated number of complete innerducts sold over the life of the asset.
- **Estimated Individual Fiber Leased/Sold** – This is the estimated number of fiber optic strands sold over the life of the asset.
- **Public Benefit Rating Scale** – These are the most important set of estimates to make before using the model.

- **Public Benefit Rating** – This variable represents the relative amount of added public benefit. It is reported on a scale of 1-10 and is assigned values from the Pubic Benefit Rating Scale. The scale represents the values at which the public benefit rating is converted into monetary units by associating the rating with a percentage of capital investment covered by public benefit. It is suggested that this table is set to ensure that a fair level of economic return is guaranteed.
- **Estimated Inflation** – This variable represents the estimated value of inflation over the life of the asset. It is used to calculate the PV of future cash flows.
- **Price Volume Discount** – This is the discount given to purchasers of full innerducts.
- **Life of Asset** – This variable represents the estimated number of years the asset can be utilized. The lease prices returned from the model assume that leases are written over the same period.
- **Public Benefit Opportunity Cost of Funds** – This variable is meant to represent the community value added if the amount invested in the BDU were used elsewhere. Unless the BDU investment is greater than or equal to this value, the investment could have been used more productively elsewhere.
- **Capital Cost of Funds** – This variable is meant to represent the finance charge associated with the capital investment. Unless the BDU investment is greater than or equal to this value, the economic and public benefit returned by this asset will not be sufficient to pay for the financing.
- **Additional Required Return** – This variable is meant to represent the economic and public value added from this investment. This value is above and beyond all other costs.

Once set, the model is ready to run and return the minimum recommended price. The model was created using Microsoft Excel. As can be seen in *Table 4* below, it is based on the premise that the PV of Total Investment plus the PV of Additional Costs subtracted from the PV of Total Economic Benefit and the PV of Total Public Benefit should Net zero (0). If the model does Net zero (0) it means that all of the costs are covered by benefits, both economic and public. However, if the model has a positive Net value, the costs are greater than the benefits and vice versa.

PV of Total Investement	
Initial Capital Expenditure	1,100,000
PV of Future Service & Maintenance	1,000,000
PV of Total Investment	2,100,000
Economic Benefit	
PV of Estimated Portion Used by City	262,500
PV of Conduit Economic Benefit	691,200
PV of Individual Fiber Economic Benefit	895,731
PV of Total Economic Benefit	1,586,931
Public Benefit	
Public Benefit %	40%
PV of Total Public Benefit	840,000
Additional Costs	
PV of Total Opportunity Cost	42,000
PV of Total Capital Costs	0
PV of Total Additional Required Return Cost	42,000
PV of Additional Costs	84,000
Investment Analysis	
PV of Total Investment	2,100,000
- PV of Total Economic Benefit	1,586,931
- PV of Total Public Benefit	840,000
+ PV of Additional Costs	84,000
Net	-242,931

Table 4 – BDU Pricing Model Algorithm

Essentially, this ensures that the recommended minimum price returns the required amount of economic benefit given the established variables to make up for all associated one-time and reoccurring costs as well as any additional cost constraints put on the investment.

The pricing outputs for the variables listed in *Table 3* and the analysis shown in *Table 4* are shown below in *Figure 8*. The total price rows represent the PV of the future payments made over the usable life of both individual fiber strands as well as full innerducts. These can also be interpreted as one-time payments. These values are also displayed in equivalent yearly payment terms which represents a constant value to be paid one a year for the usable life of both individual fiber strands as well as full innerducts.

Pricing			Partner Level	Discount
Total Price per Fiber - Partner Level 1	$10,000		1	0%
Total Price per Fiber - PL 2	$9,000		2	10%
Total Price per Fiber - PL 3	$8,000		3	20%
Total Price per Innerduct - PL 1	$864,000			
Total Price per Innerduct - PL 2	$777,600			
Total Price per Innerduct - PL 3	$691,200			
Yearly Payment (per fiber) - PL 1	$612			
Yearly Payment (per fiber) - PL 2	$550			
Yearly Payment (per fiber) - PL 3	$489			
Yearly Payment (per innerduct) - PL 1	$52,839			
Yearly Payment (per innerduct) - PL 2	$47,555			
Yearly Payment (per innerduct) - PL 3	$42,272			

Figure 8 – Pricing Output

2.2.3 Benefits of the Model

The model above, proposed for use in pricing the City's BDU asset, was built around identified strengths of the City and opportunities in the current environment. Benefits of this strategic approach to pricing are as follows:

- The public benefit return is spread across the price at which the BDU is offered to partners and telecommunications providers alike. This ensures that all taxpayers paying for Internet services have the ability to benefit.
- The model has the ability to build in additional returns such that the City can expand the BDU and/or ensure that existing BDU assets are replaced once obsolete.
- Pricing benefits from the City's "patient" financing over the entire life of the asset as opposed to the 3-5 year return required of private providers.
- Pricing based on NPV of future payments per fiber enables the City to extrapolate pricing for all types of contracts including partial ring and short term leases.
- The subjective public benefit portion can be left out of the model and it still runs properly as a purely economic model.

2.2.4 Additional Caveats and Recommendations

Additionally, the following caveats and recommendations apply to this pricing strategy:

- Pricing is consistent regardless of whether the asset is sold, leased as a capital lease, or leased as an operational lease. The idea is that over the full life of the asset the numbers associated with each are the same. The difference is that in a capital lease or sale, the asset transfers from the City's balance sheet to the customer or lessee's.

- Fiber leased for a period shorter than the life of the asset should be priced higher than the model suggests. This will account for the extra effort the City will have to undertake to find a new lessee.
- Pricing for fiber leased on a partial ring basis can be calculated by multiplying the percentage of total ring leased by the yearly fiber lease price. It is also recommended that a premium is added to this value to make up for the stranded fiber on the rest of the ring. In the case of most dark fiber providers, the whole run must be purchased even if only a small percentage is used since the stranded part is assumed to be worthless.
- The cost of installing lateral builds from BDU handholes/manholes into buildings should be paid for by the end user. The reason for passing the cost in such a manner stems from the fact that the infrastructure can be, and should, be included as an asset of the property. Thus, the investment will automatically increase its value, perhaps more so than the original investment.
- Prices for all portions of the BDU should be fully disclosed to all interested parties.

2.3 Growth Strategy

The purpose of the Growth Strategy is to set a course for the future expansion of the BDU. In the case of this strategy, growth refers to any project, relationship, or collaboration that works towards the mission of the BDU. Currently, the City's ability to grow the BDU is limited by a contract signed between the City of Bloomington and Kiva/ION as well as BDU Policies approved under Resolution 03-28. The following are limitation imposed by these documents:

- Resale ducts installed during the Kiva/ION project may be purchased by any certified public utility at a fixed rate of $5.00 per duct per foot. The City receives $1 from such arrangements.
- The City will not sell, lease, give, barter, or relinquish any ownership control of the three City ducts until an equal number of resale ducts have been sold.
- Until the completion of the sale of any Resale Duct, the City shall have the right to lease strands of fiber which run through the City ducts only to public entities, governmental units and not-for-profit groups.
- The City shall not use its fiber optic assets to provide telecommunications services to end users (any person to whom telecommunications services

are provided and that are not in the business of providing telecommunications services to other persons).

- The City shall strive to make its fiber optic assets available to telecommunications providers on equal terms. To the greatest extent possible, the City shall remain a neutral party, maintaining a neutral playing field on which telecommunications providers can compete on equal terms.
- The City shall make fiber optic conduit and fiber strands available directly to telecommunications providers and to dark fiber providers.
- The City shall not make fiber optic conduit and fiber strands available directly to end users, other than public entities, governmental units, and not-for-profits serving a public, educational, or charitable interest.
- The City shall make fiber optic conduit of fiber strands available to customers on an indefeasible right to use (IRU) lease basis. Ownership of the fiber optic assets shall remain with the City.

BDU Policies do however, give the City explicit approval to take advantage of opportunities to install fiber optic conduit during City construction projects. Thus, the constraints don't necessarily limit growth; instead they limit what the City can do with extra capacity as they grow. Fortunately, the contract with Kiva/ION is null and void in February 2006. Thus, the following sections recommend new growth decision process and constraints based on the internal and external environmental analyses.

2.3.1 Investment Decision

As the City looks to expand the BDU it is imperative that documentation is created and filed that justifies future builds by showing their alignment with the mission of the BDU. According to the mission, subsequent builds should provide both public and economic benefit to the community. This is essential because without the public benefit the City is acting the part of a private provider and without economic benefit taxpayer money is being given away for free. Given that both public and economic benefit can be associated with an investment; the following list is a recommended set of initial criteria for making an investment decision:

- Infrastructure and/or necessary services from other sources are unavailable in desired build area,
- Estimated economic and public benefit are such that the lease price required to generate returns is attractive enough to encourage utilization by private providers, and

- NPV of City portion of investment minus the estimated public benefit is less than the NPV of a comparable lease from a private provider.

2.3.2 Return on Investment

A great strength of the BDU is that the initial construction decision saved the City nearly $1 M in today's dollars on future lease payments to SBC. Questions related to this justification have plagued this project for quite some time. Now that the justification of the initial build is in tact, it will be essential to build on the initial successes by making equally successful decisions moving forward. However, including both public and economic benefit in the equation presents problems. Associating a quantifiable value with public benefit return proves to be very difficult. Thus, it is essential that the City begin collecting data that helps prove the returns, direct and indirect, associated with investments in the BDU.

2.3.3 Master Plan

Another major strength of the City is its ability to spread fixed costs over a number of initiatives in order to lessen the cost charged to each individual initiative. As the City works to build roads, repair sewers, or complete other similar projects, it has the ability to include the BDU. In these instances the cost to install BDU infrastructure is drastically minimized making it hard to not be able to justify the investment. This is why it was expressed in the BDU Policies that the City shall retain the ability to take advantage of opportunities to install fiber optic conduit during City construction projects. Taking this one step further, it is recommended that the City, namely the ITS Department, should create a Master Plan for the future expansion plans of the BDU in coordination with other City construction projects.

Master Plans work to detail future looking directions for projects. In this case, a Master Plan for the BDU will communicate the physical vision for the future of the BDU such that it may be included in any City project that works towards this vision. The following should be included in such a plan:

- Other known infrastructure(s),
- Potential City assets such as land, rights-of-way, easements, conduit, trails, etc.
- Specifications for the installation of BDU conduit during many different types of projects,
- Potential carrier grade space for the cross connection of many public and private networks,
- Areas of interest for economic development,

- A prioritization of City buildings to be connected, and
- Partner locations to be connected.

To further the impact of the Master Plan it recommended that it is inserted into Title 20 of the municipal code. This ensures that the BDU will be considered as part of all projects, public and private. It is also recommended that the Director of ITS, fulfilling the day-to-day operator role, become entrenched in the planning process. This includes becoming part of the Planning Department's email distribution list and attending important meetings.

2.3.4 Partnership Eligibility

For the purposes of the BDU, a partner is defined as an entity to which the City is entitled to provide conduit and fiber directly. The City is not in the ISP business, thus all partners and private providers alike will receive fiber and conduit inline with open access. This means that the lessee has full control over the infrastructure and may contract with whomever they would like to provide content services over the infrastructure.

According to current restrictions, public entities, governmental units, and not-for-profits serving a public, educational, or charitable interest are eligible for partnership status. Given the identified interest among entities falling into these categories, the current excess fiber capacity could be exhausted. However, there is still additional conduit capacity. Additionally, moving forward there will also be spare capacity. It will not always be the case that partners and private providers will exhaust all of this excess capacity. Thus, the following are recommendations for parameters within this strategy for expanding the scope of the BDU:

- Given non-partner interest the Governance Strategy encourages the ITS Director to facilitate a relationship between the consumer and providers,
- If no private interest is shown to meet a non-partner's needs the City should be allowed to offer partnership benefits to the entity, and
- If a project is determined to be critical to the future economic growth or wellbeing of the community, the City should be able to participate.

3.0 Migration Plan

The purpose of the Migration Plan section is to establish a roadmap for moving towards the realization of the strategies detailed in the direction section. The roadmap is presented as a group of initiatives. Each initiative is a recommended operating activity within one or more of the three strategies: Governance, Pricing, or Growth. They are listed in the chronological order in which they should be executed.

3.1 Review and Approve/Change Strategy

The strategy document delivered as part of this engagement is merely an opinion of the consultants based on historic and collected data. It is imperative that the BDUAC review the strategy and make changes/amendments as necessary before proceeding with the remaining initiatives documented below.

3.2 Amend/Change Policies

A policy initiative is recommended as part of all three strategies. The goal is to make necessary amendments/changes to current BDU policies approved under Resolution 03-28 such that they are a representation of the overall BDU strategy ratified by the BDUAC.

Under current BDU policies most aspects of the direction established as part of this strategic process is authorized. However, in the best interest of the future of the BDU, the policies should be amended/changed to more closely match the vision, direction, and migration plan of this strategy. This includes the following, most of which need to be approved by the BDUAC and possibly City Council and the Board of Public Works:

3.2.1 Vision

This portion of the policies details a general picture of the future of the BDU and describes the benefits of that future. It tells why the City of Bloomington is even considering this project. Exact language should be established by the BDUAC while the benefits should reflect those originally discussed during the origination of the project:

- Lowers the barriers to entry for competitive telecommunications carriers,
- Provides for the City of Bloomington's communications needs, and
- Protects the City's rights-of-way investments and its visual attractiveness.

3.2.2 Mission

This portion of the policies is the overall goal of the BDU. It consists of one or two sentences approved by the board that is the essence of what the BDU was created to do. A preliminary mission statement has been provided as part of this strategy. It is based on the information collected and documented in the Vision section. It is the following:

The mission of the BDU is to utilize community resources in a fair and coordinated fashion to enhance, encourage, and facilitate telecommunications advancement for the public and economic benefit of the community.

3.2.3 Authority

This portion of the policies lays the foundation for who is involved in the management of the physical BDU asset and what job and/or authority each has in its future operations.

To begin this section, each of the jobs discussed in the governance strategy should be described. This includes Oversight, Ownership, Strategic Direction, and Day-to-Day Operator. These positions and the associated responsibilities should be agreed upon by the board and then assigned to individuals/groups. Recommended changes to current policies regarding governance positions have been made in the governance strategy section.

3.3 Set General Pricing for Current BDU

A pricing initiative is recommended as part of the pricing strategy. The goal is to set a price for currently installed BDU fiber and conduit given historic and recently collected data.

In order to run the model and set an accurate price, values must be established for each variable. Thus, each variable is set based on historic and collected data regarding the current BDU installation. The values estimated for the current BDU infrastructure are shown in *Figure 9* below.

Variables	Value
Total Innerducts Installed	3
Fiber per Innerduct	96
Fiber Used by City	36
Estimated Innerduct Leased/Sold	
Estimated Individual Fiber Leased/Sold	
Public Benefit Rating	
Estimated Inflation	2%
Price Volume Discount (per innerduct)	10%
Life of Asset (years)	20
Public Benefit Opportunity Cost of Funds	2%
Capital Cost of Funds	0%
Additional Required Return	2%

Figure 9 – Estimated Variables for Current BDU Infrastructure

One problem in trying to estimate the variables is that two of them are considered unknowns. Unknowns are variables that can be more accurately represented using distributions rather than a single value. In this pricing model, the unknowns are **Estimated Innerduct Leased/Sold** and **Estimated Individual Fiber Leased/Sold**. It is much easier to estimate a distribution for these two variables rather than a single value estimate. Arguments can be made that inflation is an unknown given the definition above; however, for the sake of simplicity it will just be estimated.

In order to model the unknowns, an Excel add-in package called @Risk was used to represent the two variables with distributions. The **Estimated Innerduct Leased/Sold** variable was modeled using a discrete distribution based on the following:

- There is a 50% chance that no innerducts will be sold,
- There is a 25% chance that 1 (one) innerduct will be sold,
- There is a 20% chance that 2 (two) innerducts will be sold, and
- There is a 5% chance that all 3 (three) innerducts will be sold.

The **Estimated Individual Fiber Leased/Sold** variable was modeled using a triangular distribution based on the following:

- The minimum number of fiber strands that will be sold is 0 (zero),

- The maximum number of fiber strands that will be sold is the total available minus those used by the city, and
- It is most likely that the number of fiber strands sold will be between the two.

@Risk was then used to perform a sensitivity analysis for the price by using the variables and the average from each unknown over 5000 iterations. This was repeated over several simulations each using different **Total Price per Fiber** values. This entire model was then repeated with each level of public benefit to determine the price at which the Net is less than or equal to zero. As can be seen in *Figure 10* below run with a public benefit value of 10 (ten), simulations were run for **Total Price per Fiber** at values ranging from $4,000 to $8,500. The **Average Net** (mean of the **Net** box in the pricing model) was recorded for each simulation after taking the average value produced over the 5000 iterations. The results show that the optimal **Total Price per Fiber** value given a public benefit rating of 10 (ten) is between $8,000 and $8,500 for a lease over the life of the asset. Remember, the optimal price occurs when **Average Net** equals zero.

Total Price per Fiber	Average Net
$4,000	$579,942
$4,500	$510,685
$5,000	$441,427
$5,500	$372,170
$6,000	$302,913
$6,500	$233,656
$7,000	$164,398
$7,500	$95,141
$8,000	$25,884
$8,500	-$43,373

Figure 10 – Average Net for Several Total Price per Fiber Figures

The pricing results for the current BDU infrastructure are shown in *Figure 11* below.

Public Benefit Rating Scale	Capital Percent Equivalency	Total Price per Fiber - Partner Level 1	Total Price per Fiber - PL 2	Total Price per Fiber - PL 3	Total Price per Innerduct - PL 1	Total Price per Innerduct - PL 2	Total Price per Innerduct - PL 3	Yearly Payment (per fiber) - PL 1	Yearly Payment (per fiber) - PL 2	Yearly Payment (per fiber) - PL 3	Yearly Payment (per innerduct) - PL 1	Yearly Payment (per innerduct) - PL 2	Yearly Payment (per innerduct) - PL 3
0	0%	$16,000	$14,400	$12,800	$1,382,400	$1,244,160	$1,105,920	$979	$881	$783	$84,543	$76,089	$67,634
1	5%	$15,000	$13,500	$12,000	$1,296,000	$1,166,400	$1,036,800	$917	$826	$734	$79,259	$71,333	$63,407
2	10%	$14,500	$13,050	$11,600	$1,252,800	$1,127,520	$1,002,240	$887	$798	$709	$76,617	$68,955	$61,294
3	15%	$13,500	$12,150	$10,800	$1,166,400	$1,049,760	$933,120	$826	$743	$660	$71,333	$64,200	$57,067
4	20%	$13,000	$11,700	$10,400	$1,123,200	$1,010,880	$898,560	$795	$716	$636	$68,691	$61,822	$54,953
5	25%	$12,000	$10,800	$9,600	$1,036,800	$933,120	$829,440	$734	$660	$587	$63,407	$57,067	$50,726
6	30%	$11,000	$9,900	$8,800	$950,400	$855,360	$760,320	$673	$605	$538	$58,123	$52,311	$46,499
7	35%	$10,500	$9,450	$8,400	$907,200	$816,480	$725,760	$642	$578	$514	$55,481	$49,933	$44,385
8	40%	$9,500	$8,550	$7,600	$820,800	$738,720	$656,640	$581	$523	$465	$50,197	$45,178	$40,158
9	45%	$9,000	$8,100	$7,200	$777,600	$699,840	$622,080	$550	$495	$440	$47,555	$42,800	$38,044
10	50%	$8,000	$7,200	$6,400	$691,200	$622,080	$552,960	$489	$440	$391	$42,272	$38,044	$33,817

Figure 11 – Pricing Results for Current BDU Infrastructure

Prices are broken down in several ways. New additions from the original model are the partner levels. Each level warrants a slightly different price, depending upon the variables inputted into the partner level box shown in *Figure 12* below.

Partner Level	Discount
1	0%
2	10%
3	20%

Figure 12 – Partner Level Variables for Current BDU Infrastructure

The discounts are applied in relation to the price determined for **Partner Level** 1 (one), thus it must always be 0 (zero).

It is recommended that the City of Bloomington offer single strand fiber pricing on the current BDU infrastructure for $1,000 a year. The price was calculated using a public benefit rating of 0 (zero) and the variables shown in *Figure 9*. Thus, a pair of fiber strands costs $2,000 per year, much lower than the cost for a year long point to point T-1. Ultimately, the board should set the price on an individual basis taking into consideration fair penalties, if any, for segment versus whole ring and short term versus life of asset leases as well as partnership level discounts.

3.4 Develop Partnership Agreement

An initiative to develop a partnership agreement is recommended as part of the growth strategy. The goal is to ensure that participants in the BDU program understand their rights and the rights retained by the city.

The partnership agreement should protect the city. The partnership agreement is a contract between the city and those eligible for partnership as stated in the partnership eligibility section of the growth strategy. Partnership agreements must only be signed following approval from the entity described for this duty in the policies.

A partner may either be a level 1 (one), 2 (two), or 3 (three). Levels determine pricing and are described as follows:

- Level 1 – Any entity profiting commercially from access to the BDU.
- Level 2 – Any non-profit entity.
- Level 3 - A government entity or any entity providing a non-commercial, necessary social service with help from access to the BDU.

The BDUAC should approve levels and appropriate descriptions.

Additionally, partnership agreements should protect the end user. When drafting the partnership agreement the city should ensure that resellers of the BDU are governed by certain tariffs. This will ensure that cost savings are partially passed on to the end user.

3.5 Decide on HoosierNet Proposal

Over the past few months the BDUAC has been in discussions with HoosierNet in regards to granting HoosierNet access to BDU infrastructure. HoosierNet would like to replace several T-1 lines with fiber optics in order to increase reliability and bandwidth while hopefully lowering costs. This connection does not impact the City and MCCSC's connection to HoosierNet. Instead it impacts HoosierNet's connection to the Internet. HoosierNet currently pays $250 per month for a point to point T-1. Internet bandwidth is additional.

It is recommended that the city grant HoosierNet access to BDU infrastructure at Partner Level 2 status. Under current policies, as well as the recommended changes in this document, the city has every right to lease a portion of the BDU to HoosierNet. Leasing a pair of fiber at a cost under $2,000 per year will be beneficial for HoosierNet if they simply replace a single T-1.

3.6 Develop and Implement Master Plan

A master planning initiative is recommended as part of the growth strategy. The goal is to ensure that the BDU is included in projects, public and private, crucial to its growth through expansion.

Establishing a master plan can help increase the awareness of the BDU within city government. The plan can be included in the overall city master plan as well as attached to other master plans such as the Parks and Recreation Department's trail plan, the Street Department's thoroughfare plan, and many others. This will ensure that as projects are in the planning phase the BDU will be considered early in the process.

Establishing a master plan can also help increase the awareness of the BDU outside of city government. It is very important that the BDU align with county, state, and federal initiatives and projects as well as private projects happening in and around the city. By officially recognizing a master plan the city is saying to

other entities that any project slated for an area designated as part of the master plan must include the BDU. In some cities in Indiana the master plan has required private individuals to install public infrastructure if they plan to develop an area that is already part of a master plan.

The master planning process has already started within the city's ITS Department. Both the Director and Associate Director of ITS have been working to map current and future BDU plans. It is recommended that in addition they do the following:

- Designate specifications for BDU installation including specs for required conduit installation under intersections,
- Have the master plan officially recognized,
- Communicate the plan to proper state and federal authorities such that the BDU is included as part of both the Indiana 45/46 expansion and I-69 construction, and
- Work with Economic Development to specify and forecast potential areas crucial to economic development and needing connectivity.

3.7 Establish County Partnership

An initiative to establish an official partnership with Monroe County is recommended as part of the growth strategy. The goal is to formalize the relationship between the city and the county in regards to sharing connectivity infrastructure.

The partnership should follow the same structure as other partnerships and a partnership agreement should be signed. As part of the agreement, the county should be given Partner Level 3 status. It is only fair that money trade hands considering the city's substantial investment. However, if and when the time comes for the city to utilize county installed assets the city should pay the county. In the instance of joint builds, specifics of the deal should be established prior to construction.

This partnership will free the county to begin looking at connections for the convention center and libraries in both Bloomington and Ellettsville.

3.8 Revamp/Renew Rights-of-way Ordinance

A rights-of-way ordinance/agreement redesign initiative is recommended as part of the growth strategy. The goal of the redesign is to protect future city

investments in conduit and fiber optic infrastructure, ensure safety and visual attractiveness in the public rights-of-way, and guarantee the integrity of city streets.

Section 253 of the Telecommunications Act of 1996 authorizes a municipality to manage its rights-of-way with respect to telecommunications companies. Section 253 states that a state or local government may not "prohibit or have the effect of prohibiting" any telecommunications service in the municipality; however, the section also contains a "safe harbor" provision that expressly allows the local government to manage its rights-of-way on a competitively neutral and non-discriminatory basis and to obtain "fair and reasonable compensation" from telecommunication companies.

Municipalities in the State of Indiana are governed by the following authorizations/restrictions in regards to their rights-of-way:

Franchise Authority – Indiana municipalities may enact ordinance provisions regarding occupation of public rights-of-way, but the Utility Regulatory Commission (URC) may preempt local rights-of-way authority if a public utility is not granted permission to use the rights-of-way within 30 days of its request. Ind. Code § 8-1-2-101(a)(1) and (4).

Compensation Authority Under State Law – Indiana municipalities have authority to require providers to pay the "direct, actual, and reasonably incurred costs of managing the rights-of-way caused by the public utility's… occupancy." Ind. Code § 8-1-2-101(b). Management costs may include registration, inspection, rights-of-way restoration, and ordinance administration costs, but may not include rent or franchise fees. Ind. Code § 8-1-2-101(b)(1)-(6).

Management and Permit Conditions – Indiana municipalities have authority to: adopt ordinance provisions that protect the safety or the traveling public; require the rights-of-way to be restored as reasonably as is possible to its original condition; require additions and extensions to the physical plant of public utilities; and to designate the location, nature, timetable for completion, and all construction conditions for such additions and extensions. Ind. Code § 8-1-2-101(b) and (a)(2).

Given the above federal and state authorizations/restrictions, an effective rights-of-way ordinance includes, at a minimum, the following[6]:

- A permitting process for companies wishing to install equipment and/or provide telecommunications services in the public rights-of-way. The process includes obtaining relevant legal and technical information from the companies and evaluating the information in the best interests of the municipality.
- Construction safety standards to ensure safe conditions for workers and a safe environment for nearby residents.
- Limitations on equipment placed on utility poles and underground depending on the space available for such equipment.
- Legal protections for the municipality in the event of liability resulting from accidents in the rights-of-way.
- Limited compensation from telecommunications companies for use of the rights-of-way.
- Reporting requirements on telecommunications companies related to the type and placement of their equipment in the public rights-of-way.
- Requirements for assigning, transferring or removing the equipment from the public rights-of-way.
- Penalties for failure to comply with the requirements contained in the ordinance.

In 2001, the State of Michigan passed legislation requiring a common rights-of-way ordinance for all municipalities within the state. This ordinance included all of the bulleted points above. In addition, the State of Michigan required that all applicants must include maps showing provider's existing and proposed facilities as well as provide as-built engineering prints within 90 days of completion of construction.

For the City of Bloomington, it is recommended that a rights-of-way redesign incorporate the following:

- The bulleted points listed above (many of which are already included in the current ordinance).
- Disclosure of infrastructure locations through pre-construction and as-built documents similar to those required by the State of Michigan.

[6] Recommended by the National Association of Telecommunications Officers and Advisors

- Rewards for coordinated builds and shared trenches (separated vertically as well as horizontally).
- Requirements for providers to offer the City first right of refusal to install BDU conduit during construction.
- Significant penalties for those providers insisting on overbuilding already installed BDU infrastructure.

3.9 Plan Certified Technology Park Network Architecture

Recent trends in technology park (tech park) architecture planning have shifted the focus from carrier based connectivity to open access. Open access architectures separate the physical wires that create the network infrastructure from the applications delivered over the infrastructure.

There are several ways in which communities are facilitating open access networks in their tech parks. The most common, especially in the state of Indiana, involves the city's ownership of the physical portion of the infrastructure. In this model, the city runs its own infrastructure between all buildings in the tech park. Most importantly is the city's ability to then connect the infrastructure to a co-location facility. This enables the city to potentially hire someone to manage the network as well as allows participants of the park to choose from a number of co-located vendors for critical communications services.

In the City of Bloomington's newly announced tech park, the BDU is in the perfect position to facilitate this model for the city. The BDU is already installed throughout most of the tech park area. It would only need to be extended to individual buildings not currently connected. Additionally, the BDU is connected to both the telecom hotel and another private peering point. Either of these existing or a new co-location facility could be used to provide the link between service providers and the end users in the park. Finally, network management would be required to enable multiple service providers to connect to a single end user. This service can be provided by the city thorough the current RPR technology being deployed internally, it can be outsourced to a number of reputable sources, or individual end users can provide it for themselves.

The main advantages of this model are that it prevents monopolization and lowers the barriers to entry for competing telecommunications companies because the city, as owner, completely opens access to the physical network

without prejudice or discrimination. By starting a pilot in the tech park the model can be tested, proven, and expanded to other areas where the BDU is prevalent.

3.10 Facilitate BDU Connectivity to Public, Education and Government (PEG) Channels

The BDU has the ability to expand the programming potential of the current licensed and unlicensed PEG channels. Currently, the CATs production facility does not have origination abilities due to bi-directional limitations on Insight's current network. However, the BDU is connected to the library. By expanding this connection to include CATs as well as a BDU connection to Insight's production facility, all locations with BDU access could potentially originate material to be distributed on the PEG channels. This ability offers tremendous public safety, education, and government access advantages.

Appendix A – Interview List

The interview list that follows was created by the BDUAC. Not everyone on the list was interviewed due to several different factors.

Name	Company	Communications Notes
BDU Advisory Board		
Rick Dietz	City of Bloomington	Regular Meetings
Bruce Myers	Kiva Networking	Met
Charlie Webb	CallNet	Emailed 12/27, 1/11, Not Meeting
Linda Williamson	Bloomington Economic Development Corporation	Met
Mark McMath	Bloomington Hospital	Met
Brian Voss	Indiana University	Emailed 11/29, 1/11, Not Meeting
Brian Kleber	InVenture	Met
City of Bloomington		
Rick Routon	City of Bloomington	Regular Meetings
Ron Walker	City of Bloomington	Met
Duane Busick	City of Bloomington	Met
David Sabbagh	City Council	Met
Patrick Murphy	City of Bloomington	Met
Steven Volan	City of Bloomington	Emailed 12/27, 1/11, No Response
Andy Ruff	City of Bloomington	Met
Regina Moore	City of Bloomington	Emailed 12/27, 1/11, 1/28
Dan Sherman	City of Bloomington	Met
Justin Wykoff	City of Bloomington	Met
Patrick Shay	City of Bloomington	Met
Talisha Coppock	Downtown Bloomington Commission	Met
Mark Kruzan	City of Bloomington	Emailed 1/14, Not Meeting
Dave Wiliams	Parks and Rec	
Monroe County		
Eric Ost	Monroe County	Met
Larry Smith	Monroe County	Met with Colleagues
Iris Kiesling	Monroe County Council	Met
Bill Williams	Monroe County	Met
Patrick Stoffers	City of Ellettsville	Emailed 12/31, Not Meeting
Frank Nowalk	City of Ellettsville	Met
Bill Brower	Monroe County	Met
Randy Smith	Monroe County	
State of Indiana		
Matt Pierce	State of Indiana	Met
Tom Harris	State of Indiana	
Small Business / Venture		
Steve Bryant	BTN LifeSciences Partnership	Not Meeting
Bill West	Option 6	Emailed 12/15
Mike Halbrook	Pervasive Technology Labs	Met
Greg Travis	Pervasive Technology Labs	Met
Sonny Kirkley	Information in Place	Emailed 12/15
Chris Borland	Information in Place	Emailed 12/15
Jim Santo	Clip-tomania	Emailed 12/30
Bill Maegerlein	Certified IT	Meeting Scheduled
Kathy Crouch	CACI	Met
Alan Minton	Cornerstone Info. Systems	Wrong Email Address
Ari Vidali	ENVISAGE	Emailed 12/30
Angela Huang	Hirons & Company	Emailed 12/30
Richard Martin	Tinwisle Corp. / County Planner	Met
Steve Kaser	Pathway	Met

Higher Education		
Thom Gillespie	Indiana University	Met
Gregory Rawlins	Indiana University	Emailed 12/30
Brett Pfingston	Ivy Tech	Met
Marty Siegel	Indiana University	Met
Robert Flynn	Indiana University	
K-12 Education		
Karen Portal	Monroe County Community School Corporation	Met
Steve Bonchek	Harmony School	Not Meeting
Denise Lessow	DePaul School	Not Meeting
	Lighthouse Christian Academy	Not Meeting
	Bloomington Montessori School	Not Meeting
	SDA Church School	Not Meeting
	Clear Creek Christian School	Not Meeting
	Grace Baptist Academy	Not Meeting
	Wings of Love Christian Academy	Not Meeting
	Bloomington Juv Corr Fac	Not Meeting
	Saint Charles Boromeo School	Not Meeting
Industrial / Large Business		
Dan Peterson	Cook	Emailed 12/15, 1/11
John Brooks	Baxter	Met
Social Service / Medical / Non-Profit		
Katherine Stroud	Hospital	Met
Todd Rowland	Hospital	Met
Dennie Morrison	Center for Behavioral Health	Met
Ned Baugh	Library	Met
Michael White	CATs	Met
David Ernst	HoosierNet	Met
Bet Savich	City of Bloomington Community & Family Resources	Met
Barry Lessow	United Way	Emailed 12/15, 12/31
Liz Grenat	Big Brothers Big Sisters	Emailed 1/5, Not Meeting
Sally Gaskill	Bloomington Area Arts Council	Emailed 1/5, Not Meeting
Sarah Ward	Boys and Girls Club	Emailed 1/5, Not Meeting
Tim Clougher	Community Kitchen	Emailed 1/5, Not Meeting
Amy Robinson	Hoosier Hills Food Bank	Emailed 1/5, Not Meeting
Toby Strout	Middle Way House	Emailed 1/5, Not Meeting
Sarah Hayes	Monroe County Humane Association	Emailed 1/5, Not Meeting
Cliff Edens	Monroe County United Ministries	Emailed 1/5, Not Meeting
Pam Kinnaman	Shalom Community Center	Emailed 1/5, Not Meeting
Jeanne Gunning	Wonderlab Museum of Science and Technology	Emailed 1/5, Not Meeting
Service Providers		
Bob Walters	SBC	Met, Wants additional information
Bill Slater	ION	Emailed 12/15
	US Signal	Don't need to meet, already have infrastructure maps
Cathy Gorman	Cinergy Communications	Called 12/30, 1/28
Windy Henry	Insight	Met
Cullen McCarty	Smithville	Met
Bob Phelps	Smithville	Met
Bruce Myers	Kiva	Met
Others		
Jeffrey Willsey	Former City Council Member	Emailed 12/15
Jane Martin	Village Ventures	Met

Appendix B – Comparative NPV Analysis

The following spreadsheet represents the model used in analyzing the NPV of actual and alternative cash outflows associated with the BDU and viable alternatives.

	DS-1 Lease	DS-3 Lease	GigaMan (1 Gbps Ethernet)	FiberMan (2 Gbps Ethernet)	OC-3	OC-12	OC-48	OC-192	BDU
Bandwidth	1.544 Mbps	45 Mbps	1000 Mbps	2000 Mbps	155.52 Mbps	622.08 Mbps	2488.3 Mbps	9953.2 Mbps	
CAPEX									
Construction									$1,181,465
Equipment	< $80,000	< $80,000	$80,000	$80,000	> $80,000	> $80,000	> $80,000	> $80,000	$80,000
OPEX									
Non-Recurring Charge									
Per Order	$50	$50	$140	$0	$50	$50	$50	$50	
Per Circuit	$144	$400	$230	$0	$600	$600	$600	$2,250	
Per Node Termination	$213	$750	$755	$1,500	$0	$0	$0	$0	
Per Month Recurring Charge (per node termination)									
Monthly to Month Contract	$300								
12 Month Contract	$230	$2,470	$3,300	$5,145	$0	$0	$0	$0	
24 Month Contract	$165	$1,740	$3,100	$4,200	$0	$0	$0	$0	
36 Month Contract	$140	$1,255	$2,850	$4,000	$1,770	$3,850	$5,890	$22,000	
60 Month Contract	$125	$1,008	$2,500	$3,500	$1,415	$3,080	$4,715	$17,650	
Central Office Node									
36 Month Contract	$0	$0	$0	$0	$1,000	$2,620	$5,240	$19,650	
60 Month Contract	$0	$0	$0	$0	$800	$2,095	$4,190	$15,700	
Mileage (per mile between node)									
36 Month Contract	$0	$0	$0	$0	$260	$260	$260	$260	
60 Month Contract	$0	$0	$0	$0	$220	$220	$220	$220	
Multiplexing DS-3 to DS-1 (per month)	$825								
Depreciation (per year)									$59,073
Maintenance/Repair (per year)									$6,000
Support (per year)									
Internal									$25,000
External									$10,000
Telecom Hotel Rent (fixed)									
2004									$20,491
2005									$18,262
2006									$15,989
2007									$8,074

BDU Comparables	DS-1	DS-3	1 Gbps	2 Gbps	OC-3	OC-12	OC-48	OC-192	
Bandwidth	1.544 Mbps	45 Mbps	1000 Mbps	2000 Mbps	155.52 Mbps	622.08 Mbps	2488.3 Mbps	9953.2 Mbps	
Orders	2	1	1	1	1	1	1	1	
Circuits	6	6	6	6	1	1	1	1	
Node Terminations	6	6	6	6	6	10	6	6	
Months on Contract	60	60	60	60	60	60	60	60	
Mileage	NA	NA	NA	NA	6	6	6	6	
Non-recurring Charge (Per Order)	$50	$50	$140	$0	$50	$50	$50	$50	
Non-recurring Charge (Per Circuit)	$144	$400	$230	$0	$600	$600	$600	$2,250	
Non-recurring Charge (Per Node Termination)	$213	$750	$755	$1,500	$0	$0	$0	$0	
Per Month Recurring Charge (Per Node Termination)	$125	$1,008	$2,500	$3,500	$1,415	$3,080	$4,715	$17,650	
Central Office Node	$0	$0	$0	$0	$800	$2,095	$4,190	$15,700	
Mileage	$0	$0	$0	$0	$220	$220	$220	$220	
Multiplexing	$825	$0	$0	$0	$0	$0	$0	$0	
Non-Recurring Total	$3,035	$6,950	$6,050	$9,000	$650	$650	$650	$2,300	$1,181,465
Recurring Total (Yearly)	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	NA
Year 1	$32,531	$79,526	$186,050	$261,000	$127,970	$411,230	$406,250	$1,477,340	$1,242,956
Year 2	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$59,262
Year 3	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$56,989
Year 4	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$49,074
Year 5	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$49,074
Year 6	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$49,074
Year 7	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$49,074
Year 8	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$49,074
Year 9	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$49,074
Year 10	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$49,074
Year 11	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$49,074
Year 12	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$49,074
Year 13	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$49,074
Year 14	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$49,074
Year 15	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$49,074
Year 16	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$49,074
Year 17	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$49,074
Year 18	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$49,074
Year 19	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$49,074
Year 20	$29,496	$72,576	$180,000	$252,000	$127,320	$410,580	$405,600	$1,475,040	$49,074
Total	$592,955	$1,458,470	$3,606,050	$5,049,000	$2,547,050	$8,212,250	$8,112,650	$29,503,100	$2,193,465
NPV @ Various Discount Rates									
6%	$341,180.00	$838,997.61	$2,070,293.37	$2,898,910.71	$1,460,963.58	$4,709,933.46	$4,652,813.25	$16,920,762.41	$1,704,891.65
7%	$315,317.49	$775,366.50	$1,912,576.77	$2,678,102.80	$1,349,437.37	$4,350,297.85	$4,297,539.65	$15,628,744.31	$1,651,027.91
8%	$292,406.26	$718,997.05	$1,772,868.39	$2,482,506.48	$1,250,648.38	$4,031,736.81	$3,982,842.44	$14,484,289.78	$1,602,279.90
9%	$272,039.99	$668,889.48	$1,648,688.68	$2,308,650.39	$1,162,842.76	$3,748,594.61	$3,703,134.45	$13,467,080.10	$1,557,965.80
10%	$253,875.17	$624,198.58	$1,537,941.47	$2,153,599.88	$1,084,537.84	$3,496,089.90	$3,453,692.35	$12,559,937.94	$1,517,508.48

Comparative Analysis (Number of Nodes)	SBC	BDU
6	$2,237,445	$1,517,508
7	$2,552,106	$1,517,508
8	$2,866,767	$1,517,508
9	$3,181,429	$1,517,508
10	$3,496,090	$1,517,508