Availability and Cost of Broadband Internet Service Options in Ohio

BROADBAND OHIO

OSC

Ohio Department of Development

2006 Broadband Ohio Study

Conducted by the Ohio Supercomputer Center for the Ohio Department of Development

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Acknowledgements

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Finally, we must acknowledge the pioneering work of Pari Sabety, whose foresight provided us with the first report on Ohio's readiness for electronic commerce – ECom-Ohio. That first in the nation assessment provides an excellent base for comparison for this and other future studies. ECom-Ohio recognized early the importance of broadband connectivity to the future of economic development.

Executive Summary

The ECom-Ohio Study, completed in the spring of 2000, sought to evaluate the current use and demand for broadband services and assess the availability of fiber throughout the state as an indicator of Ohio's future readiness to enter the digital age. The study involved tabulating data on available access to high tech applications and services, and was based on the level of technology at that time. This primarily included traditional phone lines, potentially public and private fiber-optic cable plants, and the emerging residential-based broadband services of cable modem and Asymmetric Digital Subscriber Line (DSL or ADSL).

Since that time, a number of developments have greatly altered the landscape of broadband services for applications and services. Newer technologies and applications have made it possible to use high-capacity networks for many aspects of business development including sharing large databases, videoconferencing, direct sales, and disaster recovery services. Higher-capacity broadband services are fast replacing cable modem and DSL services in medium-to large-business applications. They are also leading to innovative network uses for education and training that are increasing economic opportunities for Ohio's workforce.

Additionally, many private providers are offering businesses in many areas of the state more competitive rates for higher-capacity broadband services. Demand is continually growing for bandwidth based on service convergence and high-capacity networks for businesses, government organizations, and educational institutions. Extra bandwidth is needed to serve typical business applications for data transfer, Internet transactions, videoconferencing, and other emerging applications. Broadband services will give Ohio an economic development advantage in competing with other states for employers, improving the quality of life for our citizens, and maintaining and growing our population and potential workforce.

In contrast to the 2000 report, the purpose of the new 2006 Broadband-Ohio study was to determine the availability and relative cost of broadband service options for government, health care, and business use in all 88 Ohio counties. The study provides an overview of the current market for higher-capacity broadband services that are used by business, government, and other large customers as well as the geographic distribution of those services and relative costs throughout the state. The two higher-capacity broadband services focused on in this study are the Time Division Multiplexing (TDM) Circuit-based (DS3/43 Mbps, OC3/155 Mbps and OC12/622 Mbps) and Ethernet-based (10 Mbps, 100 Mbps, and 1 Gbps) services. Study results can be used as the basis for evaluating the potential impacts of service availability and cost on economic development efforts as well as opportunities for public/private partnerships that improve services in markets that might otherwise be too small to attract sufficient private investment.

The data reported here should not be used as an indicator of the delivered prices of broadband services to any particular location. The actual price quoted on a specific project may vary from the costs reported here because each project will involve a different combination of services and capacities. In addition, the broadband market has been changing rapidly over the past several years. This has resulted in major drops in prices as new technologies and services become available. Consequently, current pricing may be significantly different than that reported here. However, the report does give a snapshot of the availability and relative costs for higher-capacity broadband services across the state and can serve as a guide for future discussion of telecommunications and economic development policies.

Data for the study were obtained through a standardized survey of 94 telephone, cable, and independent Internet service providers in Ohio. Service availability and cost was requested for 236 sample locations spanning all of the 88 Ohio counties. Responses were received from 91 of the companies. Seventy-five respondents either offered no service or no standard service at this bandwidth. Sixteen service providers, including all of the state's largest service providers, replied with standard pricing.

DS3 service (45 Megabits per second or Mbps) with Internet is available throughout the state and is available at 100% of the sample locations. The average cost in the six largest counties (Cuyahoga,

Franklin, Hamilton, Lucas, Summit, and Montgomery) is significantly lower than in other locations. In the lowest density rural counties, prices were more than twice the lowest available cost. There is a wide variation in cost from $6,600 to $9,000 per month found in the highest population counties, to almost $16,000 per month in some of the rural counties. This is expected given the smaller number of customers to be served in rural areas.

As we move from DS3 to higher-capacity OC3 (155 Mbps) and OC12 (622 Mbps) services, availability declines and costs increase. OC3 services are available in all counties but costs range from a low of $15,000 per month to a high of almost $95,000 per month. OC12 services are not available in 20 Ohio counties. Where the OC12 service is available, costs range from around $30,000 to almost $155,000 per month.

Ethernet services (10 Mbps, 100 Mbps, and 1 Gpbs) are less costly but are not yet as universally available as the TDM Circuit services. Where Ethernet services are available, their cost is much lower than TDM circuits, making Ethernet services more affordable at all levels.

Conclusions:

Ohio's major metropolitan areas are well provisioned with multiple broadband service providers, service choices, and more competitive pricing. As one moves to medium and low-density population counties, the number of service providers declines as does the availability, resulting in higher costs for services. The private sector is unlikely to invest as rapidly in these areas because the market is limited, and therefore, will yield much lower returns on investment. The number of providers in many urban areas is a good indication of significant competition to provide telecommunications services. Ethernet services are more widely available than was expected. Their availability is potentially important to contribute to economic development since Ethernet services are lower in cost and easier to deploy.

Where there are significant public facilities and the potential for economic growth in low-density counties, there is an opportunity for public/private partnerships to make investments in the network infrastructure to improve the potential for economic development in those areas. Such investments would improve public service delivery and the business climate, providing market opportunities for telecommunications companies and other employers. Consideration should be given to new approaches in Ohio to provide our communities with competitive advantages for economic growth by encouraging rapid installation of high-speed broadband services.

Introduction

The original ECom-Ohio study was the first in the nation to evaluate the current use and demand for broadband services and assess the availability of fiber throughout the state as an indicator of future broadband capability. Completed in the spring of 2000, the study tabulated information on the quality of current telephone lines used for dial-up Internet services, availability of the emerging residential broadband services through cable modems and DSL, and potential for expansion of broadband services as it related to the location of public and private fiber-optic cable plants. It also conducted extensive surveys of both businesses and residents to assess adoption rates of the Internet and related technologies. A findings comparison of the ECom-Ohio report and this Broadband-Ohio report can be found in section 5.0.

Since the 2000 study was completed, there has been a phenomenal growth in broadband services for both residential and business uses. In the nation, data from the FCC show a growth rate for high-speed lines of 897% from 2000 to 2005 (FCC, 2006). Successful businesses are increasingly using the network for internal communications, business transactions with suppliers, receipt and tracking of orders, communications with customers and suppliers, and direct sales. As a result, the availability of broadband has become an important factor in business location and expansion decisions (for example, see Harchauoi et al, 2002; Ford and Koutsky, 2005).

The bandwidth requirements for many network applications exceed what is available through lower capacity broadband services using cable modems or ADSL. Businesses needing additional bandwidth must then procure higher-capacity broadband services through a local telephone, cable, or independent network services provider. Table 1 shows several examples of these applications and estimates bandwidth requirements based on a reasonable set of operating assumptions. The range of estimates in the table is from 16 to 42 Mbps per second of network transmission capacity. To put these needs in context, the typical cable modem provides up to 4 Mbps download speed and 512 Kbps to 1 Mbps upload speed. DSL service provides 1.5 to 9 Mbps download speed and 15 to 640 Kbps upload speed. These are significantly lower than the capacities required for the examples below -- especially because of the asymmetric nature of the bandwidth available, limitations associated with shared bandwidth for cable modem users, and distance from a central office for ADSL users.

The 2006 Broadband-Ohio study is focused on the current availability and cost of broadband Internet services in Ohio with capacities of 10 Mbps and higher for government, business, and health care. Recent state trends have provided fertile ground for developing a broadband infrastructure that could be used as an economic development advantage for the state. New application services are being offered by a range of providers in some markets, while the rates for higher-capacity bandwidth have dropped significantly in recent years. However, the primary beneficiaries of these trends continue to be the state's major population centers. The goal of this study is to survey all current providers of higher-capacity broadband services and compile data on the availability and cost of the services in each of Ohio's 88 counties.

How We Define Broadband?

A widely accepted definition of "broadband services" refers to Internet connections with data rates greater than 200 Kbps. We define *lower capacity* broadband services as those served by cable modems and ADSLs with data rates greater than 200 Kbps and less than 10 Mbps. We define *higher-capacity* broadband services as those served by TDM-circuit and Ethernet with data rates of 10 Mbps and higher.

Table 1: Business Examples Requiring High Bandwidth Services			
Business Type	**Application Use-cases During Business Hours**	**Required Bandwidth**	
Specialty Hospital Center	Patient's digital images or other information needs to be transferred to another hospital or doctor for a consultation; Videoconferencing is used for telemedicine consultations with remote offices or clinics; Voice over IP (VoIP) is used for all incoming and outgoing telephone calls	42 Mbps	Assumes several uses occur at once; an MRI is about 250 Mbps and would transfer in 5 minutes at 7 Mbps; worst case assumes five simultaneous transfers
Insurance Company Call Center	Videoconferencing is used for meetings with other branch offices; VoIP is used for all incoming and outgoing customer service/marketing telephone calls; customer billing records are backed up at a remote site for disaster recovery purposes	16 Mbps	Assumes a firm with about 100 employees all actively using these network services
University Distance Learning Center	Videoconferencing is used by students to remotely interact with professors during lectures; Video streaming is used by students to download archived course content; VoIP is used for all incoming and outgoing telephone calls; office and student records are backed up for disaster recovery purposes	18 Mbps	A high-quality videoconferencing call requires 768 Kbps; the worst case data rate calculations assume five simultaneous videoconferences in progress; a high-quality video streaming session requires 1,200 Kbps; the worst case data rate calculations assume 10 simultaneous sessions in progress
Bank Data Center	Videoconferencing is used for meetings with other branch offices; VoIP is used for all incoming and outgoing customer service/marketing telephone calls; customer electronic checks and other transaction records are backed up for disaster recovery purposes	26 Mbps	A high-quality VoIP call requires 64 Kbps; the worst case data rate calculations assume 250 simultaneous VoIP calls in progress in a call center business and 25 calls in the other businesses; a scanned check image file size is 30 KB; assuming it takes 10 seconds for a single image transfer, the data rate of image transfer is 24 Kbps; the worst case data rate calculations assume 200 simultaneous check image transfers in progress

3.0 Methodology

To obtain a representative sample of the range of businesses, hospitals, and public institutions that are seeking or are expected to seek higher-capacity broadband services, we collected information on a range of institutions and georeferenced their locations. This included the three largest private employers in each county, location of the courts, location of hospitals, and The Ohio State University extension offices. We then analyzed those locations and chose a sample in which no two locations were closer than ten miles from one another. Our reasoning was that locations closer together are more likely to be able to purchase like services at the same price. Many of the courts, businesses, and hospitals were located in the same areas, especially in rural counties where the county seat is the largest population center. Using this strategy, we created a sample of 236 locations with at least one location in each county. The resulting distribution of locations and their types are shown in Figure 1.

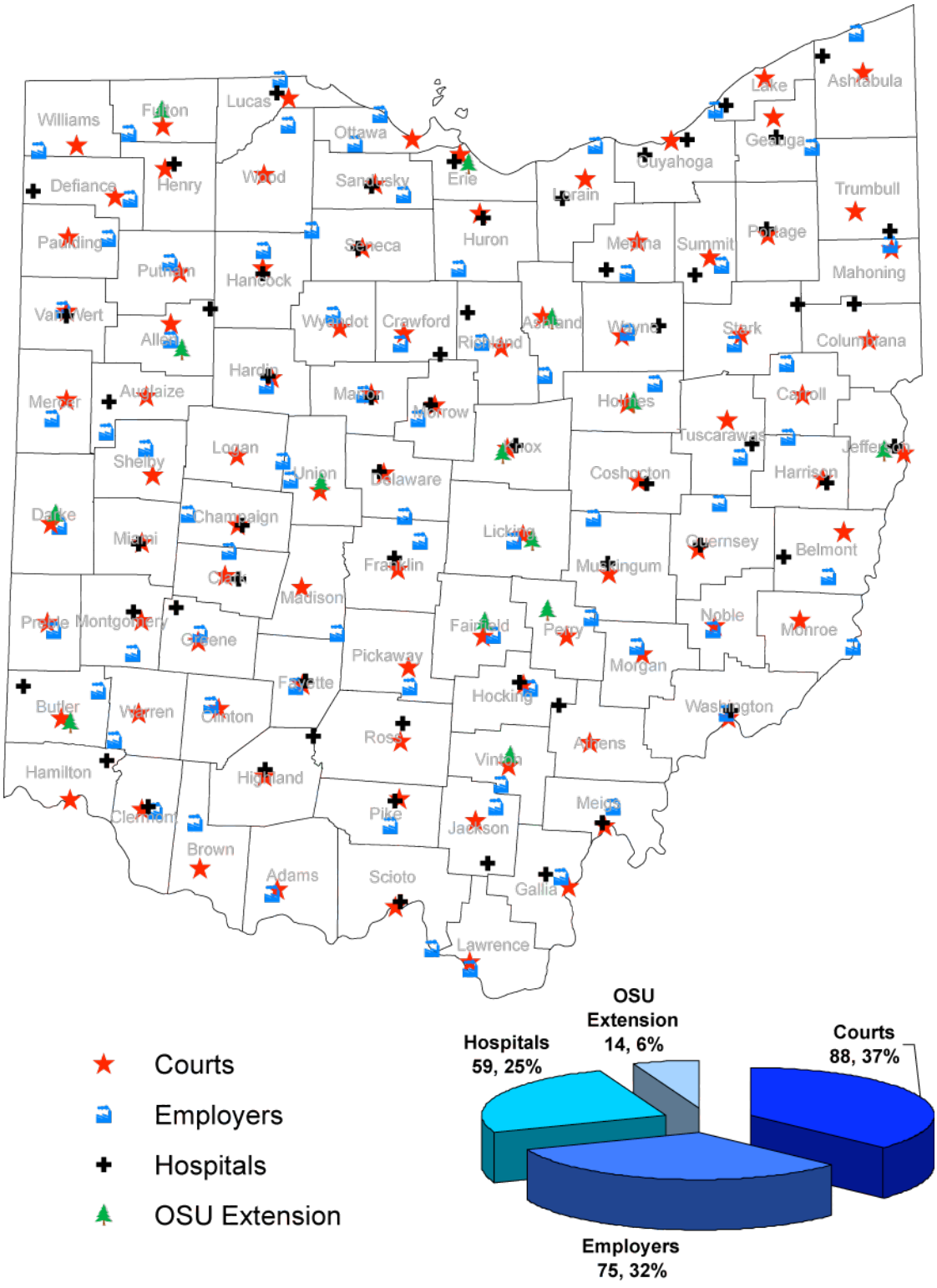
We then prepared a standardized survey which was sent to a total of 94 broadband service providers. Each provider was requested to respond with availability and cost information for Time Division Multiplexing (TDM) Circuit-based (DS3/45 Mbps, OC3/155 Mbps and OC12/622 Mbps) and Ethernet-based (10 Mbps, 100 Mbps, and 1 Gbps) broadband services at all of the 236 sample locations they served (see the inset below for definitions). The provider list was derived from membership lists of the Ohio Cable Telecommunications Association and the Ohio Telecom Association. It lists providers maintained by OARnet, the Ohio Supercomputer Center's (OSC) networking division.

Of the 94 providers who were sent the survey, 91 (96.8%) responded with availability and cost information. Among the respondents, 75 providers indicated they do not provide higher-capacity broadband services as a standard offering to any of the sample locations. In many of these cases, special construction would be required to offer the service, making it unaffordable for most businesses. The other 16 respondents who provided availability and cost information included all the major broadband service providers in Ohio and several medium-to-small providers. We note that some providers who indicated non-service availability indicated that they may be able to provide these services later and cost can then be determined on an individual case basis. However, since cost information was unavailable at the time of the survey, we assumed that any business requesting service from those providers would also be unable to acquire them at this time.

The cost information contained in this report should not be construed as the actual price that any particular business would pay for broadband services in that county. Those prices could vary significantly due to a number of factors including the bundle of services provided with the connectivity, length of contract period, tie to services for the same company in different locations, and current market conditions at the time of sale. The broadband market has been changing rapidly over the past few years because of both the rapid changes in technology and the equally dynamic changes in the telecommunications market. The costs reported here will serve as a snapshot of current conditions and relative costs in different areas of the state. The costs provided here are not a price guide for buyers.

The remainder of this report discusses survey results in terms of the availability and relative costs of higher-capacity broadband services for business throughout the state.

Figure 1:
Sample Location and Types for Survey



4.0 Results

To understand the survey results, it is also important to understand the market for broadband services and its relationships with Ohio's population centers. Broadband, like many other services, has a greater return on investment in areas with larger populations. For a given investment in network infrastructure, there will be more potential customers that utilize the services, making them more cost-effective to supply.

Ohio counties have been divided into three logical groups by the U.S. Bureau of the Census – high population density (HPD) counties at the center of major metropolitan areas, medium population density (MPD) counties at the periphery of major metropolitan areas, and low population density (LPD) counties outside of metropolitan areas.

Table 2 and Figure 2 provide an overview of Ohio counties using that classification scheme.

Broadband Connection Types and Capacities

The two types of broadband connections we looked at in this study were the traditional telephone-based TDM circuits and the newer Ethernet services. TDM circuits are dedicated portions of larger transmission bundles that go from a provider's "point of presence" (PoP) and the end-user's premises. Ethernet services can be provided more simply using less expensive switching equipment, which does not have fixed bandwidth allocations like the TDM circuits it replaces. Thus, it can be allocated and managed much more cost-effectively. The table below shows the amount of bandwidth associated with each type of connection, displayed as the maximum Megabits or Gigabits per second of data transmitted.

Connection Name	Connection Speed
T1	1.544 Mbps
10 Mbps Ethernet	10 Mbps
DS3	43 Mbps
OC-1	51.85 Mbps
100 Mbps Ethernet	100 Mbps
OC-3	155.52 Mbps
OC-12	622.08 Mbps
Gigabit Ethernet	1000 Mbps
OC-24	1.244 Gbps
OC-48	2.488 Gbps
OC-192	9.952 Gbps
OC-255	13.21 Gbps

How fast is 8 Gbps or 8,000 million bits per second broadband capacity?

Approximately one million one-page essays can be transferred per second

- or -

Approximately 1,000 novels worth of data can be transferred per second

- or -

The entire movie, “The Matrix,” can be downloaded in less than 40 seconds over such a link compared to taking 25 hours for the same movie to be downloaded over a DSL modem connection (512 Kbps) or 250 hours over dial-up (56 Kbps).

Table 2: Comparison of Counties Grouped by Population Density						
	Number of Counties	Total Population	Average Population	Population Density	Average Employment	Employment Density
HPD Counties	6	4,865,274	810,879	1,827	442,630	949
MPD Counties	34	4,275,532	125,751	287	43,796	100
LPD Counties	48	2,212,334	46,090	94	15,105	31

4.1 DS3 Services

Statewide, the number of broadband providers is related to both the market area and the capacity of the requested service. For TDM circuits, the largest numbers of providers are available for DS3 circuits, ranging from 1 to 4 providers per county. Every sample location has a provider and every county has at least four providers of DS3 circuits as shown in Figure 3.

Figure 2:
Counties Classified by Census Density Categories

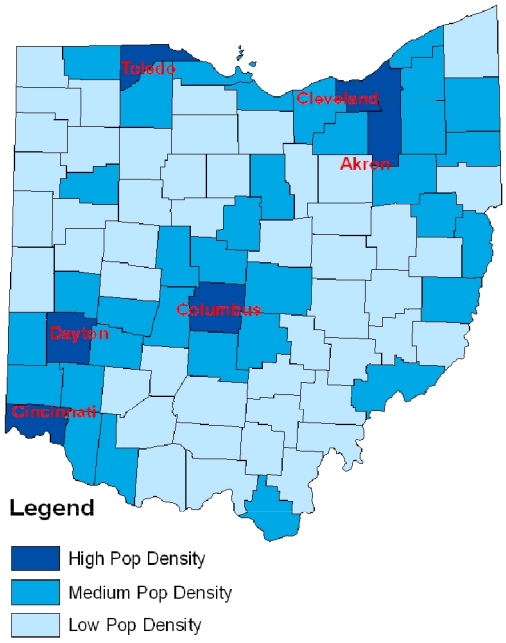
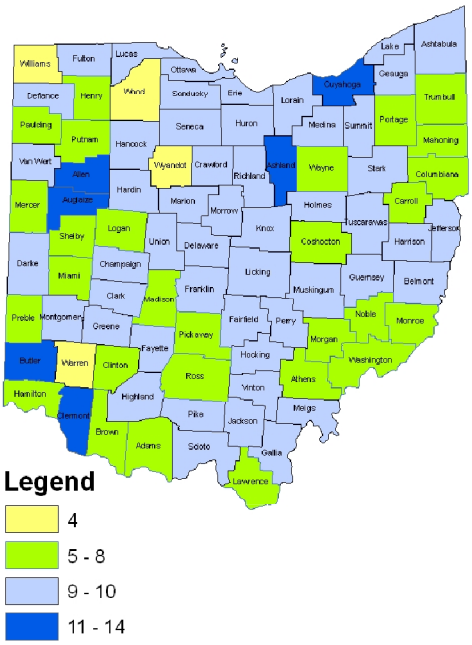


Figure 3:
Number of DS3 Service Providers



All of the survey sample sites have DS3 circuits available to them as illustrated in Figure 4. However, there is a wide variation in cost as shown in Figure 5. The largest, high-density counties have the lowest DS3 pricing between $6,600 and $8,700 per month. The cost goes up significantly as one goes to the surrounding counties and then to the rural low-density areas. In those low-density counties, costs range from over $12,000 per month to as much as $16,000 per month. This is expected, given the lower number of customers in those areas. However, at this price, many firms would find the service unaffordable.

Figure 4:
Number of Sample Locations with DS3 Service

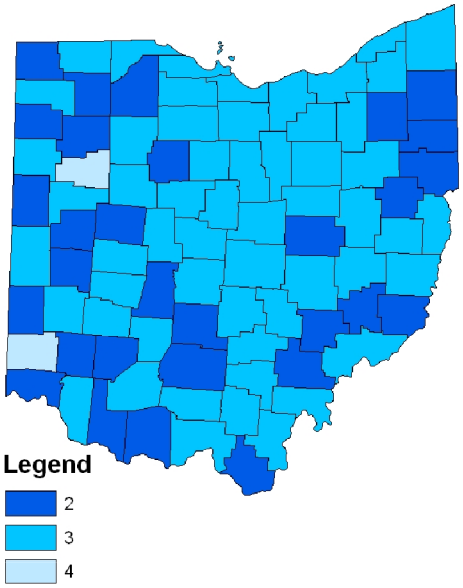
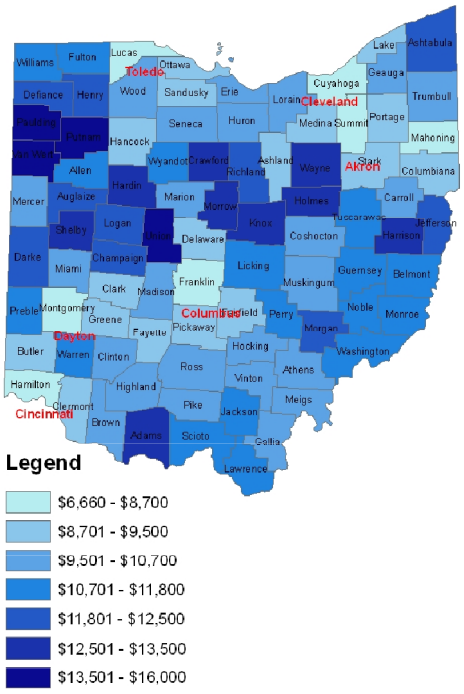


Figure 5:
Average Monthly Costs for DS3 Services



There is a strong and significant negative correlation between population or population density and the costs for the DS3 circuits. Again, this reflects the market conditions both in terms of the number of service providers available in higher-density areas and the return on investment for those services. The correlation persists as one increases the bandwidth and is still significant but weaker. Table 3 shows the correlations along with their statistical significance. All of the correlations are significant at the 1% confidence level. This means that the relationship is very strong and has a 99% likelihood that it is not caused by chance.

Table 3: Correlations of Cost with Population and Population Density

		TDM Circuit-based Service		
		DS3	OC3	OC12
Population	Correlation Coefficient	**-0.551**	**-0.504**	**-0.372**
	P-Value	0.000	0.000	0.002
Population Density	Correlation Coefficient	**-0.570**	**-0.513**	**-0.392**
	P-Value	0.000	0.000	0.001

4.2 OC3 (155 Mbps) Services

As one increases the bandwidth of the circuits, costs rise and availability declines as expected. OC3 (155 Mbps) services are available at all of the sample sites but fewer service providers offer the service and the price range is much larger. Figures 6 and 7 illustrate the distribution. Again the high-density counties have the lowest costs and largest number of service providers. Costs range from a low of about $15,000 per month in Cuyahoga County to a maximum of nearly $95,000 per month in Clinton County.

Figure 6:
Number of OC3 Service Providers

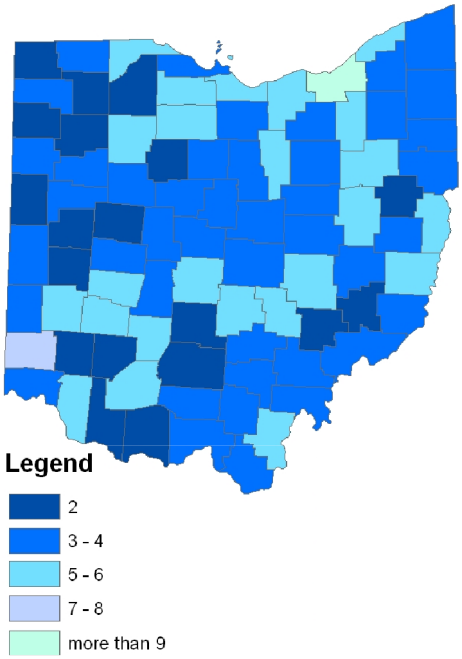
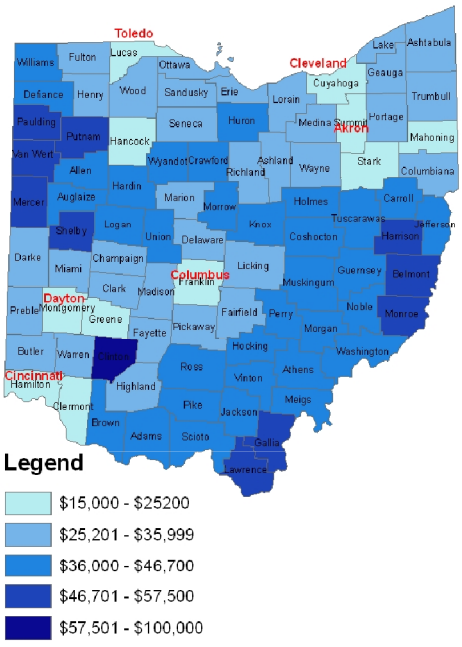


Figure 7:
Average OC3 Monthly Costs



How Broadband Impacts Economic Development: Case 1

One broadband case study we compiled involves Longaberger, the nation's premier maker of handcrafted baskets, headquartered at a relatively rural location in Newark, Ohio. In 2003, when Longaberger wanted to establish a data center to handle its web portal transactions, it needed a higher-capacity broadband connection. Due to the excessive pricing of higher-capacity broadband services in Newark, Longaberger decided to locate its data center operations in New York. This represents a lost opportunity to create jobs in Ohio that can be attributed to the costs of network services.

4.3 OC12 (622 Mbps) Services

As we go up to OC12 service (622 Mbps), the availability declines markedly and the cost differential also increases. OC12 services are not available at all in 20 counties as shown in Figure 8. The number of service providers offering the service and the percentage of sample sites where one can obtain the service also declines. Figure 8 shows that there are many counties where the service is available at only a percentage of the sample locations. Most typically, this is in the largest one or two communities in those counties and nowhere else.

The costs for OC12 service also represent a larger differential than the lower bandwidth circuits. Costs range from a low of around $29,000 per month to a maximum of $155,000 per month (Figure 9).

Figure 8: Percentage of Sample Sites with OC12 Service

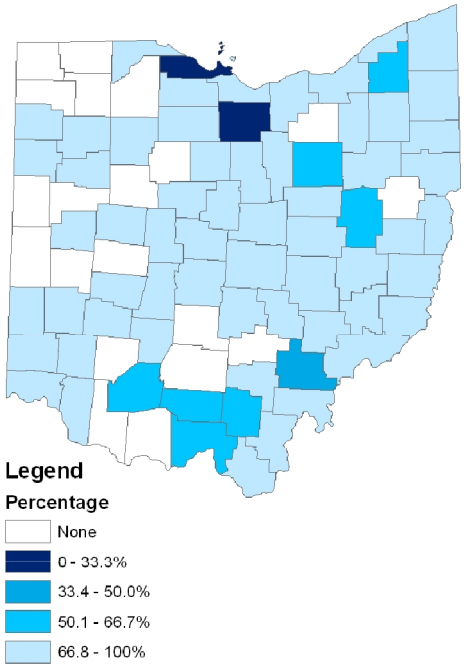
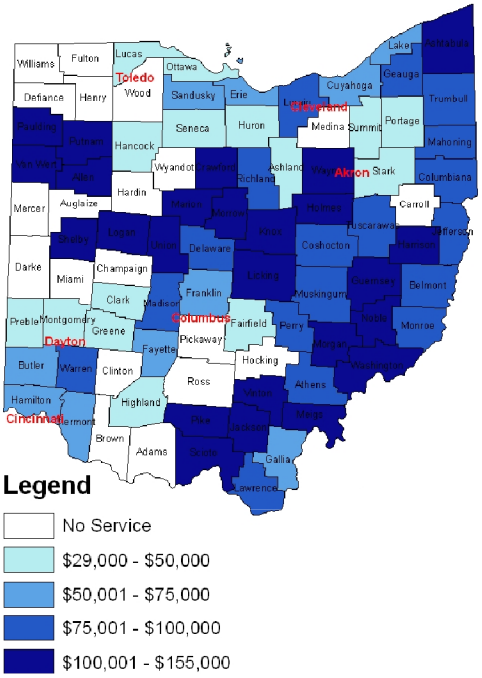


Figure 9: Average Monthly Costs for OC12 Services



4.4 Ethernet Services

Ethernet services are a newer and less costly way to provide higher bandwidth broadband. Our survey asked about the availability and costs for 10 Mbps, 100 Mbps, and 1 Gbps Ethernet services. There are 28 counties with no service providers for 10 Mbps Ethernet service as shown in Figure 10.

There are also a large number of counties (24 and 32) with two or three providers. This is a significant amount of market penetration for this technology, which brings with it significantly lower costs.

Figures 11 and 12 show the availability and cost for 10 Mbps Ethernet services in Ohio. Pricing for the service is much more evenly distributed around the state and has a much smaller range of prices than the traditional TDM circuits.

Figure 10:
Number of 10Mbps Service Providers by County

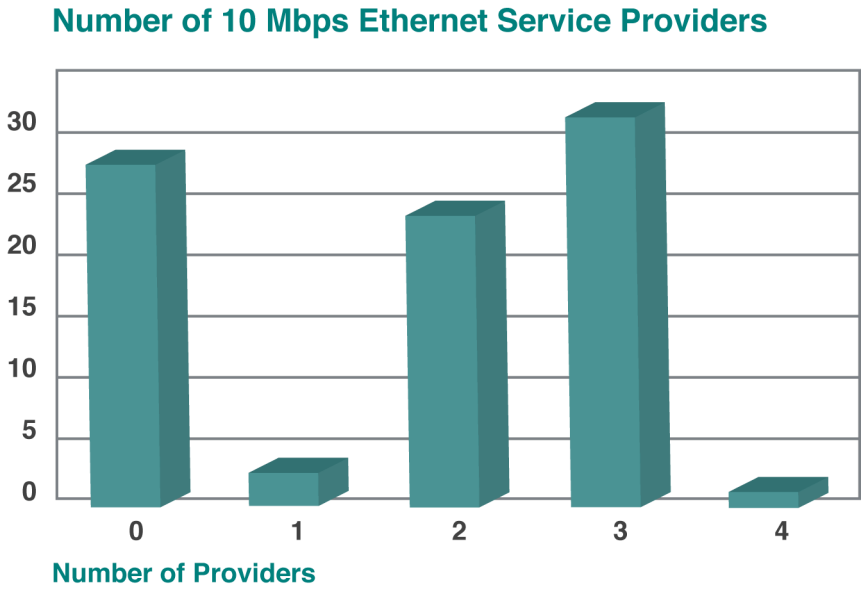


Figure 11:
Percent of Sample Sites with 10Mbps Ethernet Service

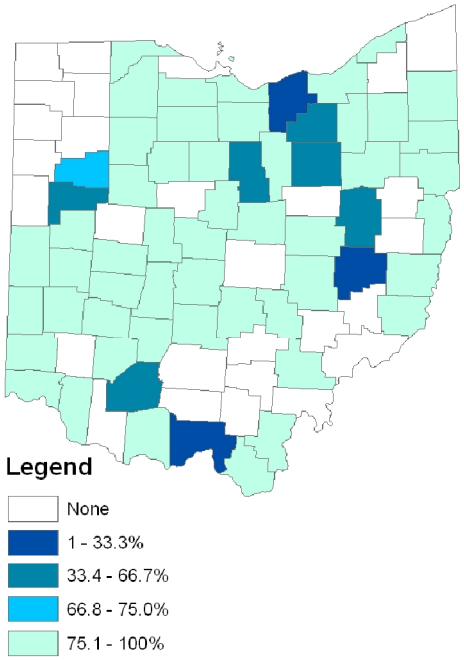
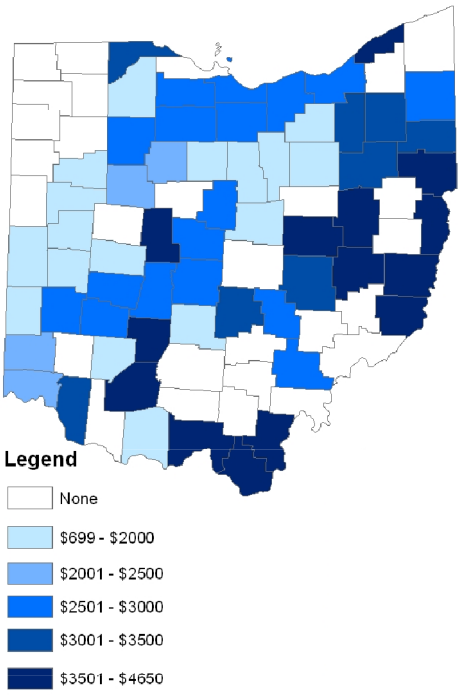


Figure 12:
Monthly Costs for 10Mbps Services



Comparing these costs to the DS3 costs is interesting. To do this, we took the 10 Mbps cost and multiplied it by 4.4 to get the approximate equivalent in bandwidth associated with a DS3. We then took the ratio of the DS3 costs to the adjusted 10 Mbps costs for all of those counties where both services are available. The average ratio between the prices is about 1.08 to 1 with a range from a minimum difference of 0.43 to 1 and a maximum of 3.05 to 1. In some areas, the prices are nearly equivalent on a per megabit basis, while in others, the 10 Mbps Ethernet service is substantially more cost-effective. A similar calculation comparing 100 Mbps service with DS3 shows the average cost of DS3 to be 27 times that of Ethernet. Figures 13 through 16 show the costs and availability for 100 Mbps and 1 Gbps services.

How Broadband Impacts Economic Development: Case 2

The City of Dublin in the late 1990s created DubLink, an underground network of conduits for fiber-optic cable. This conduit infrastructure has provided Dublin several breakthroughs in broadband connectivity for public groups and private businesses. It has also curtailed repeated cutting into city streets by businesses that want to install lines in the city's right-of-way. DubLink has also helped Dublin attract new businesses and high-paying jobs. After DubLink came into being, The Ohio State University established medical research facilities there. This is which are expected to bring thousands of high-paying jobs. Companies such as Qwest, Nationwide, Verizon Wireless, OhioHealth, and Battelle have located and expanded their offices in Dublin, in part due to the broadband connectivity advantages DubLink offers. Following the example of Dublin's leadership in using broadband as a development tool, many other cities are looking to duplicate Dublin's success.

Figure 13: Percent of Sample Sites with 100 Mbps Service

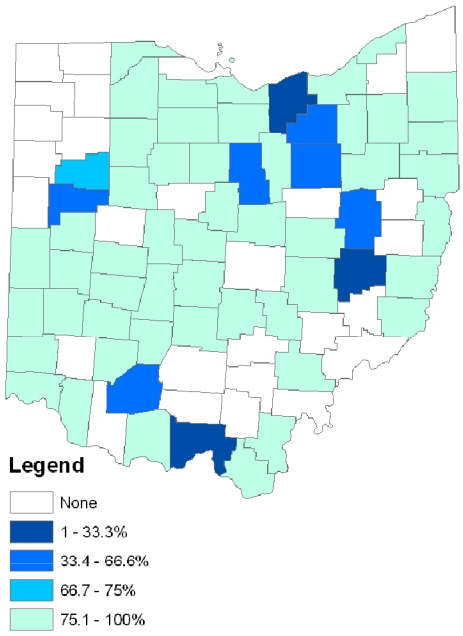


Figure 14: Monthly Costs for 100 Mbps Services

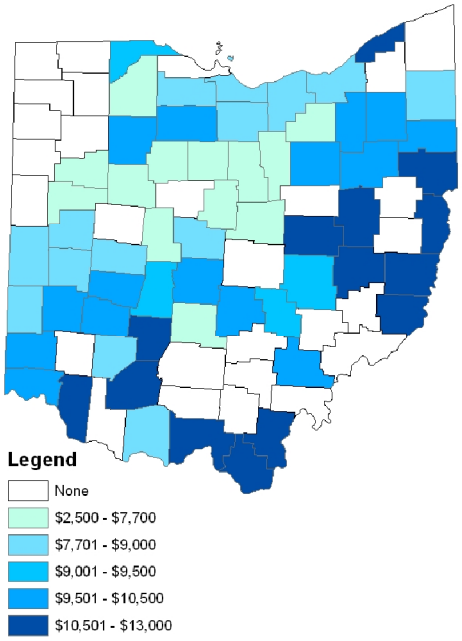


Figure 15: Percentage of Sites with 1 Gbps Service

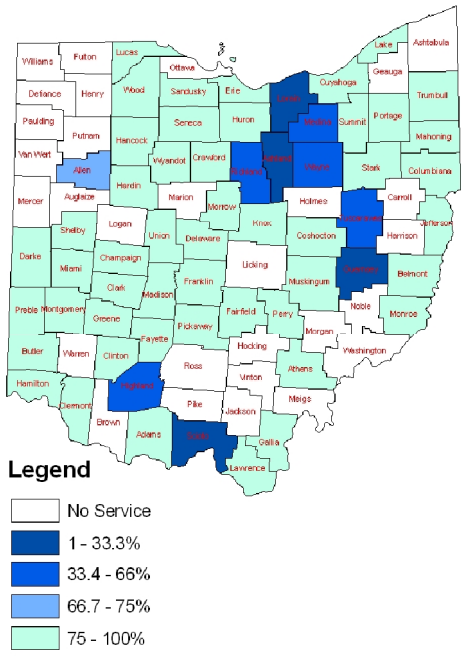
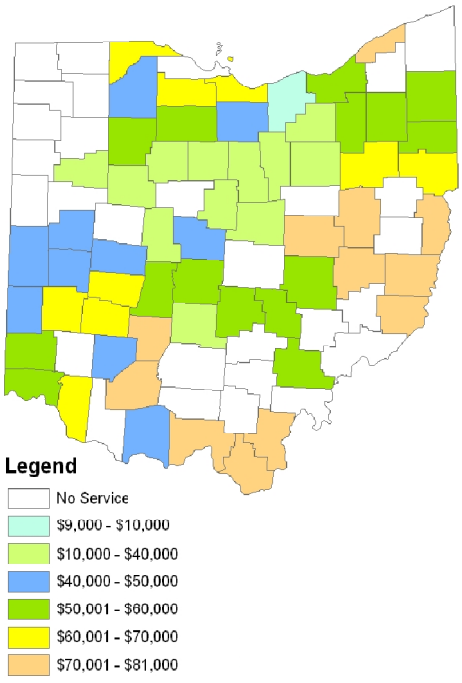


Figure 16: Monthly Cost for 1 Gbps Services



5.0 Comparison Between ECom-Ohio and Broadband-Ohio Reports

The original ECom-Ohio report primarily focused on the Internet's penetration to to bring businesses and citizens online. The technology at the time of the 2000 report was dominated by dial-up services and the initiation of lower-capacity broadband services offered through DSL and cable modems. Thus, the data compiled for that report focused on those services and markets including dial-up modem (56 Kbps), ISDN (128 Kbps), T-1 (1.544 Mbps), cable modem (1.5 Mbps), and DSL (up to 9 Mbps). Specific pricing ranges were not analyzed.

The 2006 Broadband-Ohio study focuses is on analyzing the availability and cost of higher-capacity (10 Mbps and higher) broadband services with TDM Circuit-based and Ethernet-based services. Table 4 compares the service availability compilations from the two studies for the state as a whole and for the major regions shown in Figure 17.

Figure 17:
Ohio Regional Map

Table 4. Comparisons of the service availability between 2000 and 2006			
	2000 ECom-Ohio Study	2006 Broadband Ohio Study	
	Lower-capacity broadband services and other lower services	Higher-capacity broadband services	
		TDM Circuit-based	Ethernet-based
Statewide	• Dialup access at 56K is available throughout Ohio for residents and small businesses. • ISDN and cable modems are available in urban and suburban areas. • ISDN, T-1s, DSL and cable technologies are not widely available throughout the state. • The urban and suburban Ohio market is highly diverse and boasts a variety of options for broadband service.	• DS3 (45 Mbps) and OC3 (155 Mbps) services are available in all sample locations of 88 Ohio counties. • OC12 (622 Mbps) service is available in 176 (75%) sample sites of 68 (77%) counties. • OC12 service is available in all sample sites in high-density counties and 79.3% and 67.7% of sample sites in medium-density counties and low-density counties, respectively.	• All Ethernet services (10 Mbps, 100 Mbps, and 1 Gbps) are available in all sample sites in high-density counties. • 10 Mbps and 100 Mbps services are available in 60 (68%) counties (71.7% and 53.5% of sample sites in medium-density counties and low-density counties, respectively). • 1 Gbps service is available in 59 (67%) counties (71.7% and 50.4% of sample sites in medium-density counties and low-density counties, respectively).
Central	• Dialup access is available throughout the region. • ISDN and cable modem are available in urban and suburban areas. • ISDN and T-1s are available throughout the region.	• DS3, OC3, and OC12 are available throughout the region. • OC12 is available in 12 (80%) counties.	• Ethernet service is available in 10 (67%) counties.
Northeast	• Dialup access is available throughout the region. • ISDN and cable modem are available in urban and suburban core. • T-1s are available throughout the region.	• DS3, OC3, OC12 are available throughout the region. • OC12 is available in 16 (94%) counties.	• Ethernet service is available in 14 (82%) counties.
Southeast	• Dialup access is available throughout the region. • T-1s are available in certain areas of the region.	• DS3, OC3, and OC12 are available throughout the region. • OC12 is available in 17 (94%) counties.	• Ethernet service is available in 10 (50%) counties.
Southwest	• Dialup access is available throughout the region. • ISDN, DSL, and cable modem are available in urban and suburban core. • T-1s are available throughout the region.	• DS3 and OC3 are available throughout the region. • OC12 is available in five (71%) counties.	• Ethernet service is available in five (71%) counties.
West	• Dialup access is available throughout the region. • ISDN and T-1s are available throughout the region.	• DS3 and OC3 are available throughout the region. • OC12 is available in five (56%) counties.	• Ethernet service is available in nine (100%) counties.
Northwest	• Dialup access is available throughout the region. • ISDN and cable modem are available in urban and suburban core. • T-1s are available throughout the region.	• DS3 and OC3 are available throughout the region. • OC12 is available in 12 (55%) counties.	• 10Mbps and 100Mbps are available in 13 (59%) counties • 1Gbps is available in 12 (55%) counties.

6.0 Summary and Conclusions

Ohio's major metropolitan counties are well served by high-capacity broadband services. These areas tend to have the greatest number of providers and lowest costs for broadband services. For the traditional TDM circuits availability is greatest for DS3 circuits. DS3 circuits are available at all of the sample sites in each of the 88 Ohio counties. Higher-capacity circuits are not available everywhere, and they are more costly in many rural counties.

Newer Ethernet services are available at much lower cost but are not available in many areas of the state. Currently, 60 counties have Ethernet services. This is larger than the number we expected to see but still leaves a large part of the state without those services. The cost range for Ethernet services is smallest for the 10 Mbps service. Where they are available, the 10 Mbps services are, thus, the most cost-effective. As one progresses to 100 Mb and 1 Gbps services, there is a larger differential in the cost for some areas, although lower cost pricing for these services is available in a larger number of counties.

In general, many of the rural counties in Ohio remain at a disadvantage in terms of the availability and cost-effectiveness of high bandwidth network services. This is to be expected given the current market. However, an increasing number of analysts in the U.S. are concerned about these trends, given the more rapid deployment of broadband services in other nations. Frieden (2005) notes that there are a number of other countries where broadband deployment has been more rapid than in the U.S. He suggests that a combination of regulatory decisions and limited capital investment by incumbent telecommunications providers are the underlying causes. He recommends a blend of government and private investment in that infrastructure to boost economic development advantages in the U.S.

Lai and Brewer (2006) examine the lack of broadband competition in New York City. They note several studies that demonstrate that the U.S. is behind in broadband penetration – 16th in the world by one study. They also note the increasing importance of broadband as a necessity for economic development. They examine the potential for local policy to impact broadband availability and affordability. Some of the same international rankings are cited by Turner (2006) in discussing the need for revised federal policies and possible state participation to bridge the gap in broadband availability. Similarly, Turner (2006) summarizes a range of research that compares the availability and price of broadband services in the U.S. with those of other nations and adds to the discussion on the potential policy changes that would make the U.S. more competitive.

What these and the studies cited earlier have recognized is the competitive advantage that is associated with areas providing cost-effective broadband services. Given the current infrastructure in Ohio, there is potential to enhance the competitiveness of many of Ohio's communities to attract new development and expand employment opportunities once broadband is readily available at reasonable costs. Both the number of competing providers in many counties as well as the availability of less expensive Ethernet services promise to aid economic development in those counties where they are available. A combination of regulatory changes, private and public investments may be necessary to create the incentives to encourage such conditions in other counties.

A broader discussion of the options and their consequences should take place in the near future so that Ohio has the opportunity to make its broadband services a positive factor in attracting business development to the state.

References

Federal Communications Commission, 2006. Local Telephone Competition and Broadband Deployment, High Speed Services for Internet Access. http://www.fcc.gov/wcb/iatd/comp.html, July 7, 2006 release.

George S. Ford and Thomas M. Koutsky, 2005. Broadband and Economic Development: A Municipal Case Study from Florida. Applied Economic Studies, April 2005. p 1-17.

Rob Frieden, Lessong from broadband development in Canada, Japan, Korea and the United States. Telecommunications Policy 29 (2005) p. 593-613.

Tarek M. Harchaoui, Faouzi Tarkhani, Chris Jackson, and Philip Armstrong, 2002. Information Technology and Economic Growth in Canada and the US. Monthly Labor Review, October 2002, p. 3-12.

Bruce Lai and Gale A. Brewer, 2006. New York City's broadband problem and the role of municipal government in promoting a private-sector solution. Technology in Society 28 (2006) p. 245-259.

S. Derek Turner 2006. Broadband Reality Check II. Freepress, http://www.freepress.net/docs/bbrc2-final.pdf.

Appendices

The appendices that follow contain the county-level availability and cost information gathered for this report. The original data showing exact locations, service providers, and actual costs have been expunged to protect the confidentiality of the information submitted by the service providers. As indicated earlier, even the average costs given here should only be used for relative comparison purposes. Anyone seeking network connectivity should contact the service providers in their area for a price quote on the specific services they are seeking.

A-1: Statistics of Ohio Counties

Table A-1: Population and Employment Statistics for Ohio Counties						
	County	Population	Employment	Area	Population Density	Employment Density
HPD	Cuyahoga	1,393,978	705,778	458	3,043.60	1,541.00
HPD	Hamilton	845,303	502,788	407	2,076.90	1,235.40
HPD	Franklin	1,068,978	591,366	540	1,979.60	1,095.10
HPD	Lucas	455,054	214,292	340	1,338.40	630.3
HPD	Summit	542,899	256,358	413	1,314.50	620.7
HPD	Montgomery	559,062	265,200	462	1,210.10	574
MPD	Lake	227,511	90,349	228	997.9	396.3
MPD	Butler	332,807	120,731	467	712.6	258.5
MPD	Stark	378,098	158,237	576	656.4	274.7
MPD	Mahoning	257,555	90,051	415	620.6	217
MPD	Lorain	284,664	89,577	492	578.6	182.1
MPD	Warren	158,383	59,200	400	396	148
MPD	Clermont	177,977	51,757	452	393.8	114.5
MPD	Trumbull	225,116	78,886	616	365.4	128.1
MPD	Clark	144,742	45,793	400	361.9	114.5
MPD	Medina	151,095	51,074	422	358	121
MPD	Greene	147,886	46,363	415	356.4	111.7
MPD	Erie	79,551	30,326	255	312	118.9
MPD	Portage	152,061	42,966	492	309.1	87.3
MPD	Allen	108,473	49,716	404	268.5	123.1
MPD	Richland	128,852	50,467	497	259.3	101.5
MPD	Delaware	109,989	65,084	442	248.8	147.2
MPD	Fairfield	122,759	30,476	505	243.1	60.3
MPD	Miami	98,868	37,231	407	242.9	91.5
MPD	Geauga	90,895	29,121	404	225	72.1
MPD	Licking	145,491	48,332	686	212.1	70.5
MPD	Wood	121,065	47,483	617	196.2	77
MPD	Jefferson	73,894	25,381	410	180.2	61.9
MPD	Ottawa	40,985	11,158	255	160.7	43.8
MPD	Lawrence	62,319	9,517	455	137	20.9
MPD	Belmont	70,226	19,714	537	130.8	36.7
MPD	Pickaway	52,727	12,262	502	105	24.4
MPD	Fulton	42,084	18,125	407	103.4	44.5
MPD	Preble	42,337	8,903	425	99.6	20.9
MPD	Washington	63,251	21,877	635	99.6	34.5
MPD	Union	40,909	22,331	437	93.6	51.1
MPD	Madison	40,213	11,403	465	86.5	24.5
MPD	Brown	42,285	5,683	492	85.9	11.6
MPD	Morrow	31,628	4,440	406	77.9	10.9
MPD	Carroll	28,836	5,060	395	73	12.8
LPD	Columbiana	112,075	28,516	532	210.7	53.6
LPD	Wayne	111,564	42,188	555	201	76

Table A-1: Population and Employment Statistics for Ohio Counties

	County	Population	Employment	Area	Population Density	Employment Density
LPD	Marion	66,217	24,018	404	163.9	59.5
LPD	Tuscarawas	90,914	33,334	568	160.1	58.7
LPD	Sandusky	61,792	24,048	409	151.1	58.8
LPD	Ashtabula	102,728	28,831	702	146.3	41.1
LPD	Hancock	71,295	39,757	531	134.3	74.9
LPD	Scioto	79,195	19,168	612	129.4	31.3
LPD	Muskingum	84,585	34,381	665	127.2	51.7
LPD	Ashland	52,523	16,821	424	123.9	39.7
LPD	Athens	62,223	13,293	507	122.7	26.2
LPD	Huron	59,487	20,819	493	120.7	42.2
LPD	Shelby	47,910	24,885	409	117.1	60.8
LPD	Crawford	46,966	14,694	402	116.8	36.6
LPD	Auglaize	46,611	18,040	401	116.2	45
LPD	Ross	73,345	22,224	688	106.6	32.3
LPD	Seneca	58,683	20,645	551	106.5	37.5
LPD	Knox	54,500	18,195	527	103.4	34.5
LPD	Logan	46,005	18,175	458	100.4	39.7
LPD	Clinton	40,543	22,870	411	98.6	55.6
LPD	Defiance	39,500	15,785	411	96.1	38.4
LPD	Williams	39,188	15,868	422	92.9	37.6
LPD	Holmes	38,943	13,803	423	92.1	32.6
LPD	Champaign	38,890	9,676	429	90.7	22.6
LPD	Darke	53,309	15,963	600	88.8	26.6
LPD	Mercer	40,924	13,694	463	88.4	29.6
LPD	Perry	34,078	4,797	410	83.1	11.7
LPD	Guernsey	40,792	12,684	522	78.1	24.3
LPD	Jackson	32,641	10,986	420	77.7	26.2
LPD	Highland	40,875	9,926	553	73.9	17.9
LPD	Van Wert	29,659	10,197	410	72.3	24.9
LPD	Putnam	34,726	9,080	484	71.7	18.8
LPD	Henry	29,210	9,042	416	70.2	21.7
LPD	Fayette	28,433	10,775	407	69.9	26.5
LPD	Hardin	31,945	7,498	470	68	16
LPD	Hocking	28,241	5,708	423	66.8	13.5
LPD	Gallia	31,069	9,460	469	66.2	20.2
LPD	Coshocton	36,655	12,741	564	65	22.6
LPD	Pike	27,695	9,235	441	62.8	20.9
LPD	Wyandot	22,908	9,894	406	56.4	24.4
LPD	Meigs	23,072	2,544	429	53.8	5.9
LPD	Paulding	20,293	4,084	416	48.8	9.8
LPD	Adams	27,330	4,613	584	46.8	7.9
LPD	Harrison	15,856	2,928	404	39.2	7.2
LPD	Morgan	14,897	1,651	418	35.6	3.9
LPD	Noble	14,058	2,014	399	35.2	5
LPD	Monroe	15,180	3,826	456	33.3	8.4
LPD	Vinton	12,806	1,682	414	30.9	4.1

A-2: Summary of Broadband Services Availability

Table A-2: Number of Providers Serving TDM Circuit-based Services at the Sample Locations														
		Number of DS3 Providers					Number of OC3 Providers				Number of OC12 Providers			
Type	County	Total	1	2	3	4	Total	1	2	3	Total	0	1	2
HPD	Cuyahoga	3	0	0	0	3	3	0	0	3	3	0	0	3
HPD	Franklin	3	0	0	3	0	3	0	3	0	3	0	0	3
HPD	Hamilton	2	0	0	0	2	2	0	2	0	2	0	0	2
HPD	Lucas	3	0	0	3	0	3	0	3	0	3	0	3	0
HPD	Montgomery	3	0	0	3	0	3	0	3	0	3	0	3	0
HPD	Summit	3	0	0	3	0	3	0	3	0	3	0	3	0
LPD	Adams	2	0	0	2	0	2	2	0	0	2	2	0	0
LPD	Ashland	3	0	0	0	3	3	0	3	0	3	0	2	1
LPD	Ashtabula	3	0	0	3	0	3	3	0	0	3	0	3	0
LPD	Athens	2	0	0	2	0	2	1	1	0	2	1	0	1
LPD	Auglaize	3	0	0	0	3	3	3	0	0	3	3	0	0
LPD	Champaign	3	0	0	3	0	3	3	0	0	3	3	0	0
LPD	Clinton	2	0	0	2	0	2	2	0	0	2	2	0	0
LPD	Columbiana	2	0	0	2	0	2	0	2	0	2	0	2	0
LPD	Coshocton	2	0	0	2	0	2	0	2	0	2	0	0	2
LPD	Crawford	3	0	0	3	0	3	3	0	0	3	0	3	0
LPD	Darke	3	0	0	3	0	3	3	0	0	3	3	0	0
LPD	Defiance	3	0	0	3	0	3	3	0	0	3	3	0	0
LPD	Fayette	3	0	0	3	0	3	0	3	0	3	0	0	3
LPD	Gallia	3	0	0	3	0	3	0	3	0	3	0	3	0
LPD	Guernsey	3	0	0	3	0	3	2	1	0	3	0	2	1
LPD	Hancock	3	0	0	3	0	3	0	3	0	3	0	3	0
LPD	Hardin	3	0	0	3	0	3	3	0	0	3	3	0	0
LPD	Harrison	3	0	0	3	0	3	3	0	0	3	0	3	0
LPD	Henry	2	0	0	2	0	2	2	0	0	2	2	0	0
LPD	Highland	3	0	0	3	0	3	1	2	0	3	1	2	0
LPD	Hocking	3	0	0	3	0	3	3	0	0	3	3	0	0
LPD	Holmes	3	0	0	3	0	3	3	0	0	3	0	3	0
LPD	Huron	3	0	0	3	0	3	2	1	0	3	2	1	0
LPD	Jackson	3	0	0	3	0	3	3	0	0	3	1	2	0
LPD	Knox	3	0	0	3	0	3	3	0	0	3	0	3	0
LPD	Logan	2	0	0	2	0	2	2	0	0	2	0	2	0
LPD	Marion	3	0	0	3	0	3	3	0	0	3	0	3	0
LPD	Meigs	3	0	0	3	0	3	3	0	0	3	0	3	0
LPD	Mercer	2	0	0	2	0	2	2	0	0	2	2	0	0
LPD	Monroe	2	0	0	2	0	2	0	2	0	2	0	0	2
LPD	Morgan	2	0	0	2	0	2	2	0	0	2	0	2	0
LPD	Muskingum	3	0	0	3	0	3	1	2	0	3	0	1	2
LPD	Noble	2	0	0	2	0	2	2	0	0	2	0	2	0
LPD	Paulding	2	0	0	2	0	2	2	0	0	2	0	2	0
LPD	Perry	3	0	0	3	0	3	1	2	0	3	0	1	2
LPD	Pike	3	0	0	3	0	3	3	0	0	3	1	2	0
LPD	Putnam	2	0	0	2	0	2	2	0	0	2	0	2	0
LPD	Ross	2	0	0	2	0	2	2	0	0	2	2	0	0
LPD	Sandusky	3	0	0	3	0	3	0	3	0	3	0	3	0
LPD	Scioto	3	0	0	3	0	3	2	1	0	3	1	1	1
LPD	Seneca	3	0	0	3	0	3	0	3	0	3	0	3	0

Table A-2: Number of Providers Serving TDM Circuit-based Services at the Sample Locations

		Number of DS3 Providers					Number of OC3 Providers				Number of OC12 Providers			
Type	County	Total	1	2	3	4	Total	1	2	3	Total	0	1	2
LPD	Shelby	2	0	0	2	0	2	2	0	0	2	0	2	0
LPD	Tuscarawas	3	0	0	3	0	3	1	2	0	3	1	0	2
LPD	Van Wert	3	0	0	3	0	3	3	0	0	3	0	3	0
LPD	Vinton	3	0	0	3	0	3	3	0	0	3	0	3	0
LPD	Wayne	3	1	2	0	0	3	3	0	0	3	1	2	0
LPD	Williams	2	0	2	0	0	2	2	0	0	2	2	0	0
LPD	Wyandot	2	0	2	0	0	2	2	0	0	2	2	0	0
MPD	Allen	4	0	0	4	0	4	4	0	0	4	0	4	0
MPD	Belmont	3	0	0	3	0	3	0	3	0	3	0	0	3
MPD	Brown	2	0	0	2	0	2	2	0	0	2	2	0	0
MPD	Butler	4	0	0	2	2	4	1	3	0	4	0	2	2
MPD	Carroll	2	0	0	2	0	2	2	0	0	2	2	0	0
MPD	Clark	3	0	0	3	0	3	0	3	0	3	0	3	0
MPD	Clermont	3	0	0	0	3	3	0	3	0	3	0	0	3
MPD	Delaware	3	0	0	3	0	3	2	1	0	3	0	2	1
MPD	Erie	3	0	0	3	0	3	0	3	0	3	0	3	0
MPD	Fairfield	3	0	0	3	0	3	0	3	0	3	0	3	0
MPD	Fulton	3	0	0	3	0	3	3	0	0	3	3	0	0
MPD	Geauga	3	0	0	3	0	3	3	0	0	3	1	2	0
MPD	Greene	3	0	0	3	0	3	0	3	0	3	0	3	0
MPD	Jefferson	3	0	0	3	0	3	0	3	0	3	0	0	3
MPD	Lake	3	0	0	3	0	3	0	3	0	3	0	0	3
MPD	Lawrence	2	0	0	2	0	2	0	2	0	2	0	0	2
MPD	Licking	3	0	0	3	0	3	3	0	0	3	0	3	0
MPD	Lorain	3	0	0	2	1	3	1	2	0	3	0	2	1
MPD	Madison	2	0	0	2	0	2	1	1	0	2	0	1	1
MPD	Mahoning	2	0	0	2	0	2	0	2	0	2	0	2	0
MPD	Medina	3	0	0	3	0	3	3	0	0	3	3	0	0
MPD	Miami	2	0	0	2	0	2	2	0	0	2	2	0	0
MPD	Morrow	3	0	0	3	0	3	3	0	0	3	0	3	0
MPD	Ottawa	3	0	0	3	0	3	2	1	0	3	2	1	0
MPD	Pickaway	2	0	0	2	0	2	2	0	0	2	2	0	0
MPD	Portage	2	0	0	2	0	2	0	2	0	2	0	2	0
MPD	Preble	2	0	0	2	0	2	0	2	0	2	0	2	0
MPD	Richland	3	0	0	3	0	3	3	0	0	3	0	3	0
MPD	Stark	3	0	0	3	0	3	0	3	0	3	0	3	0
MPD	Trumbull	2	0	0	2	0	2	1	1	0	2	0	2	0
MPD	Union	3	0	0	3	0	3	3	0	0	3	0	3	0
MPD	Warren	2	0	2	0	0	2	2	0	0	2	0	2	0
MPD	Washington	3	0	3	0	0	3	3	0	0	3	0	3	0
MPD	Wood	2	0	2	0	0	2	2	0	0	2	2	0	0
State-wide		236	1	13	205	17	236	139	94	3	236	60	132	44
Counties	HPD	17	0	0	12	5	17	0	14	3	17	0	9	8
	MPD	92	0	7	79	6	92	48	44	0	92	19	54	19
	LPD	127	1	6	114	6	127	91	36	0	127	41	69	17

Table A-3: Number of Providers Serving Ethernet-based Services at the Sample Locations

		Number of 10Mbps Providers				Number of 100Mbps Providers				Number of 1Gbps Providers			
Type	County	Total	0	1	2	Total	0	1	2	Total	0	1	2
HPD	Cuyahoga	3	0	0	3	3	0	0	3	3	0	0	3
HPD	Franklin	3	0	0	3	3	0	0	3	3	0	0	3
HPD	Hamilton	2	0	0	2	2	0	0	2	2	0	0	2
HPD	Lucas	3	0	0	3	3	0	0	3	3	0	0	3
HPD	Montgomery	3	0	0	3	3	0	0	3	3	0	0	3
HPD	Summit	3	0	0	3	3	0	0	3	3	0	0	3
LPD	Adams	2	0	2	0	2	0	2	0	2	0	2	0
LPD	Ashland	3	0	2	1	3	0	2	1	3	2	1	0
LPD	Ashtabula	3	3	0	0	3	3	0	0	3	3	0	0
LPD	Athens	2	0	2	0	2	0	2	0	2	0	2	0
LPD	Auglaize	3	1	2	0	3	1	2	0	3	3	0	0
LPD	Champaign	3	0	3	0	3	0	3	0	3	0	3	0
LPD	Clinton	2	0	2	0	2	0	2	0	2	0	2	0
LPD	Columbiana	2	0	1	1	2	0	1	1	2	0	1	1
LPD	Coshocton	2	0	2	0	2	0	2	0	2	0	2	0
LPD	Crawford	3	0	3	0	3	0	3	0	3	0	3	0
LPD	Darke	3	0	3	0	3	0	3	0	3	0	3	0
LPD	Defiance	3	3	0	0	3	3	0	0	3	3	0	0
LPD	Fayette	3	0	3	0	3	0	3	0	3	0	3	0
LPD	Gallia	3	0	3	0	3	0	3	0	3	0	3	0
LPD	Guernsey	3	2	1	0	3	2	1	0	3	2	1	0
LPD	Hancock	3	0	0	3	3	0	0	3	3	0	0	3
LPD	Hardin	3	0	3	0	3	0	3	0	3	0	3	0
LPD	Harrison	3	3	0	0	3	3	0	0	3	3	0	0
LPD	Henry	2	2	0	0	2	2	0	0	2	2	0	0
LPD	Highland	3	1	2	0	3	1	2	0	3	1	2	0
LPD	Hocking	3	3	0	0	3	3	0	0	3	3	0	0
LPD	Holmes	3	3	0	0	3	3	0	0	3	3	0	0
LPD	Huron	3	0	2	1	3	0	2	1	3	0	2	1
LPD	Jackson	3	3	0	0	3	3	0	0	3	3	0	0
LPD	Knox	3	0	3	0	3	0	3	0	3	0	3	0
LPD	Logan	2	2	0	0	2	2	0	0	2	2	0	0
LPD	Marion	3	3	0	0	3	3	0	0	3	3	0	0
LPD	Meigs	3	3	0	0	3	3	0	0	3	3	0	0
LPD	Mercer	2	2	0	0	2	2	0	0	2	2	0	0
LPD	Monroe	2	0	2	0	2	0	2	0	2	0	2	0
LPD	Morgan	2	2	0	0	2	2	0	0	2	2	0	0
LPD	Muskingum	3	0	1	2	3	0	1	2	3	0	1	2
LPD	Noble	2	2	0	0	2	2	0	0	2	2	0	0
LPD	Paulding	2	2	0	0	2	2	0	0	2	2	0	0
LPD	Perry	3	0	1	2	3	0	1	2	3	0	1	2
LPD	Pike	3	3	0	0	3	3	0	0	3	3	0	0
LPD	Putnam	2	2	0	0	2	2	0	0	2	2	0	0
LPD	Ross	2	2	0	0	2	2	0	0	2	2	0	0
LPD	Sandusky	3	0	0	3	3	0	0	3	3	0	0	3
LPD	Scioto	3	2	1	0	3	2	1	0	3	2	1	0
LPD	Seneca	3	0	0	3	3	0	0	3	3	0	0	3
LPD	Shelby	2	0	2	0	2	0	2	0	2	0	2	0

Table A-3: Number of Providers Serving Ethernet-based Services at the Sample Locations

		Number of 10Mbps Providers				Number of 100Mbps Providers				Number of 1Gbps Providers			
Type	County	Total	0	1	2	Total	0	1	2	Total	0	1	2
LPD	Tuscarawas	3	1	2	0	3	1	2	0	3	1	2	0
LPD	Van Wert	3	3	0	0	3	3	0	0	3	3	0	0
LPD	Vinton	3	3	0	0	3	3	0	0	3	3	0	0
LPD	Wayne	3	1	2	0	3	1	2	0	3	1	2	0
LPD	Williams	2	2	0	0	2	2	0	0	2	2	0	0
LPD	Wyandot	2	0	2	0	2	0	2	0	2	0	2	0
MPD	Allen	4	1	3	0	4	1	3	0	4	1	3	0
MPD	Belmont	3	0	3	0	3	0	3	0	3	0	3	0
MPD	Brown	2	2	0	0	2	2	0	0	2	2	0	0
MPD	Butler	4	0	1	3	4	0	1	3	4	0	1	3
MPD	Carroll	2	2	0	0	2	2	0	0	2	2	0	0
MPD	Clark	3	0	0	3	3	0	0	3	3	0	0	3
MPD	Clermont	3	0	3	0	3	0	3	0	3	0	3	0
MPD	Delaware	3	0	2	1	3	0	2	1	3	0	2	1
MPD	Erie	3	0	0	3	3	0	0	3	3	0	0	3
MPD	Fairfield	3	0	0	3	3	0	0	3	3	0	0	3
MPD	Fulton	3	3	0	0	3	3	0	0	3	3	0	0
MPD	Geauga	3	3	0	0	3	3	0	0	3	3	0	0
MPD	Greene	3	0	0	3	3	0	0	3	3	0	0	3
MPD	Jefferson	3	0	3	0	3	0	3	0	3	0	3	0
MPD	Lake	3	0	3	0	3	0	3	0	3	0	3	0
MPD	Lawrence	2	0	2	0	2	0	2	0	2	0	2	0
MPD	Licking	3	3	0	0	3	3	0	0	3	3	0	0
MPD	Lorain	3	2	1	0	3	2	1	0	3	2	1	0
MPD	Madison	2	0	1	1	2	0	1	1	2	0	1	1
MPD	Mahoning	2	0	0	2	2	0	0	2	2	0	0	2
MPD	Medina	3	1	2	0	3	1	2	0	3	1	2	0
MPD	Miami	2	0	2	0	2	0	2	0	2	0	2	0
MPD	Morrow	3	0	3	0	3	0	3	0	3	0	3	0
MPD	Ottawa	3	3	0	0	3	3	0	0	3	3	0	0
MPD	Pickaway	2	0	2	0	2	0	2	0	2	0	2	0
MPD	Portage	2	0	0	2	2	0	0	2	2	0	0	2
MPD	Preble	2	0	2	0	2	0	2	0	2	0	2	0
MPD	Richland	3	1	2	0	3	1	2	0	3	1	2	0
MPD	Stark	3	0	1	2	3	0	1	2	3	0	1	2
MPD	Trumbull	2	0	1	1	2	0	1	1	2	0	1	1
MPD	Union	3	0	3	0	3	0	3	0	3	0	3	0
MPD	Warren	2	2	0	0	2	2	0	0	2	2	0	0
MPD	Washington	3	3	0	0	3	3	0	0	3	3	0	0
MPD	Wood	2	0	2	0	2	0	2	0	2	0	2	0
State-wide		236	85	94	57	236	85	94	57	236	89	91	56
Counties	HPD	17	0	0	17	17	0	0	17	17	0	0	17
	MPD	92	26	42	24	92	26	42	24	92	26	42	24
	LPD	127	59	52	16	127	59	52	16	127	63	49	15

A-3: Summary of Broadband Services Costs

Table A-4: Average Service Costs by Service Types							
		TDM Circuit-based Services			Ethernet-based Services		
Type	County	DS3	OC3	OC12	10 Mbps	100 Mbps	1 Gbps
HPD	Cuyahoga	$6,660	$15,909	$50,151	$2,686	$8,058	$55,061
HPD	Franklin	$8,092	$20,573	$64,147	$2,771	$9,572	$57,561
HPD	Hamilton	$8,020	$20,693	$66,907	$2,096	$10,237	$59,000
HPD	Lucas	$8,293	$21,633	$40,095	$3,034	$9,213	$65,783
HPD	Montgomery	$8,649	$22,211	$39,666	$2,699	$10,072	$64,561
HPD	Summit	$8,609	$21,875	$40,095	$3,123	$9,572	$57,561
LPD	Adams	$13,018	$43,800	N/A	$1,150	$8,500	$49,000
LPD	Ashland	$9,384	$25,656	$29,568	$699	$2,575	$35,000
LPD	Ashtabula	$12,242	$34,514	$106,200	N/A	N/A	N/A
LPD	Athens	$10,165	$39,147	$76,989	$2,921	$9,572	$57,561
LPD	Auglaize	$11,970	$42,891	N/A	$1,200	$3,600	N/A
LPD	Champaign	$12,107	$31,912	N/A	$1,150	$8,500	$49,000
LPD	Clinton	$10,021	$94,619	N/A	$1,150	$8,500	$49,000
LPD	Columbiana	$9,314	$26,565	$89,865	$3,881	$10,646	$65,464
LPD	Coshocton	$10,478	$38,814	$79,258	$4,247	$11,644	$80,121
LPD	Crawford	$12,587	$36,332	$108,807	$1,863	$7,500	$35,000
LPD	Darke	$12,008	$35,900	N/A	$1,150	$8,500	$49,000
LPD	Defiance	$12,247	$40,116	N/A	N/A	N/A	N/A
LPD	Fayette	$9,374	$31,545	$73,134	$4,247	$11,644	$80,121
LPD	Gallia	$10,530	$47,599	$65,287	$4,247	$11,644	$80,121
LPD	Guernsey	$10,901	$42,129	$108,619	$4,247	$11,644	$80,121
LPD	Hancock	$8,948	$24,840	$42,213	$2,921	$9,572	$57,561
LPD	Hardin	$12,848	$39,342	N/A	$2,262	$7,500	$35,000
LPD	Harrison	$12,874	$47,444	$133,120	N/A	N/A	N/A
LPD	Henry	$11,914	$35,737	N/A	N/A	N/A	N/A
LPD	Highland	$10,223	$35,880	$46,433	$4,247	$11,644	$80,121
LPD	Hocking	$9,726	$37,086	N/A	N/A	N/A	N/A
LPD	Holmes	$12,857	$39,504	$113,657	N/A	N/A	N/A
LPD	Huron	$10,256	$36,100	$41,087	$2,560	$8,536	$46,280
LPD	Jackson	$10,843	$41,191	$119,906	N/A	N/A	N/A
LPD	Knox	$13,498	$37,560	$111,062	$1,595	$7,500	$35,000
LPD	Logan	$12,368	$44,866	$128,484	N/A	N/A	N/A
LPD	Marion	$9,690	$33,678	$106,911	N/A	N/A	N/A
LPD	Meigs	$10,587	$43,501	$121,971	N/A	N/A	N/A
LPD	Mercer	$10,498	$47,342	N/A	N/A	N/A	N/A
LPD	Monroe	$11,637	$51,772	$90,000	$4,247	$11,644	$80,121
LPD	Morgan	$12,388	$40,013	$116,969	N/A	N/A	N/A
LPD	Muskingum	$10,645	$36,057	$87,553	$3,137	$9,158	$53,048
LPD	Noble	$11,307	$42,898	$122,619	N/A	N/A	N/A
LPD	Paulding	$15,210	$49,431	$142,805	N/A	N/A	N/A
LPD	Perry	$10,816	$37,209	$93,891	$2,856	$9,158	$53,048
LPD	Pike	$10,626	$39,253	$115,746	N/A	N/A	N/A
LPD	Putnam	$13,781	$49,871	$140,160	N/A	N/A	N/A
LPD	Ross	$10,411	$38,521	N/A	N/A	N/A	N/A
LPD	Sandusky	$9,111	$30,128	$51,780	$2,794	$8,927	$60,652
LPD	Scioto	$11,393	$46,442	$100,683	$4,247	$11,644	$80,121
LPD	Seneca	$9,613	$29,345	$48,215	$2,921	$9,572	$57,561

Table A-4: Average Service Costs by Service Types							
		TDM Circuit-based Services			Ethernet-based Services		
Type	County	DS3	OC3	OC12	10 Mbps	100 Mbps	1 Gbps
LPD	Shelby	$12,726	$51,815	$144,755	$1,150	$8,500	$49,000
LPD	Tuscarawas	$11,039	$43,480	$86,104	$4,247	$11,644	$80,121
LPD	Van Wert	$14,558	$55,486	$153,433	N/A	N/A	N/A
LPD	Vinton	$10,620	$38,756	$115,423	N/A	N/A	N/A
LPD	Wayne	$12,720	$33,338	$114,645	$1,500	$10,000	$40,000
LPD	Williams	$11,125	$39,925	N/A	N/A	N/A	N/A
LPD	Wyandot	$11,056	$37,579	N/A	$2,095	$7,500	$35,000
MPD	Allen	$11,433	$43,787	$126,532	$1,595	$7,500	$35,000
MPD	Belmont	$11,517	$50,927	$86,476	$4,247	$11,644	$80,121
MPD	Brown	$10,247	$40,290	N/A	N/A	N/A	N/A
MPD	Butler	$8,815	$26,593	$70,480	$2,215	$9,977	$59,242
MPD	Carroll	$10,311	$36,032	N/A	N/A	N/A	N/A
MPD	Clark	$9,315	$27,558	$46,715	$2,699	$10,072	$64,561
MPD	Clermont	$8,752	$23,106	$69,413	$3,041	$11,974	$69,000
MPD	Delaware	$8,860	$25,747	$84,265	$2,709	$8,536	$46,280
MPD	Erie	$9,779	$34,489	$52,624	$2,731	$8,605	$62,198
MPD	Fairfield	$9,298	$28,784	$47,559	$3,268	$9,860	$57,848
MPD	Fulton	$11,657	$35,201	N/A	N/A	N/A	N/A
MPD	Geauga	$10,614	$29,753	$99,059	N/A	N/A	N/A
MPD	Greene	$8,833	$22,455	$42,776	$2,794	$10,114	$64,656
MPD	Jefferson	$12,141	$41,576	$94,531	$4,247	$11,644	$80,121
MPD	Lake	$8,766	$25,940	$70,541	$4,630	$12,027	$80,504
MPD	Lawrence	$11,547	$49,571	$89,729	$4,247	$11,644	$80,121
MPD	Licking	$10,969	$30,535	$101,218	N/A	N/A	N/A
MPD	Lorain	$10,561	$28,070	$92,915	$2,510	$7,950	$9,450
MPD	Madison	$10,146	$29,528	$85,864	$2,671	$9,073	$50,232
MPD	Mahoning	$8,377	$19,496	$84,552	$3,123	$9,572	$57,561
MPD	Medina	$8,875	$32,814	N/A	$1,998	$7,500	$35,000
MPD	Miami	$9,687	$32,614	N/A	$1,150	$8,500	$49,000
MPD	Morrow	$13,431	$37,056	$109,871	$2,730	$7,500	$35,000
MPD	Ottawa	$9,229	$28,857	$38,393	N/A	N/A	N/A
MPD	Pickaway	$9,311	$33,364	N/A	$1,595	$7,500	$35,000
MPD	Portage	$9,132	$25,685	$43,901	$3,123	$9,572	$57,561
MPD	Preble	$10,909	$29,523	$46,433	$1,150	$8,500	$49,000
MPD	Richland	$11,974	$31,714	$97,267	$1,998	$7,500	$35,000
MPD	Stark	$9,140	$24,252	$45,964	$3,347	$9,986	$62,073
MPD	Trumbull	$9,618	$25,749	$89,953	$2,748	$8,881	$50,040
MPD	Union	$13,952	$44,471	$127,398	$3,730	$7,667	$35,000
MPD	Warren	$11,031	$28,157	$90,124	N/A	N/A	N/A
MPD	Washington	$11,577	$42,559	$106,320	N/A	N/A	N/A
MPD	Wood	$9,822	$29,430	N/A	$1,215	$5,566	$44,276
State-wide		$10,707	$35,972	$86,313	$2,714	$9,209	$55,856
County	HPD	$8,054	$20,482	$50,177	$2,735	$9,454	$59,921
	MPD	$10,283	$32,226	$79,291	$2,750	$9,187	$53,225
	LPD	$11,339	$40,561	$97,924	$2,676	$9,177	$57,487

Appendix B: Broadband Initiatives in Ohio's Neighboring States

B-1: OHIO

a. Operated by:
OARnet, A Division of the Ohio Supercomputer Center

b. Website:
http://www.oar.net

c. User Community:
Connects 124 institutions including K-12, higher education, libraries, healthcare, public broadcasting and research labs

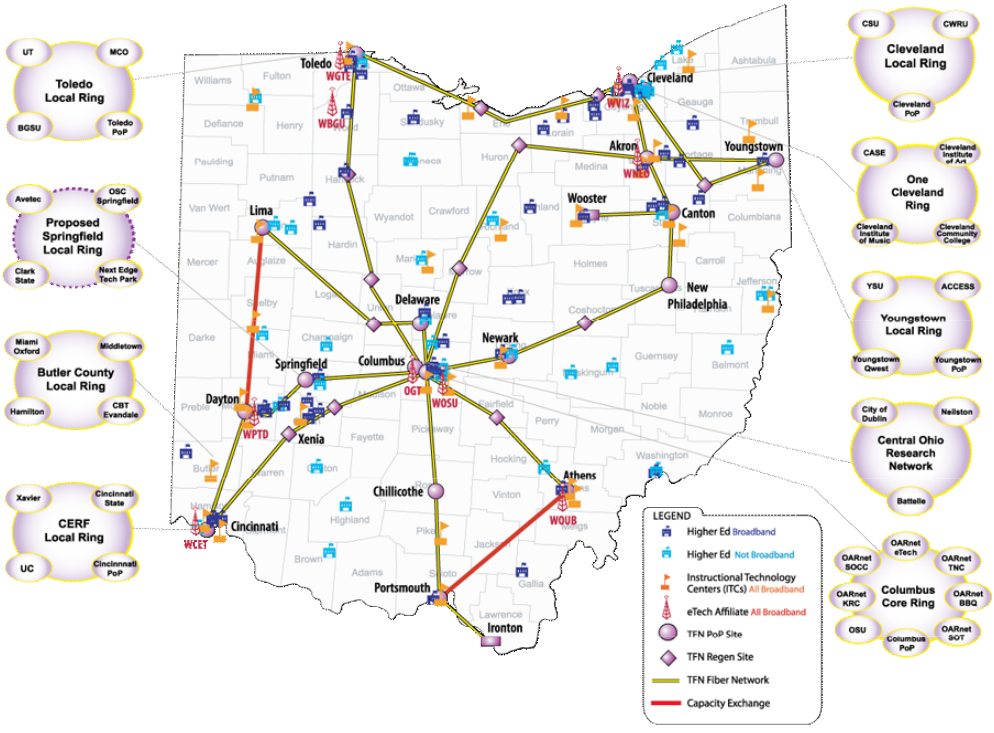
d. Networking Infrastructure:
Over 1,600 route miles of dedicated high-speed fiber-optic network – the Third Frontier Network – dedicated to research and education

e. Services Offered:
I1, I2, Intra-state, videoconferencing bridging, video streaming, disaster recovery, network monitoring

f. Internet2 Membership:
Yes

g. NLR Membership:
Yes

h. Map:



B-2: MICHIGAN

a. Operated by:
Merit Networks

b. Website:
http://www.merit.edu

c. User Community:
Connects 13 members and over 300 affiliates including K-12, higher education, healthcare, libraries, public broadcasting and research labs

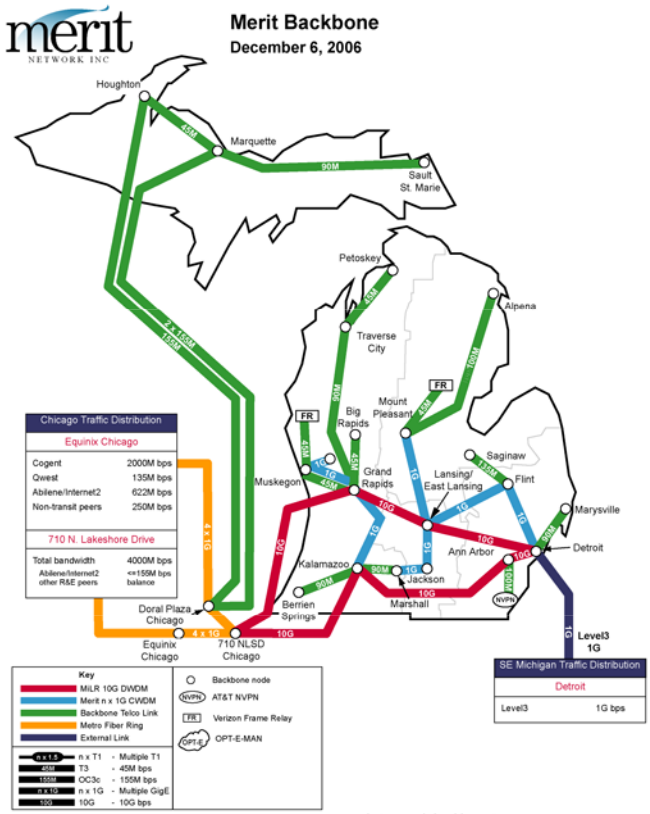
d. Networking Infrastructure:
Over 2,500 route miles of fiber (includes planned portions) dedicated to research and education

e. Services Offered:
I1, I2, Intra-state, network security, network time protocol

f. Internet2 Membership:
Yes

g. NLR Membership:
No

h. Map:



B-3: INDIANA

a. Operated by:
IHETS – Indiana Higher Education Telecommunications System

b. Website:
http://www.ihets.org

c. User Community:
Connects 71 member institutions including K-12, Higher Education, Libraries, Health-care, Public Broadcasting and Research Labs

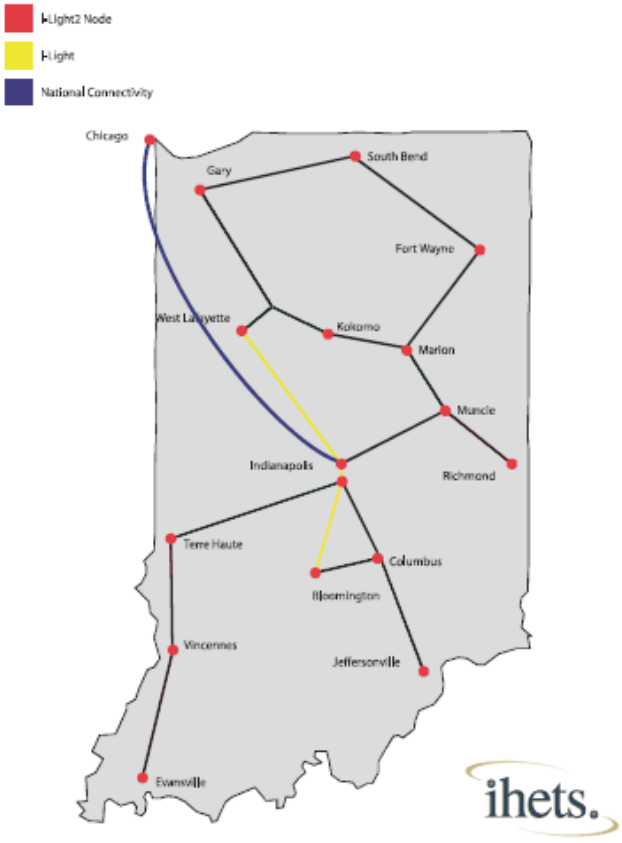
d Networking Infrastructure:
Over 3500 route miles of fiber (includes planned portions) dedicated to Research and Education.

e. Services Offered:
I1, I2, Intra-state, videoconferencing bridging, disaster recovery, network monitoring, network security

f. Internet2 Membership*:*
Yes

g NLR Membership:
Yes

h. Map:



B-4: PENNSYLVANIA

a. Operated by:
MAGPI, A Division of the University of Pennsylvania

b. Website:
http://www.magpi.net

c. User Community:
Connects 142 institutions including K-12, higher education, libraries, healthcare, public broadcasting, Pennsylvania Department of Economic Development and research labs

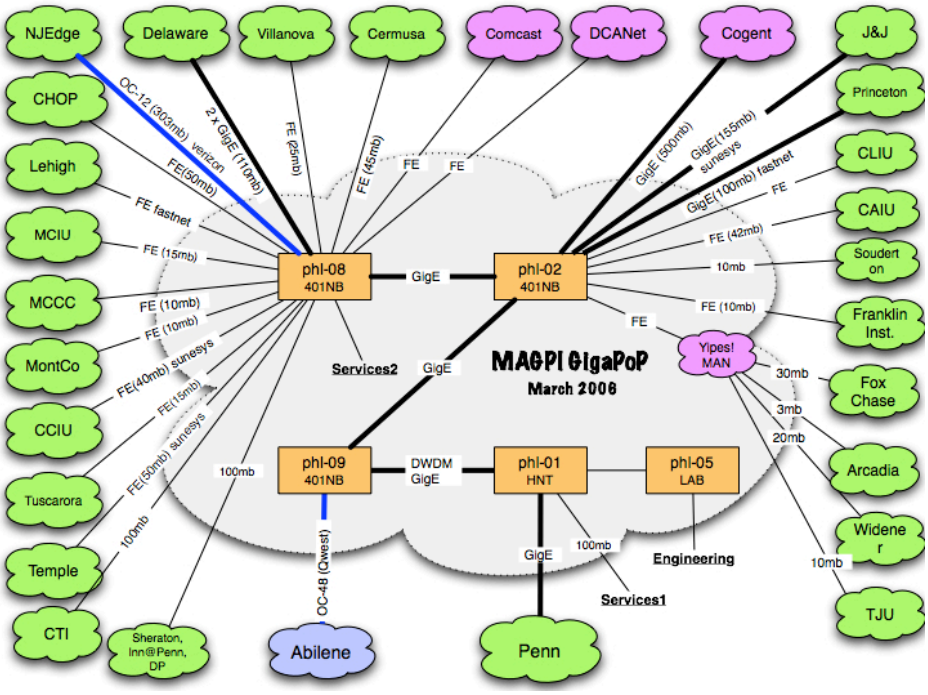
d. Networking Infrastructure:
MAGPI is one of the three unconnected networks in the state of Pennsylvania. Including all three networks, there are approximately 490 route miles of fiber dedicated to research and education

e. Services Offered:
I1, I2,((EDITOR'S NOTE: Spell out??)) Intra-state, videoconferencing bridging, disaster recovery

f. Internet2 Membership:
Yes

g. NLR Membership:
No

h. Map:



Appendix C: Glossary of Terms

i. **ADSL (Asymmetric Digital Subscriber Line):** A technology that allows more data to be sent over existing copper telephone lines (POTS). ADSL supports data rates of from 1.5 to 9 Mbps when receiving data and from 16 to 640 Kbps when sending data.

ii. **Bandwidth (Data rate):** The amount of data that can be transmitted in a fixed amount of time. For digital devices, the bandwidth is usually expressed in bits per second (bps).

iii. **Broadband:** Term used to reference Internet connections with more than 200 Kbps data rates.

iv. **Broadband Capacities:**

Connection Name	Bandwidth
T1	1.544 Mbps
DS3	45 Mbps
OC3	155.52 Mbps
OC12	622.08 Mbps
1Gpbs	1000 Mbps

v. **Cable Modem:** A modem designed to operate over cable TV lines. Because the coaxial cable used by cable TV provides much greater bandwidth than telephone lines, a cable modem can be used to achieve extremely fast access to the Internet.

vi. **TDM Circuit:** A network connection that uses Time Division Multiplexing (TDM) for combining multiple data streams from different applications by assigning each stream to a different time slot in a set.

vii. **Competitive Local Exchange Carrier (CLEC):** A telephone company that competes with an ILEC such as a Regional Bell Operating Company (RBOC), GTE, ALLNET, etc. With the passage of the Telecommunications Act of 1996, there has been an explosion in the number of CLECs. The Act allows companies with CLEC status to use ILEC infrastructure for providing related services.

viii. **Ethernet:** A data transfer protocol for Local Area Networks or LANs.

ix. **FCC (Federal Communications Commission):** FCC is responsible for rating personal computers and other equipment as either Class A or Class B. Class A ratings indicate that radiation emitted from a personal are not harmful. Class B ratings indicate that the machine's radio frequency (RF) emissions are so low that they do not interfere with other devices such as radios and TVs.

x. **Fiber:** Provides physical connectivity between two ends using light as a communication mechanism.

xi. **Gbps (Gigabits per second):** Transmission of one billion bits per second over a Broadband connection.

xii. **Incumbent Local Exchange Carrier (ILEC):** A telephone company that was providing local service when the Telecommunications Act of 1996 was enacted.

xiii. **Kbps (Kilobits per second):** Transmission of one thousand bits per second over a Broadband connection.

xiv. **Mbps (Megabits per second):** Transmission of one million bits per second over a Broadband connection.

xv. **Third Frontier Network (TFN):** A dedicated high-speed fiber-optic network linking Ohio colleges and universities with research facilities to promote research and economic development. Over 1,600 miles of fiber create the network backbone connecting colleges and universities, K-12 schools, and communities together.