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ABSTRACT

Ohio's Legislative Office of Education Oversight (LOEO) evaluates education-related activities funded wholly or in part by that state. SchoolNet initiatives seek to increase Ohio K-12 schools' access to computers, networks, and other technology, with a particular emphasis on low-wealth districts. This report addresses the gap between the expectations of SchoolNet and what actually can be achieved, given current technology and the amount of district and state funding available for this initiative. The report also examines the advantages and disadvantages of using the existing Ohio Education Computer Network (OECN) to provide public schools with access to the Internet and other online information resources once the network wiring purchased with SchoolNet funds is installed. An explanation of the technology of computer networks and distance learning and their associated costs is also provided. Conclusions and recommendations are presented. Appendices include: a selected bibliography of print and online resources; agencies that participated on the 1991 Technology Committee; local phone companies serving each school district; LOEO school district questionnaire; comparison of resolution and motion handling for distance learning equipment; equipment and costs for four distance learning systems; and existing state-funded distance learning projects. (Contains 42 references.) (SWC)

Ohio SchoolNet Initiatives: The Role of the Ohio Education Computer Network

LEGISLATIVE OFFICE OF EDUCATION OVERSIGHT
Columbus, Ohio
August, 1996

LEGISLATIVE OFFICE OF EDUCATION OVERSIGHT
30 East Broad St. - 27th Floor
Columbus, OH 43266-0927
Phone (614) 752-9686 Fax (614) 752-3058

The Legislative Office of Education Oversight (LOEO) serves as staff to the Legislative Committee on Education Oversight. Created by the General Assembly in 1989, the Office evaluates education-related activities funded wholly or in part by the state of Ohio. This LOEO report examines the advantages and disadvantages of using the existing Ohio Education Computer Network (OECN) to provide public schools with access to the Internet and other online information resources. It also explains the technology of computer networks and distance learning and their associated costs. ***Conclusions and recommendations in this report are those of the LOEO staff and do not necessarily reflect the views of the Committee or its members.***

This report is the third in a series of four studies on Ohio's SchoolNet initiatives:

- Description of SchoolNet, SchoolNet Plus, and the Ameritech Agreement
- Ohio SchoolNet Initiatives: School Readiness for Computers and Networks
- Ohio SchoolNet Initiatives: The Role of the Ohio Education Computer Network
- Ohio SchoolNet Initiatives: Summary of LOEO Findings

Summary

Ohio SchoolNet Initiatives: The Role of the Ohio Education Computer Network

This report is the third in a series of Legislative Office of Education Oversight (LOEO) reports focusing on the SchoolNet initiatives. It examines the advantages and disadvantages of using the existing Ohio Education Computer Network (OECN) to provide public schools with access to the Internet and other online information resources. It also explains the technology of computer networks and distance learning and their associated costs.

SchoolNet provides every Ohio public school classroom with wiring for at least one telecommunications connection to other classrooms in the same school. In the Capital Improvements Act of the 120th General Assembly, $95 million was appropriated for SchoolNet. The 121st General Assembly appropriated an additional $27 million to SchoolNet in its operating budget.

Through SchoolNet Plus, the state intends to provide at least one interactive computer workstation for every five students enrolled in grades K-4. In the operating budget of the 121st General Assembly, $125 million was appropriated for this initiative. An additional $150 million has been appropriated in the Capital Improvements Act for the 1996-1998 biennium. The General Assembly intends to devote another $125 million to SchoolNet Plus in future appropriations.

For further description of the SchoolNet initiatives and the readiness of schools to use computers and networks, see LOEO's previous reports: Description of SchoolNet, SchoolNet Plus, and the Ameritech Agreement and Ohio SchoolNet Initiatives: School Readiness for Computers and Networks.

In this report, we address whether the Ohio Education Computer Network, which was created in 1979 for *administrative* purposes, can handle the volume of students and teachers who will use it for *instructional* purposes. The original purpose of the OECN was to provide cost-effective accounting services to school districts, including the electronic transmission of their financial data to ODE. Its responsibilities have since

expanded to include a number of other administrative duties, including transmitting cost, student, and staff data required for the Education Management Information System (EMIS). The state has invested a total of $229 million in the OECN and the EMIS to provide these services.

LOEO addresses whether the Ohio Education Computer Network has the capacity to handle the 1.8 million students and 95,000 teachers for SchoolNet

With SchoolNet, the OECN is now expected to serve students for instructional purposes. Because of SchoolNet, as many as 1.8 million students and 95,000 teachers could eventually be added to the OECN.

The OECN consists of three levels of organization: Ohio Department of Education (ODE), 24 regionally located data acquisition sites (formerly A-sites), and school districts. The 24 self-governing data acquisition sites are the basis of the OECN. Not all OECN data acquisition sites are currently providing quality services. Using information from surveys and interviews from school districts, who are the customers, LOEO rates the overall quality of data acquisition sites as follows: eight are "poor;" eight are "adequate;" and eight are "good." Data acquisition sites labeled "adequate" and "poor" need to upgrade their computer systems and increase their staff to adequately serve school districts for instructional and administrative purposes.

LOEO rates the overall quality of eight OECN data acquisition sites as poor, eight as adequate, and eight as good.

ODE and the Management Council (the coordinating body of the OECN) recognize that all data acquisition sites are not equal. ODE no longer requires school districts to remain with the same data acquisition site to which they were originally assigned. Some districts will eventually migrate to the data acquisition sites that provide better services.

For the SchoolNet initiatives to be fully realized, LOEO estimates that data acquisition sites and school districts across the state will have to invest in both one-time and recurring annual costs. School districts will experience approximately $20 million in recurring annual costs for high-speed T1 transmission lines. The OECN data acquisition sites must invest a minimum of $2.2 million in one-time costs for upgrading computers and $758,000 in recurring annual costs for additional staff.

Administrative and student online services provided by the OECN cost less than those offered by private vendors.

However, OECN services cost less than the services offered by private providers of administrative and student-online services. According to LOEO's analysis, the OECN per-pupil costs for administrative services would have to increase three times their average FY 1996 levels to equal the average per-pupil cost currently charged by private vendors. For student online services, private companies offering access to the Internet charge as much as $2,460 per building per month for a T1 transmission line. Because they are part of the state network, the highest price that school districts will pay is $890 per building per month ($450 for T1 line and $440 for Internet services).

The Ohio Education Computer Network offers other benefits to school districts. Its Management Council negotiates bulk purchasing arrangements that result in lower prices for hardware, software, and professional development services for all member school districts. In addition, software developed by ODE and members of various data acquisition sites is available at no cost to the site. By joining the OECN, school districts also avoid purchasing expensive equipment for their own separate computer systems.

All state-funded organizations will be linked to SOMACS, the new statewide computer network.

Future issues

Although LOEO currently sees the OECN as the best solution for connecting students to online services, the world of telecommunications is changing too quickly for this to remain a fixed decision. The deregulation of the telecommunications industry by the federal Telecommunications Act of 1996 could substantially reduce the cost of access to online services. As a result, school districts will have options other than OECN data acquisition sites to provide access to the Internet and other online information resources.

Ohio's statewide computer network

LOEO also addressed the question of whether higher education institutions and other education-related organizations, such as the Cooperative Extension Service, are networked in the most cost-effective way. All state-funded organizations are benefiting from the extensive and careful planning that resulted in Ohio's first statewide computer network in 1985. Because of a more recent 1993 state technology plan, this network is being replaced by the higher-capacity State of Ohio Multi-Agency Communications System (SOMACS). All public organizations, including the OECN, colleges, universities, and Cooperative Extension Service agencies, will be electronically connected to the SOMACS.

One expectation of SchoolNet is that distance learning will help solve school funding equity concerns.

As a result of SOMACS, elementary and secondary schools can purchase high-capacity T1 transmission lines for no more than $450 per month anywhere in the state. In higher cost remote areas, the price of a T1 line could have been as high as $3,500 per month. A minimum of a T1 capacity transmission line is required for districts to adequately fulfill the expectations of SchoolNet -- particularly for distance learning applications.

Distance learning

One expectation of SchoolNet is that distance learning will help solve funding equity concerns by allowing low-wealth schools to increase

their number of course offerings. Distance learning is group video-conferencing in which the instructor can see and communicate directly with students who are physically located in other classrooms. Distance learning is not the same as using computers over networks to access online data bases and libraries. These are entirely different functions and have different associated costs.

LOEO's research indicates that hardware and software systems that provide group distance learning are too expensive for many school districts to purchase.

LOEO's research indicates the hardware and software systems that provide group distance learning are too expensive for many school districts to purchase. School districts in Ohio which currently have group distance learning systems received donations from a number of sources, including local telephone companies, to help them purchase the systems.

The estimated cost for putting a moderately priced group video-conferencing system in place is $79,072 for one classroom. If, for example, Ohio intended to provide just one distance learning classroom in each of the state's 200 low-wealth districts, the total one-time cost would be nearly $16 million. An additional $1.3 million per year would be needed to pay for the operating costs to connect to the sites delivering the instruction.

Only one percent ($2.5 million) of SchoolNet funds has been designated for instructional programming to be used for distance learning. However, this funding is not currently designated for purchasing the hardware and software needed by schools for group video-conferencing systems. Assuming these funds were to be reallocated for equipment, this amount would equip only 32 classrooms. An additional $215,000 per year still would be needed to make the equipment in these 32 classrooms operational.

Recommendations

LOEO concludes that the advantages of using the OECN for student online services currently outweigh the disadvantages, particularly in terms of cost. However, not all OECN data acquisition sites are currently providing quality services.

LOEO recommends the Ohio Department of Education convene a working group to determine the extent of the OECN's role with regard to the SchoolNet initiatives. In addition, the minimum level of service that each data acquisition site must offer to qualify for state subsidy should be outlined.

LOEO recommends the General Assembly continue to invest in the OECN as the current best solution to providing access to online networks for student instructional use. However, poor-quality data acquisition sites that cannot quickly improve their services to member districts should not continue to receive state subsidy.

LOEO recommends that the cost-effectiveness of the services provided by the OECN data acquisition sites be evaluated on an ongoing basis.

LOEO recommends that given the expense of distance learning, the General Assembly consider the following options: whether it is simply too expensive to fund; whether it should be provided to only the most isolated school districts; or whether the state should fund it for all 200 low-wealth school districts.

LOEO recommends that school districts' use of distance learning be evaluated on an ongoing basis to determine the cost-effectiveness of this technology in improving student learning. If the results of the evaluations determine that this technology does not improve student learning in a cost-effective manner, state funding should be eliminated.

LOEO recommends that the Ohio Department of Education investigate methods of financing expensive technology. The strategy of technology leasing should be considered to see if it offers a means of making technology more affordable for school districts. Technology leasing also would allow school districts to update their equipment more inexpensively as technology changes.

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CHAPTER I
Introduction

This report is the third in a series of Legislative Office of Education Oversight (LOEO) reports focusing on the SchoolNet initiatives. It examines the advantages and disadvantages of using the existing Ohio Education Computer Network to provide elementary and secondary schools with access to online information resources located across the United States and worldwide. It also explains the technology of computer networks and distance learning and their associated costs.

Background

Computers and related technology can improve teaching and learning and are essential for preparing students for the workplace of tomorrow. Low-income groups and people residing and attending school in rural areas have less access to information technology at home, in public schools, and in libraries. Before low-income groups are able to use this technology, it must be accessible and affordable.

On the federal level, the concept of "universal service" emerged from the Telecommunications Act of 1996. The goal of universal service is to ensure that telecommunications companies charge affordable rates for their services and offer advanced telecommunications services in all regions of the nation. Advanced services offered to low-income, rural areas and people living in other high-cost areas must be comparable to the services and rates provided in lower cost urban areas.

The Telecommunications Act of 1996 also deregulated the communications industry by permitting broadcast television, cable TV, and telephone companies to enter the others' market to provide competitive services. As a result, competing companies are offering more affordable combinations of telephone, Internet, and video services. Cable companies are offering telephone services; telephone companies are offering video services; and both are offering access to the Internet.

In Ohio, the Governor and the General Assembly have introduced initiatives with goals and objectives similar to the federal government's "universal service." Ohio's investment in the development of a statewide fiber optic backbone has resulted in low-cost, high-capacity transmission lines being more affordable for schools, libraries, and other public facilities. These transmission lines will provide the necessary line capacity for the use of video and access to the Internet and national and worldwide databases.

To increase K-12 schools' access to computers, networks, and other technology, the Governor and the General Assembly have offered the SchoolNet and SchoolNet Plus initiatives. A major focus of these initiatives is providing technology to elementary and secondary schools in low-wealth districts.

In 1994, SchoolNet was authorized in Amended House Bill 790, the Capital Improvements Act of the 120th General Assembly. A total of $95 million was appropriated to public elementary and secondary schools for computer-related technology. Of this amount, $45 million is for purchasing computers and related technology for 152 low-wealth school districts. The remaining $50 million is to install at least one network connection for voice, video, and data transmission in every classroom in the state.

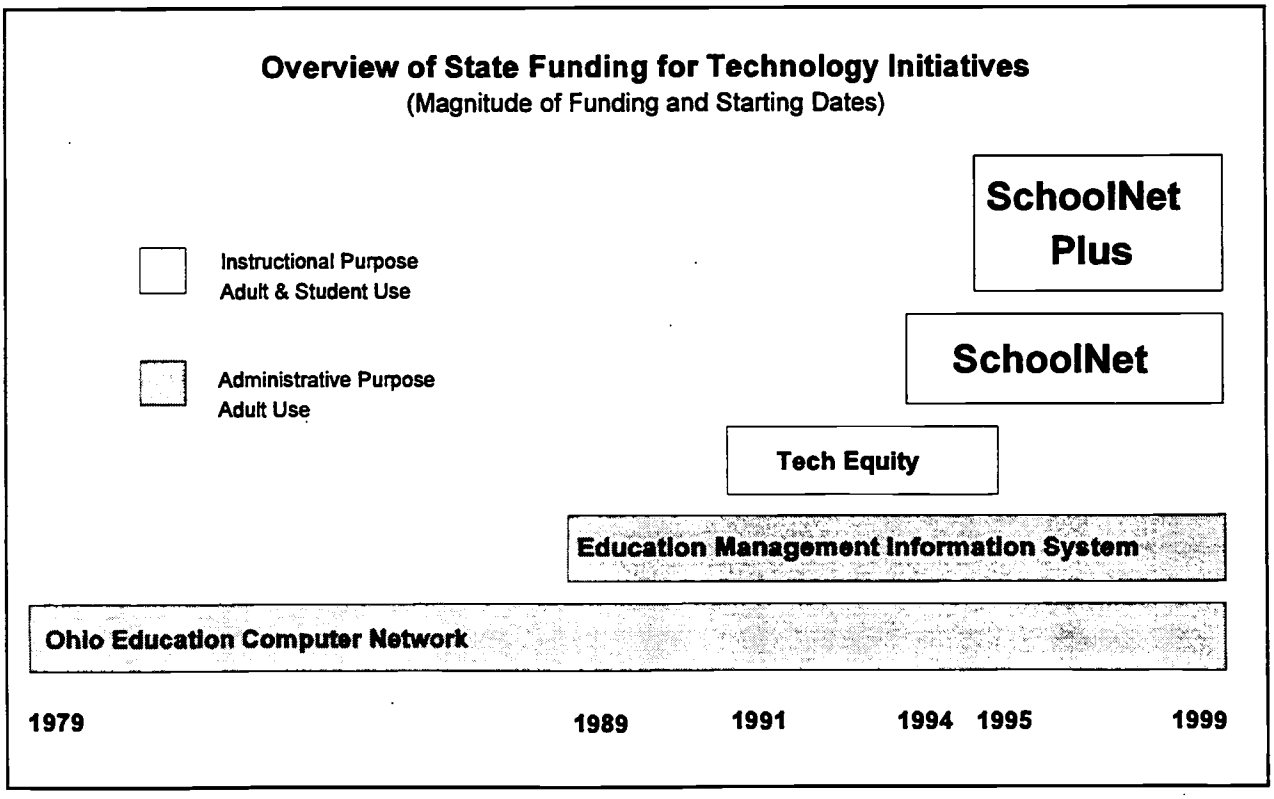
An additional $27 million was appropriated for SchoolNet in 1995 through Amended Substitute House Bill 117, the operating budget of the 121st General Assembly. Of this amount, $12.5 million is provided to a variety of organizations such as universities and public television stations to promote professional development; $2.5 million is to develope interactive instructional programming for distance learning for the 200 poorest school districts in the state; and the remaining $12 million will be used as "equity grants" to low-wealth school districts for computer hardware, software, and professional development.

Through Amended Substitute House Bill 117, $125 million was initially appropriated for SchoolNet Plus. An additional $150 million has been appropriated for the 1996-1998 biennium in Amended House Bill 748, the Capital Improvements Act of the 121st General Assembly. The General Assembly intends to devote another $125 million to SchoolNet Plus in future appropriations. SchoolNet Plus will provide at least one computer for every five students in grades K-4. (See LOEO's Description of SchoolNet, SchoolNet Plus, and the Ameritech Agreement.)

Ohio's investment in educational technology

The state's investment in educational technology began with the Ohio Education Computer Network in 1979, followed by the Education Management Information System in 1989. These two initiatives focused on administrative functions. Three subsequent initiatives were for instructional purposes: Tech Equity; SchoolNet; and SchoolNet Plus. Exhibit 1 shows the five state initiatives and illustrates the relative magnitude of funding for each.

Exhibit 1



Scope of the Report

This LOEO report pertains primarily to the networking intentions of the SchoolNet initiative. Two expectations of SchoolNet are that it will contribute to solving school funding inequities through distance learning as well as provide student access to databases and other information located across the nation and worldwide. An attachment to the June 12, 1994 Ohio SchoolNet K-12 Classroom Wiring Standards reveals the state's expectations of this initiative:

> In the future, Ohio students will find expanded course offerings; more individualized educational opportunities; interactive learning opportunities; linkages with libraries, universities, and other classrooms across the state and nation; access to worldwide data bases and information resources; and information exchanges among teachers and students.

In a general sense, this report addresses the gap between the expectations of SchoolNet and what actually can be achieved, given current technology and the amount of district and state funding available for this initiative. The report also examines whether the Ohio Education Computer Network (OECN) is the best vehicle for providing public schools with access to online computer services, such as the Internet, once the network wiring purchased with SchoolNet funds has been installed.

To connect public school buildings to the OECN, the 121st General Assembly appropriated up to $2 million in FY 1996 and $5.5 million in FY 1997 in Amended Substitute House Bill 117. However, some legislators and policymakers question whether private-sector companies, believed to have superior computers and other technology, could provide public schools with higher-quality access to online services at a lower cost.

Four questions are addressed in this report:

- What are the advantages and disadvantages of using the existing K-12 Ohio Education Computer Network as schools' access to online computer services for instructional purposes?
- What are the alternatives to using the OECN and what are their advantages and disadvantages?
- Are higher education and other education-related organizations such as the Cooperative Extension Service networked in the most cost-effective way?
- What type of distance learning is envisioned for SchoolNet and how much does it cost to provide?

To help answer these questions, a description of computer networks and how they operate is provided. In addition, how the OECN is related to the larger statewide computer network is described.

Methods

To determine who can provide schools with the best access to online computer services, LOEO examined the quality of OECN services and compared their costs to similar services offered by private-sector companies.

Moreover, to gather data for this study, LOEO conducted telephone interviews of 40 teachers and administrators and visited 12 schools. During the site visits, LOEO spoke with 29 teachers, nine principals, and 24 district-level staff including architects and business managers.

In addition, 24 OECN data acquisition sites were surveyed by mail. Four school districts served by each data acquisition site (a total of 96) were randomly selected and mailed questionnaires. Four large-city districts were also mailed questionnaires. Response rates of 91% (87) and 88% (21) were obtained from school districts and data acquisition sites, respectively. All four large-city districts returned their questionnaires.

Officials from the Ohio Department of Administrative Services, the Public Utilities Commission of Ohio, the Ohio Educational Telecommunications Network Commission, the Ohio Department of Education, and private computer companies were also interviewed. Finally, national reports and other literature on the technology of computer networks were reviewed. A bibliography is provided in Appendix A.

CHAPTER II
The Technology and Terminology of Computer Networks

This chapter explains how computer networks operate and describes their various components.

Understanding the technology of computer networks and their terminology is essential to following the discussions that are presented in this report.

A **network** is a group of interconnected computers that are capable of communicating with each other. Networks consist of wires or cables, routers, and gateways to help them communicate. **Gateways** are computers that link dissimilar networks and translate information to allow it to move from one network to another. **Routers** are computers that receive messages between networks and forward them to the correct destinations using the most efficient available route. **Backbones** interconnect various networks. They usually consist of higher capacity lines to handle the aggregation of traffic from these networks. Networks that can easily communicate or transfer information to other networks are considered **interoperable.**

Examples of networks include the telephone networks, the television broadcast networks, the Internet, and private corporate computer networks. Networks are designed to transmit one or more types of information: data, voice, or video. Each type of information places different demands on the network. These demands vary depending on the "space" that is required on the network and how that space is used. The space requirement is called the **bandwidth**. The ability of a network to accommodate bandwidth is called its **transmission capacity**. The greater the bandwidth, the greater the transmission capacity, allowing larger amounts of information to be sent more quickly.

Very high bandwidth is required to produce high-quality interactive video. The best method of transmitting video is through a digital format. Digital technology permits voice, video, and data to travel together over any type of medium. **Digitization** translates all types of information into the common language of computers, which uses ones and zeroes. The ones and zeros are called bits.

Currently, some networks (such as television) transmit their signals in an **analog format**, which uses continuous electromagnetic waves. Analog format is more costly and difficult to transmit while maintaining the quality of the signal than digital format.

All signals must travel over some type of "medium" or wire to reach their destinations. The transmission media used most often for networks are copper twisted-pair wire, coaxial cable, fiber optic cable, and over-the-air signals (radio or microwave). Information travels different distances over each of these media. Information travels the furthest on fiber optic cable and the shortest distance on copper.

In 1994, the Ohio Department of Administrative Services and the SchoolNet Technical Standards Review Committee developed classroom wiring standards to support the transmission of data, voice, and video. The standards specify a category 5 copper wire for data transmission, a category 5 copper wire for voice transmission, and two coaxial cables for the simultaneous broadcast and reception of video. Since the cost of connecting computers and other equipment to fiber optic cable is more expensive than other wiring, it was not recommended. Exhibit 2 displays the types of media that are available for computer networks and their advantages and disadvantages.

Exhibit 2
Types of Wiring and Their Uses

Transmission medium	Cost to run	Cost to connect	Near-future	Long-term	Comments
Level 5 Copper Wire	Low	Low	Excellent; best choice for data	Very Good	Some distance limitations. Will probably be around for a while.
Four-strand Fiber Optic Cable	Moderate	Very High	Fair to good; only solution for long distances	Very Good	Can be near electrical power without interference. Better weather performance than copper. Low loss, so greater distances possible.
Coaxial Cable	Moderate	Moderate	Good; required for video today	Fair	Television-quality video is likely to run on data transmission lines eventually, which will probably be a high capacity fiber optic cable.
Over-the Air (microwave or radio)	Low	Low	Fair to good	Fair	Is relatively insecure; is subject to electronic interference; and requires allocation of the frequency spectrum, a finite resource.

Source: What's in the Walls: Copper, Fiber, or Coaxial Wiring? MultiMedia Schools. September/October, 1995.

The low bandwidth of media such as copper wire generally cannot accommodate the high-transmission speeds for which fiber optic cable is designed. As a result, fiber optic cable is the chosen medium for backbones of networks where high-volume traffic from all other networks is channeled.

Transmission speeds

Integrated Services Digital Network (ISDN) allows for the digital transmission of data through regular telephone jacks, but its availability is limited to metropolitan areas. Telephone voice traffic requires a transmission capacity of about 64,000 bits per second. Television or video requires at least 30 million bits per second -- over 450 times the capacity required for voice transmission. Data such as electronic mail can run at a variety of speeds, depending on the capacity of the network.

Exhibit 3 displays various transmission speeds and describes how each can be used. All of the transmission speeds are more than adequate for voice.

Exhibit 3
Transmission Speeds and Recommended Applications

Carriers*	Transmission speed (bits per second)	Number of lines or circuits	Comments
DS-0	56,000 (56kb)	1	Moderate speeds for data.
ISDN	144,000	3	Allows simultaneous transmission of voice, video, and data. Produces quality pictures for desktop videoconferencing with proper equipment.
T1	1,544,000	24	High speed for data; adequate for images, business quality compressed video (low-quality video).
T3	45,230,000	672	Broadcast quality video; suitable for corporate backbone, data, compressed video images.
OC-3	155,000,000	2,016	Broadcast quality video; suitable for corporate backbone data, compressed video images.
OC-48	2,075,040,000	32,256	Multiple broadcast video circuits, high-definition television, very high-speed corporate multimedia backbone, and cable.

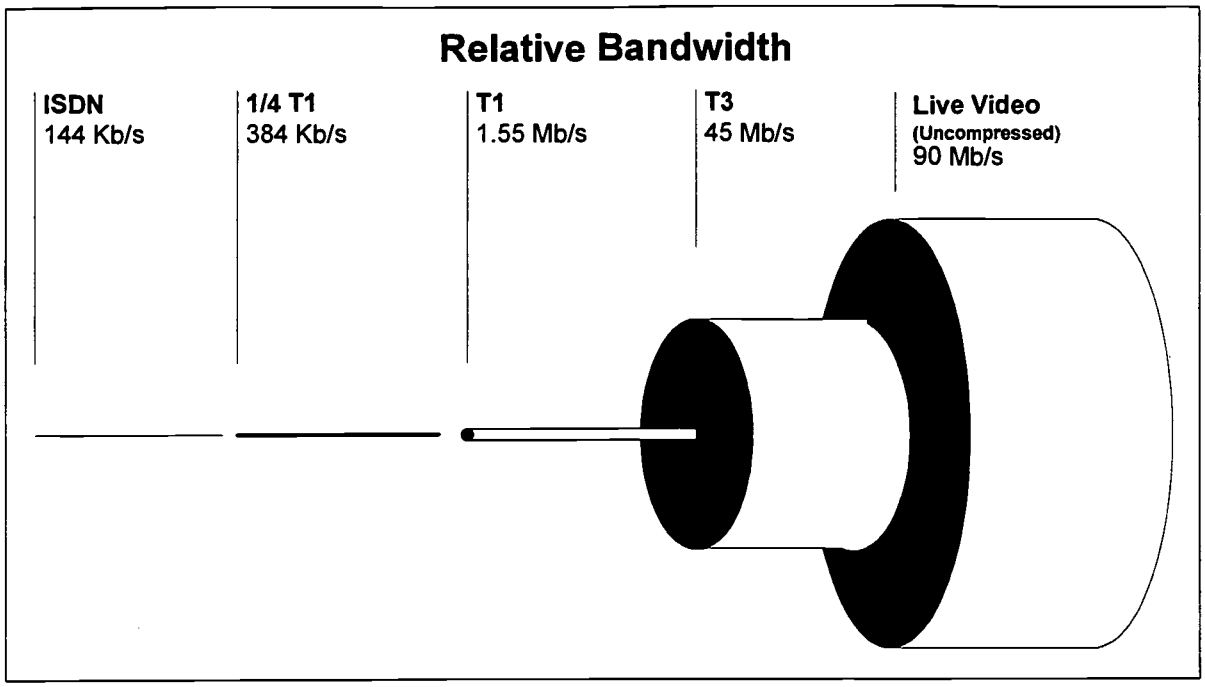
* High-speed digital transmission lines.

The number of circuits or lines for a given carrier allows it to be used for multiple purposes. For example, a T1 can be separated into 24 64kb lines or a number of other combinations of fewer lines. Organizations with video capabilities devote up to three-quarters of the T1 to "compressed" video and the remainder to voice and data. This is commonly referred to as a **split T1**.

An example of the capacity of a T3 line is that it can move data at a speed of 1,400 pages of text per second. A 20-volume encyclopedia could be sent coast-to-coast in half a minute.

If we consider the transmission speed or bandwidth as the available space inside of a pipe, Exhibit 4 illustrates the capacity of various types of bandwidths.

Exhibit 4



Source: Ohio Department of Education SchoolNet Office.

Transmission speeds are also affected by the protocol that is used. A **protocol** is a set of rules for formatting, encoding, transmitting, and receiving data across two or more networks. For example, the Transmission Control Protocol/Internet Protocol (TCP/IP) is the major protocol used over the Internet, providing reliable, ordered, end-to-end transmission of data.

Future developments

Some of the protocols now under development are designed to increase the transmission capacity of copper twisted-pair wiring used in the 560 million lines currently providing the vast majority of phone services to residences, schools, and businesses.

Over the next five years, backbone wiring will most likely continue to be fiber optic cable, while wiring for connecting computers will be mostly copper. Coaxial cable (for cable television) will continue to be the primary transmission medium for video for the near future. In the long run, however, fiber optic cable probably will replace coaxial cable and copper wire for video purposes. Although fiber optic cable is far superior to these types of media, the cost of connecting computers or other devices will limit its use until the price becomes more affordable.

CHAPTER III
Description of Computer Networks in Ohio

The state of Ohio began planning for technology in 1977. A statewide computer network began operating in 1985, making Ohio among the first states in the nation with a comprehensive network linking every major state agency.

Ohio has had a statewide computer network since 1985. This digital network is constructed of both microwave and fiber optic cable. The microwave portion is state-owned and the fiber optic cable is leased from private companies. The networking infrastructure, called the State of Ohio Network for Integrated Communication (SONIC), currently links the state's major computer systems:

- Ohio Data Network (ODN);
- Ohio Educational Telecommunications Network Commission (formerly the Ohio Educational Broadcasting Network);
- Law Enforcement Automated Data System (LEADS);
- Ohio Academic Research Network (OARnet); and
- Ohio Education Computer Network (OECN).

With the growth in the use of computers, networks, and the emergence of new technology such as video conferencing that requires very high bandwidth, the state's needs have outgrown the capacity of the SONIC. As a result, an Inter-agency Telecommunications Committee was convened in 1991 to plan for upgrading the technology used by all state-funded organizations.

The directors of ten major state agencies were represented on the Committee. Appendix B lists the agencies that participated. A state plan was developed by a subcommittee of this body and was published in 1993.

The existence of the SONIC and Ohio's 1993 technology plan illustrates the coordinated planning that has guided the state's use of technology. The Executive Summary of the Telecommunications Subcommittee Report describes the importance of technology for Ohio:

> There is compelling need to advance the speed and functionality of telecommunications infrastructure for operation of state government networks and for the state as a whole. For Ohio citizens this will mean jobs, greater prosperity, educational advantage and a better quality of life.

The subcommittee recommended developing an integrated radio and fiber optic cable-based network capable of providing voice, data, video image, and interactive television across Ohio. The State of Ohio Multi-Agency Communications System (SOMACS), currently under construction, is the product of the Committee's recommendation. SOMACS will be a fiber optic cable network with OC-48 transmission capacity. The Subcommittee expects the network to accommodate the state's networking needs "well into the 21st century."

According to the technology plan, the creation of SOMACS involves three phases. Work on all three phases began concurrently in 1994. Phase one is expected to be completed by November 1996. Completion dates for phases two and three are undetermined because individual organizations are at different stages in their current use of technology.

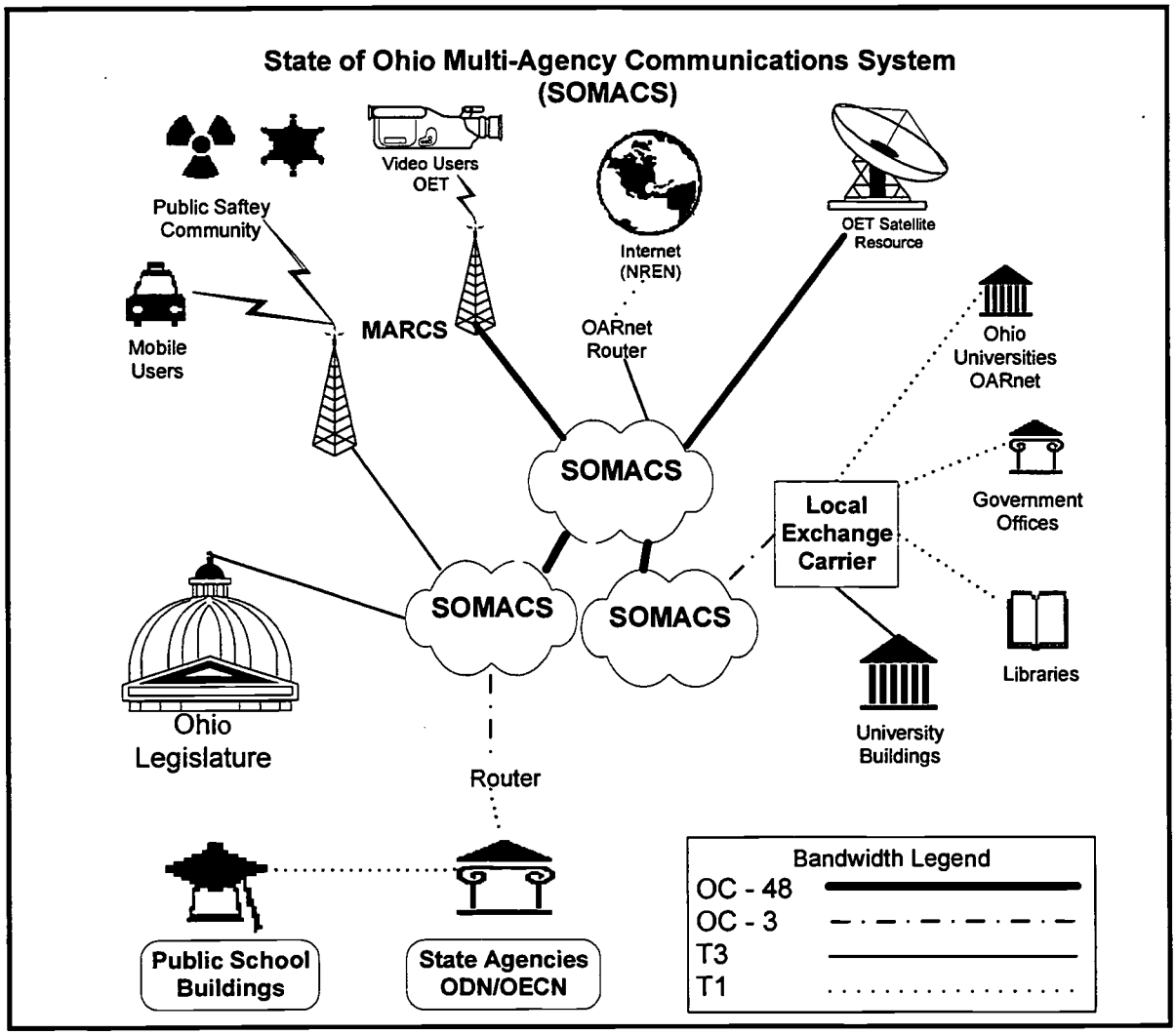
- Phase One: Creating a fiber optic cable backbone.

- Phase Two: Connecting state agencies, local government, schools, libraries, and colleges and universities with high-speed phone lines and fiber optic cable to the network.

- Phase Three: Wiring buildings and installing the necessary network-connecting equipment.

For phase one, three existing networks were merged to create the SOMACS. The Ohio Educational Telecommunications Network Commission (OET) operates an independent microwave, analog network that serves elementary, secondary, and higher education. This microwave network has reached its capacity and its technology does not meet current needs. The SONIC and OET networks will be transferred to SOMACS. SOMACS is illustrated in Exhibit 5.

Exhibit 5



In addition, the Multi-Agency Radio Communications System (MARCS) will also be integrated with SOMACS. MARCS, a radio network with 180 towers strategically located around the state, is designed to extend public safety and emergency management from 55 to all 88 counties in Ohio. MARCS is particularly important for providing communication services to remote rural areas in Ohio.

SOMACS and MARCS create a statewide network that will support remote and mobile communications and multimedia services requiring very high bandwidth. Current users of SONIC are expected to use less than 30% of the capacity of SOMACS, leaving more than 70% of the capacity for future use.

For phase two, the technology plan recommends exploring public-private partnerships for funding to connect state facilities to SOMACS. Phase three of the telecommunications plan is consistent with one of SchoolNet's goals for elementary and secondary education:

> The desired outcome is that [elementary and secondary] schools and [higher education institutions are to] become productive workplaces for both faculty and students and that school reform initiatives are supported by technological innovation.

The Telecommunications Subcommittee Report promotes the use of distance learning, participation in the National Research and Education Network (NREN), video conferencing, the Internet, and a curriculum that makes the use of this technology possible. As a part of phase three, the Subcommittee considered the needs of projects such as SchoolNet in the design of SOMACS and MARCS.

Benefits of SOMACS

The combined networking needs of all state agencies, elementary and secondary schools, and higher education institutions will be served by SOMACS. Leasing instead of purchasing the fiber optic cable for SOMACS results in substantial savings for the state. In addition, with all state-funded organizations sharing the network, the state's combined purchasing power will result in lower network operating costs for all users of SOMACS.

The cost of connecting to SOMACS will be similar to what has happened with "postal rates." In other words, just as it costs 32 cents to mail a letter anywhere in the United States, the cost of a T1 line to connect to SOMACS will be the same anywhere in Ohio. Remote locations will not pay more for their service.

Without using SOMACS, the cost of connecting to a T1 line between major cities in Ohio is typically $2,000 per month. In remote locations, such as rural areas, the cost of this connection can be as high as $3,500 per month. Within metropolitan areas, T1 lines can cost as little as $250 because of the typical short distances the lines extend from origin to destination.

The highest possible cost for such a connection under SOMACS will be $450 per month for a connection from anywhere in the state. These are 77% to 87% savings. According to officials from the Department of Administrative Services, the total savings for the state for existing high-capacity lines will be approximately $400,000 per month.

CHAPTER IV
The Ohio Education Computer Network

The Ohio Education Computer Network (OECN) was created to provide electronic accounting services to member school districts. Since its creation, other critical responsibilities have been added to the network, transforming the OECN into the principal source of data for managing and evaluating elementary and secondary education in Ohio.

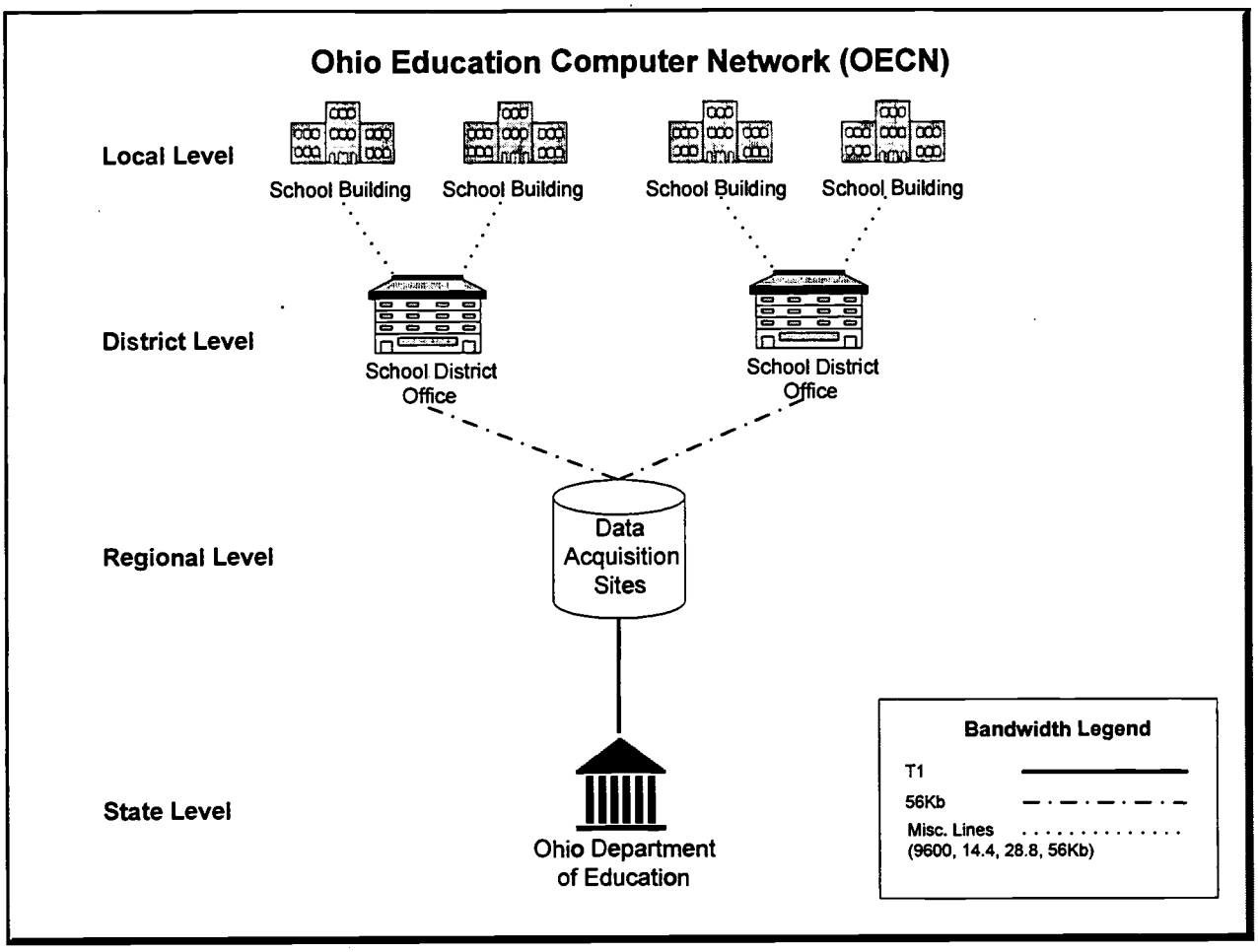
The Ohio Education Computer Network (OECN) was established in 1979 by the 113th General Assembly to provide cost-effective accounting services to school districts, including the electronic transmission of their financial data to the Ohio Department of Education (ODE). In 1989, the 118th General Assembly added the Education Management Information System (EMIS) to OECN responsibilities (See LOEO's An Assessment of Ohio's Education Management Information System). Through the EMIS, school district costs, student, and staff data are electronically transmitted to the Ohio Department of Education.

Because of SchoolNet, as many as 1.8 million students and 95,000 teachers could eventually be added to the OECN. The question is whether the system developed in 1979 for *administrative* purposes can handle the volume of students and teachers who will use it for *instructional* purposes.

The OECN consists of three levels of organization: ODE, 24 regionally located data acquisition sites (formerly A-sites), and school districts. The 24 self-governing data acquisition sites are the basis of the OECN. Data acquisition sites share computational power, specialized software, data, and technical expertise with city, local, exempted village, joint vocational school districts as well as educational service centers (formerly county boards of education). Approximately 674 districts are members of the OECN.

Districts not served by the OECN are considered "independent" districts. These districts have self-contained computer systems and are electronically connected to data acquisition sites for only e-mail purposes. All independent districts use data acquisition sites to aggregate EMIS data to send electronically to ODE. There are 32 independent districts; nine are large-city districts with student enrollments over 20,000. Exhibit 6 displays the configuration of the OECN and the capacity of the transmission lines connecting different sites on the network.

Exhibit 6



Most school buildings are connected to their respective data acquisition sites through the school districts' central offices. The most inexpensive path connecting each school to the data acquisition site is selected, resulting in several different configurations throughout the state. For example, for many schools to connect to their district office, they must use the transmission lines located in the service areas of different local telephone companies.

A telephone company's service area is called a **local access and transport area (lata)** and each company charges a separate fee to use the lines in its lata. As many as four telephone companies operate within one school district, each with its own lata. Schools must pay as many separate local transmission line fees as there are latas between their buildings and the district office.

To avoid these extra charges, some schools use local telephone companies or other businesses located within the same lata. These companies, in turn, link the schools to the data acquisition site. Appendix C provides a list of the local telephone companies operating within each school district.

Currently, the majority of the installed transmission lines extending from school buildings are plain telephone lines using 9600, 14.4, or 28.8 kb modems to transmit data, or lines with 56kb capacity. To accommodate data, voice, and the video envisioned in SchoolNet, as well as the large numbers of students who will be using the network, these lines require upgrading.

For the high-quality video that is necessary for distance learning, all the transmission lines from schools need to be a minimum of T1 capacity. (See Exhibit 3). Although some schools are connected with T1 lines, an inventory has not been taken to determine the capacity of the lines extending from all 3,657 school buildings to their respective district offices. The transmission lines connecting each data acquisition site to the statewide backbone were upgraded to T1 in 1993. However, given the number of students, teachers, and administrators who could be online simultaneously, the capacity of one T1 extending from each data acquisition site may not be enough.

* * * *

OECN Funding

The OECN receives funding from state and local sources. The 113th General Assembly appropriated $6.3 million to implement the network during the 1979-1981 biennium for 187 school districts. It became necessary to supplement this appropriation with local funding to help support an additional 248 districts. The 121st General Assembly appropriated $38.2 million for the OECN for the 1995-1997 biennium. Exhibit 7 shows the total state investment for the OECN and the Education Management Information System (EMIS).

Exhibit 7
State Investment in the OECN and the EMIS

House Bill	General Assembly	Biennium	OECN Funding (Line item GRF-426)	EMIS Funding (Line item GRF-446)	Total Investment
117	121st	1995-1997	$38,240,380	$18,428,411	$56,668,791
152	120th	1993-1995	$21,323,136	$18,000,000	$39,323,136
298	119th	1991-1993	$20,723,124	$13,500,000	$34,223,124
111	118th	1989-1991	$20,258,040	$7,044,696	$27,302,736
171	117th	1987-1989	$19,197,177	--	$19,197,177
238	116th	1985-1987	$18,143,024	--	$18,143,024
291	115th	1983-1985	$15,461,389	--	$15,461,389
694	114th	1981-1983	$12,268,271	--	$12,268,271
204	113th	1979-1981	$6,310,545	--	$6,310,545
Total			$171,925,086	$56,973,107	$228,898,193

State funding for each data acquisition site is based on a three-part formula: the number of students in each district served by the data acquisition site; the number of administrative software packages the data acquisition site uses; and the cost of the telephone lines that cross different local telephone service areas or latas. The more administrative software applications offered by a data aquisition site, the larger the amount of state funding. The rationale is that as the number of software packages used by a data acquisition site increases, the cost of additional staffand equipment to offer this new service increases as well. This state subsidy also functions as an incentive for school districts to join the OECN.

Funding from line item GRF-426 accounts for approximately 50% of the operating revenue of the OECN for 1995-1997 biennium; the fees paid by school districts for OECN services provide the other 50%. The number of students served by each data acquisition site during FY 1996 ranged from 21,100 to 88,354 with fees ranging from $3.36 to $25.51 per pupil. Since school districts also receive funding through the foundation formula, the state is funding a portion of these fees, further increasing its investment in the OECN.

* * * *

Services Provided by the OECN

In addition to the electronic accounting services for which it was created, the OECN offers a range of administrative support services in four areas: fiscal management; physical management; student administration; and miscellaneous packages. These four packages contain over 80 software applications. The services each data acquisition site offers is dictated by a governing council consisting of representatives from each district. Consequently, most data acquisition sites offer different services depending on their districts' needs. Examples of the range of software applications and services offered by the OECN are listed in Exhibit 8.

Exhibit 8
Typical Services Offered by the OECN to School Districts

Software Applications	Products and Services
•Uniform Staff Payroll System	•Technology Planning
•Uniform School Accounting System (USAS)	•Digital Equipment Corporation (DEC), hardware, software, services, and supplies
•Education Management Information System (EMIS)	•Local Area Network Design and Implementation
•Special Education Child Information System (SECIMS)	•Network Connectivity such as the Internet and Bitnet
•Electronic Mail	•Hardware and Software Integration
•Grade and Attendance Reporting	•Software Development and Support
•Class Scheduling	•Computer Maintenance and Support
•Discipline Tracking	•Training and Professional Development
•INFOHIO Media Center and Library	

Source: Management Council of the Ohio Education Computer Network.

OECN software applications can be locally or state developed, or purchased from private suppliers. ODE has developed software packages itself and in collaboration with the State Software Development Team (SSDT). The SSDT consists of computer programmers from several data acquisition sites. Each data acquisition site uses this software at no cost to the site.

In addition to developing software, SSDT provides technical assistance and inservice training for data acquisition site staff, who, in turn, use the applications to provide services to their member districts. The locally developed software is shared among each data acquisition site and its member districts as well.

Advantages of the OECN

A source of statewide savings results from the bulk purchasing arrangements created by the Management Council of the OECN. The Management Council consists of representatives from each data acquisition site and was created in 1984 to provide centralized coordination of the 24 sites.

The Management Council provides the 24 sites and school districts with access to professional development opportunities, software, and other services at reduced costs. According to its chairman, negotiations with software and hardware companies have resulted in purchasing arrangements at a reduced cost. Examples include a compact disc library worth $3,290 for $1,555, and computer equipment such as routers and network wiring priced at $15,000 for $10,000.

An OECN publication identifies another reason districts should join the network:

> The primary purpose of the OECN is to share computer resources. By collaborating and sharing these computer resources, school districts can provide computers at an affordable cost.

For example, according to an ODE official, a group of districts connected to one data acquisition site were interested in purchasing the computer package Mathematica priced at $7,000. Since one district could not afford to purchase the program itself, several districts purchased the package together and placed the compact discs on a server at the data acquisition site for each district to access. Other statewide savings result from eliminating the need for each school district to operate its own self-contained computer system.

During a site visit for this study, officials from one school district explained to LOEO that they had recently switched from being an "independent" district to connecting to the data acquisition site in their region for services. The cost of upgrading their self-contained system could have exceeded the cost of the services offered by the data acquisition site. According to a Management Council publication, "[the OECN] has resulted in a high-speed, cost-effective means of communication among students and education personnel throughout Ohio school districts."

* * * *

Quality of OECN Services

Prior to SchoolNet, OECN responsibilities were devoted solely to providing services for administrative tasks. Because of SchoolNet, as many as 1.8 million students and 95,000 teachers could eventually be added to the network for the first time. This potentially large increase in the number of users magnifies the need for quality services.

To measure the quality of the administrative and student services offered by the OECN, LOEO surveyed the data acquisition sites and their customers -- school districts. The results of the analyses are consistent with information collected during site visits to school districts and telephone interviews of district officials. Respondents describe some data acquisition sites as good and others as needing substantial improvement. The surveys are provided in Appendix D.

Administrative and student services

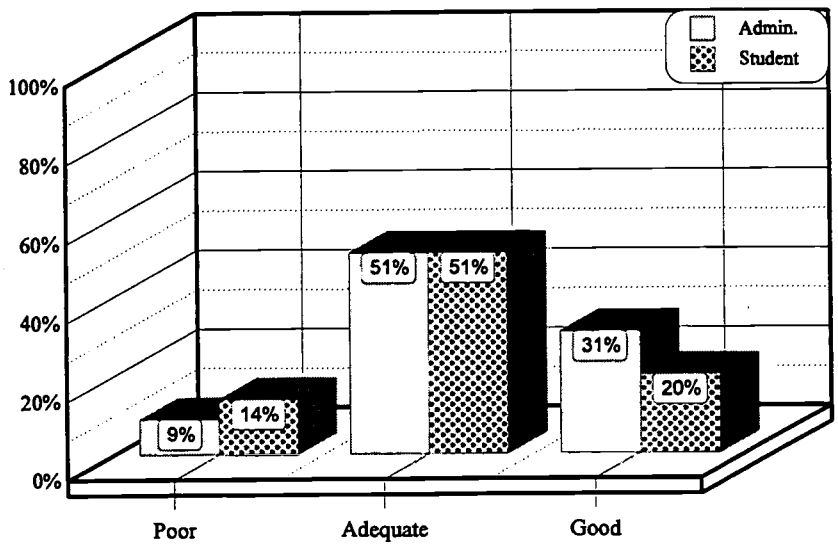
LOEO surveyed 24 data acquisition sites and four districts served by each data acquisition site and asked them to assess the quality of administrative and student online services in terms of speed, userfriendliness, and the quality of technical assistance from data acquisition site staff. Student services consist of providing access to the Internet, Bitnet, and other online services. Administrative services include software for accounting, class scheduling, and EMIS functions.

There are differences between the responses of data acquisition sites and district officials. Data acquisition site officials overwhelmingly rate the quality of their administrative and student services favorably. In other words, 95% of data acquisition site officials rate all of their student and administrative services as "adequate" or "good." Only one data acquisition site official rates one service -- the software for administrative services -- as "poor" (5%).

In contrast, nine percent of district officials rate administrative services and 14% rate student services as "poor." Most district officials, however, rate both administrative and student services as "adequate." A larger percentage of district respondents rate administrative services as "good" (31%) than student services (20%). Exhibit 9 displays districts' overall view of data acquisition site administrative and student services.

Exhibit 9

School District Ratings of Services
at Data Aquisition Sites (N=87)



Examination of the breakdown of administrative and student service ratings in terms of speed, userfriendliness, and the quality of the technical assistance illustrates the extent to which districts view administrative more favorably than student services.

Student online services

Speed of the system. The largest percentage of district officials rate the speed of student online services as "adequate" (65%). Several respondents added that the speed of the system becomes slower as the number of people using it increases or when graphics instead of only text are used. A larger percentage of districts rate the speed of the system as "poor" than "good" (22% vs. 13%).

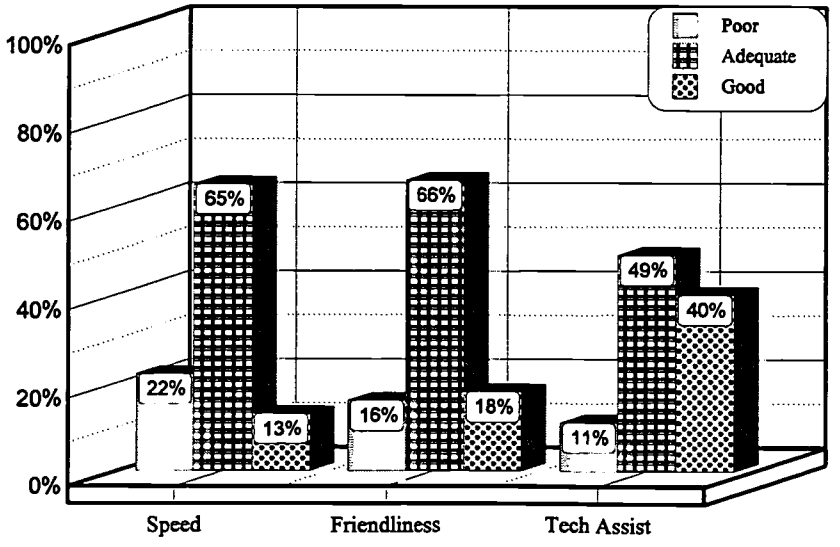
Userfriendliness of the system. Most district respondents rate the userfriendliness of the data acquisition site software as "adequate" (66%). An almost equal percentage view the software for student services as "poor" as "good" (16% and 18%).

Some respondents are unhappy with the data acquisition site software or interface used to access the Internet. For example, many students wish to use the World Wide Web on the Internet but encounter difficulty with the text-based software. Although a graphical interface called Netscape is widely used at a very affordable cost, some districts with an OECN connection apparently do not have access to this software program.

Technical assistance. Most districts rate the technical assistance provided for student services as "adequate" (49%) or "good" (40%). However, some districts elaborated, explaining that the existing staff is very knowledgeable but there needs to be more of them. Exhibit 10 illustrates districts' perceptions of data acquisition site student online services.

Exhibit 10

School District Rating of
Student Online Services (N=74)



Administrative services

District officials believe the quality of administrative services is higher than the quality of student services. Perhaps administrative services are rated higher because each data acquisition site has offered them for a longer period of time. A district official describes the quality of the administrative services one data acquisition site provides:

> The requests from additional school districts [for services] -- private and public schools -- are frequent. This is an indication of the quality of [the data acquistition site's] services.

Speed of the system. Most district respondents rate the speed of the administrative system as "adequate" (72%). Moreover, a larger percentage of district respondents rate the speed of the system as "good" than "poor" (20% vs. 8%).

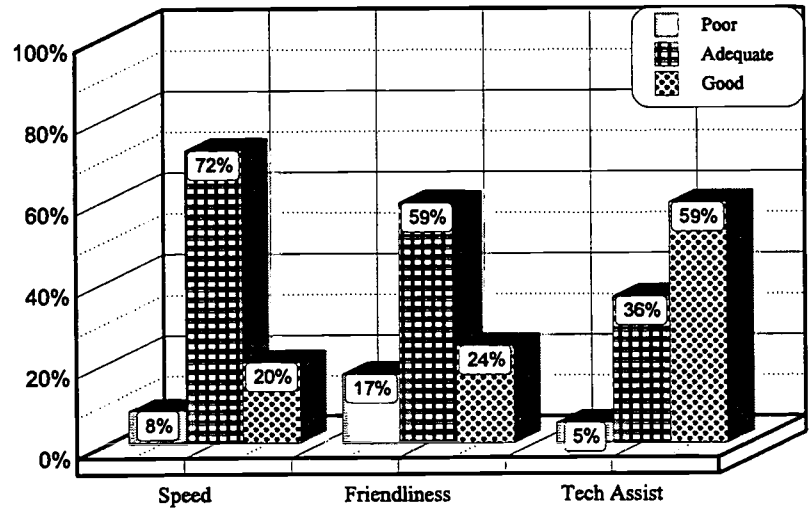
Userfriendliness of the software. Most districts rate the userfriendliness of the administrative software as "adequate" (59%). In addition, a higher percentage of districts rate the administrative software as "good" than "poor" (24% vs. 17%).

Technical assistance. The difference in quality between student services compared to administrative services can be most easily seen in terms of the technical assistance offered by the data acquisition sites. The most frequent rating given for student services was "adequate" (49%). The most frequent rating given for administrative services was "good" (59%). In fact, technical assistance for administrative services is the only category where a higher percentage of district officials rate the services as "good" rather than "adequate" or "poor." As noted, this rating may reflect each data acquisition site's longer experience in offering administrative services. Exhibit 11 displays districts' views of administrative services.

Exhibit 11

School District Rating of

Administrative Services (N=79)



Upgrading the hardware and software

Officials from one district LOEO visited believe the data acquisition site serving their district needs to upgrade its software because it does not offer all of the features of similar software now on the market. They also believe the system is slow, the data acquisition site is under-staffed, and that none of the data acquisition site's software is userfriendly. These officials also describe the e-mail software provided by the data acquisition site as too complicated. These conclusions were echoed by other districts we visited and whom we interviewed by telephone. For example, a district official described the speed and userfriendliness of a data acquisition site system during a telephone interview:

> Well, I do not think they are great. For example, I have to enter my gifted students into the computer and it is very cumbersome and very complex for our secretaries that have to enter most of the information. In terms of the quickness of the system, it takes several minutes to get the right screens -- it is very slow and awkward.

The analysis of survey data reveals that 74% (59) of school districts and 76% (16) of data acquisition sites believe that data acquisition site computer systems require upgrading. The types of upgrades that both groups of respondents believe are necessary include larger computers or servers and higher-capacity transmission lines to district offices and schools. The purpose of these upgrades is to increase the speed of the systems in anticipation of increasing numbers of students using them.

Of the 16 data acquisition sites that report a need to upgrade their computer systems, only nine provided estimates of the cost of these upgrades to LOEO. The nine estimates for the one-time cost of upgrading their computer systems range from $75,000 to $1 million. The total among all nine data acquisition sites is an estimated $2.2 million. According to the chairman of the Management Council, the coordinating body of the OECN, each data acquisition site is in the process of upgrading its computer system.

Some data acquisition site officials mentioned that a combination of local, state, and federal funds would be used to pay for the upgrades. The most frequently mentioned sources were local and state funds.

Additional staff for technical assistance

Of the 21 data acquisition sites who responded to LOEO's survey, 62% (13) report a need to increase staff. The total estimated number of additional staff that is needed at all 13 data acquisition sites is 30, for a total cost of $758,000. All of these data acquisition sites intend to use a combination of local, state, and federal funds, and user fees to pay for the increase in staffing. In addition, all 13 data acquisition sites will use the increased staffing to help support administrative and student online services and to help teachers integrate technology into the curriculum.

As part of their technical assistance duties, data acquisition site officials view themselves as playing a major role in assisting districts with integrating technology into the curriculum. Yet, districts do not believe data acquisition sites are currently playing, or will play in the future, a major role in assisting them with this task. Of the 21 data acquisition sites responding to LOEO's survey, 76% believe they are playing a major role integrating technology into the curriculum. However, only 33% of the districts believe data acquisition sites are playing a major role, and only 34% believe they will play any role with this endeavor in the future.

These differences could result from different perceptions of "assisting with the integration of technology into the curriculum." Technically oriented data acquisition site staff may view this task as solving hardware and software problems. Teachers and building administrators may view this more from a pedagogical standpoint where staff actually assist teachers with incorporating software and other forms of technology into their lesson plans. Both types of assistance are critical. Approaches to properly integrating technology into the curriculum are addressed in LOEO's report, Ohio SchoolNet Initiatives: School Readiness for Computers and Networks.

Using data from LOEO's surveys, site visits, telephone and face-to-face interviews, the quality of the data acquisition sites are rated in Exhibit 12.

Exhibit 12
LOEO Summary Rating of the Quality of Data Acquisition Sites

Rating	Number of Data Acquisition Sites	Description
Poor	8	More staff is required for technical assistance; both student and administrative systems are slow and the software is too complex, necessitating system upgrades; and some data acquisition sites do not provide graphical interfaces for accessing the Internet.
Adequate	8	Technical assistance is adequate, but more staff are needed; student system is too slow as the number of people using the system increases, necessitating some upgrades to system.
Good	8	Technical assistance is good; and both student and administrative systems are high quality; some system upgrades are required to maintain the current level of quality.

In sum, LOEO's data reveal that at least eight data acquisition sites have an overall "poor" rating. These data acquisition sites tend to have outdated software and computer systems that run slowly. The school districts served by these data acquisition sites believe the computer systems need to be upgraded, especially to accommodate the large numbers of students that will soon be using them. These data acquisition sites also tend to have too few staff to provide adequate technical assistance, although districts believe existing staff are of relatively high quality.

ODE and the Management Council recognize that all data acquisition sites are not equal. The Management Council is trying to develop strategies such as "service sharing," where districts can receive specific services from a data acquisition site other than the one that usually provides them services. In addition, ODE no longer requires school districts to remain with the data acquisition site to which they were originally assigned. As a result, school districts will eventually migrate to the data acquisition sites that provide the level and quality of services that meet their needs.

Moreover, an ODE and the Management Council are also examining whether fewer data acquisition sites could provide better services than the current number. Mergers resulting from certain data acquisition sites providing an insufficient level of services already have reduced 27 data acquisition sites to the current 24.

However, the chairman of the Management Council expressed that the level of the OECN's involvement in the implementation of SchoolNet and SchoolNet Plus has been insufficient. He believes the staff at the various data acquisition sites have substantial expertise with computers, networks, and other technology that has not been used.

Alternatives to the OECN

A 1991 Management Council study compared the cost of data processing services from the then 25 data acquisition sites with those offered by private vendors serving 15 independent districts. The study concluded that the services provided by private vendors were far more expensive than those offered by the data acquisition sites. Data acquisition site services cost an average of $17.17 per-pupil for an average of 17.5 software applications for its member sites, compared to an average per-pupil cost of $70.31 for an average of 11.3 software applications from private vendors.

Although these OECN per-pupil costs do not include the percentage of state funds that subsidize data acquisition site operations, this state funding would have to increase three times its FY 1996 levels to equal a per-pupil cost of $70.31. Independent sites are certainly paying higher costs for their data processing services than districts connected to the OECN.

Moreover, the vendors who offer services such as accounting, grading, and scheduling programs to independent school districts do not offer Internet or other online services that districts desire. As a result, districts would have to hire yet another vendor to provide these services. Private companies offering only Internet services over a 56kb line typically charge $150 to $400 per month per connection.

The cost of these private services using a full T1 line are as high as $2,460 per connection per month. Under SOMACS, the new statewide fiber optic backbone, the price of a T1 line and Internet services is no more than $890 per month anywhere in the state -- $1,570 less than any private provider can offer.

The prices charged by companies such as Compuserve, Prodigy, and America Online are higher for fewer services than data acquisition sites offer. To serve school districts, each of these companies would need to establish a configuration similar to a data acquisition site -- route traffic to a centralized link such as the district office, which in turn, would be connected to each school in the district. Each district would have to pay for the equipment for this new configuration. However, each data acquisition site already has these connections in place.

Compuserve charges $20 per student per month for unlimited Internet service. The largest district, Cleveland, with 70,000 students would pay $1,400,000 per month. Even if Compuserve reduced its fee to $5 per student, the monthly charge for Cleveland would be $350,000 per month. Unless special rates can be negotiated with these private providers, school districts will not be able to afford their services.

* * * *

Summary of Networking Costs

Exhibit 13 provides a cost summary for the upgrades that both schools and data acquisition sites will have to make to provide high-quality student online services. For high speed electronic transmission, all 3,657 school buildings in the state must be equipped with T1 transmission lines. For data acquisition sites to provide high-quality technical assistance to school districts, additional staff must also be hired. The number of additional staff required varies among the 13 dataacquisition sites reporting that need.

In addition, 16 data acquisition sites must upgrade the hardware and software to improve the quality of their computer services. Although 16 data acquisition sites report a need to make these upgrades, cost estimates were provided by only nine. As a result, the estimates in Exhibit 13 are below what it will actually cost to upgrade the computer systems of all 16 data acquisition sites.

Exhibit 13
Estimated Networking Costs for Providing Student On-line Services

	Equipment or Service Needed	Number of Sites	Costs	Estimated Total Costs	
				Recurring Annual	One-time
School Buildings	T1 line	3,657	$5,400 per year ($450 per month)	$19,747,800	-----
	Installing T1 line	3,657	$857 one-time cost	-----	$3,134,049
OECN Data Acquisition Sites	Hardware and Software Upgrades	9*	varies by site	-----	$2,200,000
	Technical Assistance	13*	varies by site	$758,000	-----
				$20,505,800	**$5,334,049**

* Number of data acquisition sites reporting costs for computer upgrades and increasing technical assistance staff.

CHAPTER V
Distance Learning Technology

Distance learning is an important component of SchoolNet because it is considered to be one solution to funding equity concerns. There are two types of distance learning technologies: personal computers that use "desktop videoconferencing" and larger group videoconferencing systems specifically designed for distance learning. These larger group systems are implied in the expectations of SchoolNet.

Distance learning occurs when students are physically distant from the instructor delivering the instruction or demonstration. Distance learning can occur in two forms: one-way **noninteractive** audio/video or two-way **interactive** audio/video. Both forms can be delivered to an individual or to groups. The form of distance learning envisioned for SchoolNet is two-way interactive audio/video distance learning.

Distance learning is not the same as using computer networks. Computer networks allow a person to access national and worldwide data bases and libraries. Videoconferencing, on the other hand, produces live audio and video, allowing the instructor to see and communicate directly with students that are physically located in other classrooms. This videoconferencing technology is what is used in distance learning.

Personal computers can deliver distance learning to an individual; this is called desktop videoconferencing. In contrast, entire rooms containing one or more television-sized monitors and other equipment are dedicated for group videoconferencing. Group videoconferencing is the type of system envisioned for SchoolNet.

Both desktop and group videoconferencing use either analog or digital transmissions. Analog transmissions are similar to television broadcasts and provide the highest quality pictures. Digital systems use the language of computers, and depending on the technology, can provide very high quality pictures as well. Digital usually is preferred over analog technology because it is more efficient and cost effective. However, providing distance learning to groups, as envisioned by advocates of SchoolNet, is expensive whether the system is digital or analog.

The quality of the video image of both desktop and larger group systems distinguishes good systems from poor ones. Two of the most important factors influencing this "quality" are resolution and motion-handling capability.

Resolution refers to the number of picture elements displayed on the screen. This is expressed in vertical elements (**lines**) times horizontal elements (**pixels**). Resolution is not affected by motion and varies little with the digital transmission rate. **Motion handling** refers to how closely the motion taking place on screen approximates real life movement. Appendix E provides additional information on resolution and motion handling for video equipment.

Desktop videoconferencing

Desktop videoconferencing equipment can be purchased for as little as $1,500 per machine. However, digital systems priced at less than $3,000 will not provide television-quality resolution of 30 frames per second; most systems offer rates between 12 and 15 frames per second. Some experts, one of which LOEO interviewed for this study, have never witnessed any desktop system providing television quality resolution. However, since desktop videoconferencing display screens are so small, motion handling is far less a concern and relatively high resolution is easier to obtain. In other words, the smaller the display screen, the better the picture.

Interoperability, the ability of different networks to communicate, has improved among desktop machines since manufacturers have agreed to use similar standards. However, interoperability still tends to be limited to machines using similar equipment.

All desktop systems run best on high-powered, fast personal computers. High bandwidth must be available to feed into the equipment or the quality of the picture will remain poor. Since desktop videoconferencing demands so much in terms of computer resources, these systems run better over networks where more resources are available. Desktop systems run best over networks dedicated to desktop videoconferencing. Dedicated video networks are expensive, however, but perfect for training purposes.

In sum, desktop videoconferencing is designed for individuals and not for groups. The systems are relatively affordable, but if group learning is the goal, desktops are not a replacement for high-quality group distance learning equipment.

Group videoconferencing

A private company supplied LOEO with cost figures for a series of group videoconferencing systems. The least expensive systems are used for business meetings where full range movements are limited. More expensive systems used for distance learning have higher resolution and better motion-handling capabilities.

Exhibit 14 displays the cost and capabilities of the various types of systems using prices negotiated by the state. The prices include systems with at least two monitors and other peripherals that LOEO's research indicated are necessary for quality distance learning to occur.

Exhibit 14
Group Videoconferencing Equipment Cost Per Classroom

Model Type*	Transmission Speeds	Motion Quality (fps)	Price	Uses
A	56 - 384 kps	up to 15	$58,305	Designed for meetings; not recommended for distance learning.
B	56 - 384 kps	up to 30	$76,665	Designed for meetings; could be used for distance learning.
C	56 - 2.048 Mbps	up to 30	$77,915	Although not designed for distance learning, it could be used for this purpose.
D	56 - 2.048 Mbps	up to 30	$93,835	Customized distance learning classroom.

Source: Norstan Communications.

* Replaces actual model numbers.
Mbps - megabits per second
kps - kilobits per second
fps- frames per second

The cost of each model listed in Exhibit 14 is to equip one classroom. An itemized list of the equipment and the costs for each model is provided in Appendix F.

The Ohio Department of Administrative Services (DAS) will connect two distance learning sites for $80 per month. To connect more than two sites, DAS charges an additional $7 per hour per site. Commercial companies typically charge $50 per hour for each site that is linked together. DAS intends to add more switching capabilities as videoconferencing use grows throughout the state.

The Ohio Department of Human Services and DAS currently have approximately 50 videoconferencing systems operating across the state on split T1 lines. Together, they plan to have a total of 100 operating by 1997.

There are a number of distance learning projects operating in Ohio that are designed to provide services to elementary and secondary education. Some of these facilities have received state funding through the Tech Equity program. These projects are described in Appendix G.

Costs of group videoconferencing

Group videoconferencing can be very expensive. The cost of accessing adequate transmission capacity merely adds to the expense. However, the state fiber optic backbone, SOMACS, has lowered the price of T1 lines, making them more affordable. School districts who have difficulty affording group videoconferencing equipment may consider **technology leasing**. Similar to automobile leasing, videoconferencing equipment is leased for the "technology life" of the equipment. This type of financing increases the price of the equipment but allows schools to upgrade their systems more inexpensively as technology changes.

Exhibit 15 presents a cost summary for providing distance learning to the 200 low-wealth school districts in Ohio. The estimated cost is based on providing one classroom in the district with a moderately priced group videoconferencing system and the accompanying T1 transmission and phone lines, and various switching, scheduling, and installation fees.

Exhibit 15
Distance Learning Costs for One Classroom in 200 Low-Wealth Districts

Equipment or Service Needed	Costs for One Site		Costs for 200 Sites	
	Recurring	One-time	Recurring	One-time
Model C Videoconferencing	-----	$77,915	----	$15,583,000
T1 lines *	$5,400 ($450 per month)	$857	$1,080,000	$171,400
Diagnostic phone line	$360 ($30 per month)	-----	$72,000	-----
Switching/Scheduling**	$960 ($80 per month)	$300	$192,000	$60,000
Total	**$6,720 per year**	**$79,072**	**$1,344,000**	**$15,814,000**

*By "splitting" a T1 line, it can be used for both Internet services and videoconferencing.
**An additional $7.00/hour fee is charged to districts for connections to more than one site on the SOMACS.

CHAPTER VI
Conclusions and Recommendations

This chapter presents LOEO's conclusions and recommendations about the continued use of the Ohio Education Computer Network and its relationship to the larger statewide computer network. The role of distance learning in helping solve funding equity concerns is also addressed.

Continued use of the OECN

In this report, LOEO addresses the advantages and disadvantages of using the existing Ohio Education Computer Network (OECN) to provide public schools access to online information resources. We address whether a system developed in 1979 for *administrative* purposes should be expanded to handle the volume of students and teachers who will use it for *instructional* purposes.

The original purpose of the OECN was to provide accounting services to school districts, including the electronic transmission of their financial data to ODE. Its responsibilities have since expanded to include a number of other administrative duties, including transmitting cost, student, and staff data required for the Education Management Information System (EMIS). Since it was created, the state has invested a total of $229 million to equip and operate the OECN for these purposes.

With SchoolNet, the 24 regional data acquisition sites of the OECN are now expected to serve students for instructional purposes. Because of SchoolNet, as many as 1.8 million students and 95,000 teachers could eventually be using the OECN.

LOEO concludes that the advantages of using the OECN for student online services currently outweigh the disadvantages, particularly in terms of cost. In general, OECN administrative and student services cost less than similar services offered by private providers. Its bulk purchasing practices result in lower prices for hardware, software, and professional development services for all member districts. In addition, software developed by the state is available to member school districts at no cost. Finally, districts can avoid purchasing expensive computer equipment for their own separate computer systems.

However, not all OECN data acquisition sites are currently providing quality services. Using information from questionnaires and interviews, LOEO rates the overall quality of data acquisition sites as follows: eight are "poor;" eight are "adequate;" and eight are "good." Poor and adequate data acquisition sites need to upgrade their computer systems and increase their staff to adequately provide instructional as well as administrative services.

The Ohio Department of Education (ODE) and the Management Council (the coordinating body of the OECN) recognize that all data acquisition sites are not equal. ODE no longer requires school districts to remain with the same data acquisition site to which they were originally assigned. Some school districts will eventually migrate to the data acquisition sites that provide better services. ODE and the Management Council are also examining whether fewer data acquisition sites could provide better services than the current 24 sites. The results of LOEO's analyses have revealed that at least eight data acquisition sites need to significantly upgrade *all* of their services before they can provide a sufficient level of quality services to the districts they serve.

Although 16 of the 24 data acquisition sites need to make some improvements, only nine provided LOEO cost estimates for the necessary upgrades. The total one-time cost of the upgrades for these nine sites is an estimated $2.2 million. A total of 13 data acquisition sites report a need to increase their number of staff by a total of 30. The estimated cost of this increased staffing is $758,000 per year.

LOEO recommends the Ohio Department of Education convene a working group to determine the extent of the OECN role with regard to the SchoolNet initiatives. In addition, the group should determine the minimum level of service that each data acquisition site must offer to qualify for state subsidy.

LOEO suggests that such minimum services should include, but not be limited to:

- assisting teachers and students with technology for instructional purposes;
- assisting teachers with the integration of technology into the curriculum; and
- assisting districts and schools with the administration and care of their networks (i.e., network administration).

LOEO recommends the General Assembly continue to invest in the OECN as the current best solution to providing access to online networks for student instructional use. However, this investment now should be contingent upon the quality of services provided by each data acquisition site. Poor quality data acquisition sites that cannot quickly improve their services to member districts should not continue to receive state subsidies.

Future issues. Although LOEO sees the OECN as the current best solution for connecting students to online services, the world of telecommunications is changing so quickly that no one decision can be made for the indefinite future. The deregulation of the telecommunications industry by the federal Telecommunications Act of 1996 could substantially reduce the cost of access to online services.

This Act allows telephone companies to offer video services; cable companies to offer telephone services; and both to offer access to the Internet and other online information resources. As the number of companies that offer these services increases, the cost of accessing the services will continue to decrease. As a result, school districts will have options other than OECN data acquisition sites to provide access to online information networks.

The federal government is in the process of developing rules to implement the changes resulting from the Telecommunications Act. Consequently, the extent of the changes to the communications industry is unknown at this time.

As a result, **LOEO also recommends** that the cost-effectiveness of the services provided by the OECN data acquisition sites be evaluated on an ongoing basis.

Ohio's statewide computer system

LOEO also addressed the question of whether higher education institutions and other education-related organizations, such as the Cooperative Extension Service, are networked in the most cost-effective way.

LOEO concludes that all state agencies and public institutions are benefiting from the extensive and careful planning that developed Ohio's first statewide computer network in 1985, the State of Ohio Network for Integrated Communication (SONIC). As a result of the more recent 1993 state technology plan, the SONIC is being upgraded to a higher-capacity network -- State of Ohio Multi-Agency Communications System (SOMACS).

Similar to the SONIC, all state-funded organizations including the OECN, colleges, universities, and Cooperative Extension Service agencies will be electronically connected to the SOMACS in the most cost-effective manner available to state government.

Distance learning

Distance learning is group video-conferencing in which the instructor can see and communicate directly with students that are physically located in other classrooms. Distance learning is *not* the same as using computers over networks to access online databases and libraries. These are entirely different functions and have different associated costs.

One expectation of SchoolNet is that distance learning will help solve funding equity concerns among Ohio school districts. The hope is that low-wealth schools could use distance learning to increase their number of course offerings. However, LOEO's research indicates the hardware and software systems that provide distance learning are too expensive for many school districts to purchase. Although several districts in Ohio have group distance learning systems, the funding for them came from donations from a number of sources, including local telephone companies.

The estimated cost for putting a moderately priced group videoconferencing system in place is $79,072. If, for example, Ohio intended to provide just one distance learning classroom in one school in each of the state's 200 low-wealth districts, the total one-time cost would be nearly $16 million. An additional $1.3 million per year is needed to pay for switching and scheduling services, and to connect to the site delivering the instruction.

Although a total of $247 million has been allocated to the SchoolNet initiatives, only one percent ($2.5 million) has been designated for a type of distance learning. This $2.5 million has been earmarked for developing instructional programming, not to purchase the hardware and software needed by schools for group videoconferencing.

Assuming these funds were to be allocated for equipment, this amount would equip only 32 classrooms. An additional $215,000 per year for switching services would still be needed to make the equipment operational.

LOEO recommends that given the expense of distance learning, the General Assembly consider the following choices:

- whether distance learning is too expensive for the state to use;
- whether state-supported distance learning can be provided to only the most isolated school districts and not to all low-wealth districts; or
- whether additional state funding should be provided for distance learning so at least the 200 low-wealth school districts can purchase the necessary equipment.

LOEO recommends that school distrcts' use of distance learning be evaluated on an ongoing basis to determine the cost-effectiveness of this technology in improving student learning. If the results of the evaluations determine that this technology does not improve student learning in a cost-effective manner, state funding should be eliminated.

LOEO also recommends that the Ohio Department of Education investigate methods of financing expensive technology. The strategy of technology leasing should be considered to see if it offers a means of making technology more affordable for school districts. Technology leasing also would allow school districts to update their equipment more inexpensively as technology changes.

Appendices

APPENDIX A
Selected Bibliography

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APPENDIX B
Agencies that Participated on the 1991 Technology Committee

In 1991, the Directors of the Office of Budget and Management and the Ohio Department of Administrative Services formed an Inter-agency Telecommunications Committee to develop a statewide plan for upgrading the state's use of telecommunications technology. The 1993 Telecommunications Subcommittee Report is the product of the committee's work. The Directors of the following ten state agencies were perceived as major stakeholders and were asked to participate on the Telecommunications Committee:

- Office of Budget and Management
- Ohio Department of Administrative Services
- Ohio Department of Development
- Ohio Department of Education
- Ohio Educational Telecommunications Network Commission (formerly Ohio Educational Broadcasting Network Commission)
- Emergency Management Agency
- Ohio Department of Public Safety
- Public Utilities Commission of Ohio
- Ohio Board of Regents
- State Library of Ohio

APPENDIX C

Local Telephone Companies Serving the 611 School Districts

KEY	CODE
LARGE TELEPHONE COMPANIES	
Ameritech	1
Cincinnati Bell Telephone Company	2
GTE North, Inc.	3
United Telephone Company of Ohio	4
The Chillicothe Telephone Company	5
The Western Reserve TelCo (ALLTEL)	6
ALLTEL Ohio, Inc. (former Mid-Ohio)	7
Century Telephone Company of Ohio	8
SMALL TELEPHONE COMPANIES	
Arcadia Telephone Company	A
Ayersville Telephone Company	B
The Bascom Mutual Telephone Company, Inc.	C
The Buckland Telephone Company	D
The Champaign Telephone Company	E
Columbus Grove Telephone Company	F
The Conneaut Telephone Company	G
Continental Telephone Company	H
Doylestown Telephone Company	I
The Fort Jennings Telephone Company	J
Frontier Telephone of Michigan	K
The Germantown Independent TelCo	L
Glandorf Telephone Company	M
Kalida Telephone Company, Inc.	N
Little Miami Communications	O
The Middle Point Home TelCo	P
Minford Telephone Company	Q
New Knoxville Telephone Company	R
The Nova Telephone Company	S
The Oakwood Telephone Company [TDS]	T
The Orwell Telephone Company	U
The Ottoville Mutual Telephone Company	V
The Ridgeville Telephone Company	W
The Sherwood Mutual Telephone Association	X
Sycamore Telephone Company	Y
Telephone Service Company	Z
United Telephone Company of Indiana	AA
Vanlue Telephone Company [TDS]	BB
More Than One Listing	*
No Listing	**

SCHOOL DISTRICT	COUNTY	TELEPHONE COMPANY
Adams County/Ohio Valley Local	Adams	1,3
Allen East Local SD	Allen	4
Apollo JVSD	Allen	4
Bath Local SD	Allen	4
Bluffton Ex Vill SD	Allen	4
Delphos City SD	Allen	4
Elida Local SD	Allen	4
Lima City SD	Allen	4
Perry Local SD	Allen	4
Shawnee Local SD	Allen	4
Spencerville Local SD	Allen	3,4
Ashland City SD	Ashland	3
Ashland County - West Holmes JVSD	Ashland	1
Hillsdale Local SD	Ashland	3
Loudonville-Perrysville Ex Vil	Ashland	3
Mapleton Local SD	Ashland	3,S
Ashtabula Area City SD	Ashtabula	6
Ashtabula County JVSD	Ashtabula	4
Buckeye Local SD	Ashtabula	6
Conneaut Area City SD	Ashtabula	G
Geneva Area City SD	Ashtabula	6
Grand Valley Local SD	Ashtabula	6,U
Jefferson Area Local SD	Ashtabula	4,6
Pymatuning Valley Local SD	Ashtabula	4
Alexander Local SD	Athens	3
Athens City SD	Athens	3
Federal Hocking Local SD	Athens	3,6
Nelsonville-York City SD	Athens	1
Tri-County JVSD	Athens	1
Trimble Local SD	Athens	4
Minster Local SD	Auglaize	3
New Bremen Local SD	Auglaize	3
New Knoxville Local SD	Auglaize	R
St Marys City SD	Auglaize	3,*
Wapakoneta City SD	Auglaize	4,B,Z
Waynesfield-Goshen Local SD	Auglaize	4
Barnesville Ex Vill SD	Belmont	1
Bellaire City SD	Belmont	1
Belmont - Harrison JVSD	Belmont	1,3
Bridgeport Ex Vill SD	Belmont	1
Martins Ferry City SD	Belmont	1
Shadyside Local SD	Belmont	1
St Clairsville-Richland City S	Belmont	1
Union Local SD	Belmont	1,3,6
Eastern Local SD	Brown	3
Fayetteville-Perry Local SD	Brown	O
Ripley-Union-Lewis Local SD	Brown	1
Southern Hills JVSD	Brown	3
Western Brown Local SD	Brown	3
Butler County JVSD	Butler	2
Edgewood City SD	Butler	1,2
Fairfield City SD	Butler	2
Hamilton City SD	Butler	2
Lakota Local SD	Butler	2
Madison Local SD	Butler	1
Middletown City SD	Butler	1
New Miami Local SD	Butler	2
Ross Local SD	Butler	2
Talawanda City SD	Butler	2,3
Brown Local SD	Carroll	3
Carrollton Ex Vill SD	Carroll	3,*
Graham Local SD	Champaign	4,7,E
Mechanicsburg Ex Vill SD	Champaign	3
Triad Local SD	Champaign	3,4
Urbana City SD	Champaign	E
West Liberty-Salem Local SD	Champaign	4
Mad River-Green Local SD	Clark	1
Northeastern Local SD	Clark	1
Northwestern Local SD	Clark	1
Southeastern Local SD	Clark	1
Springfield City SD	Clark	1
Springfield Local SD	Clark	1
Springfield-Clark County JVSD	Clark	1
Tecumseh Local SD	Clark	1
Batavia Local SD	Clermont	2
Bethel-Tate Local SD	Clermont	2
Clermont-Northeastern Local SD	Clermont	2
Felicity-Franklin Local SD	Clermont	3
Goshen Local SD	Clermont	2
Milford Ex Vill SD	Clermont	2
New Richmond Ex Vill SD	Clermont	2
U S Grant JVSD	Clermont	1
West Clermont Local SD	Clermont	2
Williamsburg Local SD	Clermont	2
Blanchester Local SD	Clinton	3
Clinton-Massie Local SD	Clinton	3
East Clinton Local SD	Clinton	3
Wilmington City SD	Clinton	3
Beaver Local SD	Columbiana	1
Columbiana County JVSD	Columbiana	1
Columbiana Ex Vill SD	Columbiana	1
Crestview Local SD	Columbiana	1

KEY	CODE
LARGE TELEPHONE COMPANIES	
Ameritech	1
Cincinnati Bell Telephone Company	2
GTE North, Inc.	3
United Telephone Company of Ohio	4
The Chillicothe Telephone Company	5
The Western Reserve TelCo (ALLTEL)	6
ALLTEL Ohio, Inc. (former Mid-Ohio)	7
Century Telephone Company of Ohio	8
SMALL TELEPHONE COMPANIES	
Arcadia Telephone Company	A
Ayersville Telephone Company	B
The Bascom Mutual Telephone Company, Inc.	C
The Buckland Telephone Company	D
The Champaign Telephone Company	E
Columbus Grove Telephone Company	F
The Conneaut Telephone Company	G
Continental Telephone Company	H
Doylestown Telephone Company	I
The Fort Jennings Telephone Company	J
Frontier Telephone of Michigan	K
The Germantown Independent TelCo	L
Glandorf Telephone Company	M
Kalida Telephone Company, Inc.	N
Little Miami Communications	O
The Middle Point Home TelCo	P
Minford Telephone Company	Q
New Knoxville Telephone Company	R
The Nova Telephone Company	S
The Oakwood Telephone Company [TDS]	T
The Orwell Telephone Company	U
The Ottoville Mutual Telephone Company	V
The Ridgeville Telephone Company	W
The Sherwood Mutual Telephone Association	X
Sycamore Telephone Company	Y
Telephone Service Company	Z
United Telephone Company of Indiana	AA
Vanlue Telephone Company [TDS]	BB
More Than One Listing	*
No Listing	**

SCHOOL DISTRICT	COUNTY	TELEPHONE COMPANY
East Palestine City SD	Columbiana	1
Leetonia Ex Vill SD	Columbiana	1
Lisbon Ex Vill SD	Columbiana	1
Salem City SD	Columbiana	1
Southern Local SD	Columbiana	1,3
United Local SD	Columbiana	3
Wellsville City SD	Columbiana	1
Coshocton City SD	Coshocton	1
Coshocton County JVSD	Coshocton	3
Ridgewood Local SD	Coshocton	1
River View Local SD	Coshocton	1,3
Buckeye Central Local SD	Crawford	3,4
Bucyrus City SD	Crawford	4
Colonel Crawford Local SD	Crawford	3,4
Crestline Ex Vill SD	Crawford	3
Galion City SD	Crawford	3
Wynford Local SD	Crawford	3,4
Bay Village City SD	Cuyahoga	1
Beachwood City SD	Cuyahoga	1
Bedford City SD	Cuyahoga	1
Berea City SD	Cuyahoga	1
Brecksville-Broadview Heights	Cuyahoga	1
Brooklyn City SD	Cuyahoga	1
Chagrin Falls Ex Vill SD	Cuyahoga	6
Cleveland City SD	Cuyahoga	1
Cleveland Hts-Univ Hts City SD	Cuyahoga	1
Cuyahoga Heights Local SD	Cuyahoga	1
Cuyahoga Valley JVSD	Cuyahoga	1
East Cleveland City SD	Cuyahoga	1
Euclid City SD	Cuyahoga	1
Fairview Park City SD	Cuyahoga	1
Garfield Heights City SD	Cuyahoga	1
Independence Local SD	Cuyahoga	1
Lakewood City SD	Cuyahoga	1
Maple Heights City SD	Cuyahoga	1
Mayfield City SD	Cuyahoga	1
North Olmsted City SD	Cuyahoga	1
North Royalton City SD	Cuyahoga	1
Olmsted Falls City SD	Cuyahoga	1
Orange City SD	Cuyahoga	1
Parma City SD	Cuyahoga	1
Polaris JVSD	Cuyahoga	1
Richmond Heights Local SD	Cuyahoga	1
Rocky River City SD	Cuyahoga	1
Shaker Heights City SD	Cuyahoga	1
Solon City SD	Cuyahoga	1
South Euclid-Lyndhurst City SD	Cuyahoga	1

SCHOOL DISTRICT	COUNTY	TELEPHONE COMPANY
Warrensville Heights City SD	Cuyahoga	1
Westlake City SD	Cuyahoga	1
Strongsville City SD	Cuyuahoga	1
Ansonia Local SD	Darke	4
Arcanum Butler Local SD	Darke	4
Franklin-Monroe Local SD	Darke	3,4
Greenville City SD	Darke	4
Mississinawa Valley Local SD	Darke	AA
Tri-Village Local SD	Darke	4
Versailles Ex Vill SD	Darke	3,4
Ayersville Local SD	Defiance	B
Central Local SD	Defiance	3,X
Defiance City SD	Defiance	4
Hicksville Ex Vill SD	Defiance	3
Northeastern Local SD	Defiance	3,4
Big Walnut Local SD	Delaware	4
Buckeye Valley Local SD	Delaware	3
Delaware City SD	Delaware	3
Delaware JVSD	Delaware	4
Olentangy Local SD	Delaware	3
Berlin-Milan Local SD	Erie	3
EHOVE JVSD	Erie	1
Huron City SD	Erie	3
Kelleys Island Local SD	Erie	3
Margaretta Local SD	Erie	1
Perkins Local SD	Erie	1
Sandusky City SD	Erie	1
Vermilion Local SD	Erie	8
Amanda-Clearcreek Local SD	Fairfield	3
Berne Union Local SD	Fairfield	1
Bloom Carroll Local SD	Fairfield	1
Fairfield Union Local SD	Fairfield	1
Lancaster City SD	Fairfield	1
Liberty Union-Thurston Local S	Fairfield	3
Pickerington Local SD	Fairfield	1
Walnut Township Local SD	Fairfield	3
Miami Trace Local SD	Fayette	1
Washington Court House City SD	Fayette	1
Bexley City SD	Franklin	1
Canal Winchester Local SD	Franklin	1
Columbus City SD	Franklin	1
Dublin City SD	Franklin	1,3
Eastland JVSD	Franklin	1
Gahanna-Jefferson City SD	Franklin	1
Grandview Heights City SD	Franklin	1
Groveport Madison Local SD	Franklin	1
Hamilton Local SD	Franklin	1

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LARGE TELEPHONE COMPANIES	
Ameritech	1
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United Telephone Company of Ohio	4
The Chillicothe Telephone Company	5
The Western Reserve TelCo (ALLTEL)	6
ALLTEL Ohio, Inc. (former Mid-Ohio)	7
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The Champaign Telephone Company	E
Columbus Grove Telephone Company	F
The Conneaut Telephone Company	G
Continental Telephone Company	H
Doylestown Telephone Company	I
The Fort Jennings Telephone Company	J
Frontier Telephone of Michigan	K
The Germantown Independent TelCo	L
Glandorf Telephone Company	M
Kalida Telephone Company, Inc.	N
Little Miami Communications	O
The Middle Point Home TelCo	P
Minford Telephone Company	Q
New Knoxville Telephone Company	R
The Nova Telephone Company	S
The Oakwood Telephone Company [TDS]	T
The Orwell Telephone Company	U
The Ottoville Mutual Telephone Company	V
The Ridgeville Telephone Company	W
The Sherwood Mutual Telephone Association	X
Sycamore Telephone Company	Y
Telephone Service Company	Z
United Telephone Company of Indiana	AA
Vanlue Telephone Company [TDS]	BB
More Than One Listing	*
No Listing	**

SCHOOL DISTRICT	COUNTY	TELEPHONE COMPANY
Hilliard City SD	Franklin	1
Plain Local SD	Franklin	1
Reynoldsburg City SD	Franklin	1
South-Western City SD	Franklin	1
Upper Arlington City SD	Franklin	1
Westerville City SD	Franklin	1
Whitehall City SD	Franklin	1
Worthington City SD	Franklin	1
Archbold-Area Local SD	Fulton	4,W
Evergreen Local SD	Fulton	4
Gorham Fayette Local SD	Fulton	3
Pettisville Local SD	Fulton	4
Pike-Delta-York Local SD	Fulton	4,7
Swanton Local SD	Fulton	4
Wauseon Ex Vill SD	Fulton	4
Gallia - Jackson - Vinton JVSD	Gallia	3
Gallia County Local SD	Gallia	6
Gallipolis City SD	Gallia	1
Berkshire Local SD	Geauga	1,6
Cardinal Local SD	Geauga	6
Chardon Local SD	Geauga	6
Kenston Local SD	Geauga	6
Ledgemont Local SD	Geauga	6
Newbury Local SD	Geauga	6
West Geauga Local SD	Geauga	1,6
Beavercreek Local SD	Greene	1
Cedar Cliff Local SD	Greene	1
Fairborn City SD	Greene	1
Greene County JVSD	Greene	1
Greeneview Local SD	Greene	1
Sugarcreek Local SD	Greene	1
Xenia City SD	Greene	1
Yellow Springs Ex Vill SD	Greene	1
Cambridge City SD	Guernsey	3
East Guernsey Local SD	Guernsey	3
Rolling Hills Local SD	Guernsey	3
Cincinnati City SD	Hamilton	2
Deer Park Community City SD	Hamilton	2
Finneytown Local SD	Hamilton	2
Forest Hills Local SD	Hamilton	2
Great Oaks Inst Of Technology JVSD	Hamilton	1,2,3
Indian Hill Ex Vill SD	Hamilton	2
Lockland City SD	Hamilton	2
Loveland City SD	Hamilton	2
Madeira City SD	Hamilton	2
Mariemont City SD	Hamilton	2
Mount Healthy City SD	Hamilton	2

SCHOOL DISTRICT	COUNTY	TELEPHONE COMPANY
North College Hill City SD	Hamilton	2
Northwest Local SD	Hamilton	2
Norwood City SD	Hamilton	2
Oak Hills Local SD	Hamilton	2
Princeton City SD	Hamilton	2
Reading Community City SD	Hamilton	2
Southwest Local SD	Hamilton	2
St Bernard-Elmwood Place City	Hamilton	2
Sycamore Community City SD	Hamilton	2
Three Rivers Local SD	Hamilton	2
Winton Woods City SD	Hamilton	2
Wyoming City SD	Hamilton	2
Arcadia Local SD	Hancock	A
Arlington Local SD	Hancock	3
Cory-Rawson Local SD	Hancock	3,U
Findlay City SD	Hancock	1
Liberty Benton Local SD	Hancock	1
McComb Local SD	Hancock	3,4
Van Buren Local SD	Hancock	3
Vanlue Local SD	Hancock	BB
Ada Ex Vill SD	Hardin	4
Hardin Northern Local SD	Hardin	4
Kenton City SD	Hardin	7
Ridgemont Local SD	Hardin	4
Riverdale Local SD	Hardin	3
Upper Scioto Valley Local SD	Hardin	4
Conotton Valley Union Local SD	Harrison	3
Harrison Hills City SD	Harrison	3,6
Four County JVSD	Henry	W
Holgate Local SD	Henry	4
Liberty Center Local SD	Henry	4
Napoleon City SD	Henry	4
Patrick Henry Local SD	Henry	4
Bright Local SD	Highland	1,3
Fairfield Local SD	Highland	3
Greenfield Ex Vill SD	Highland	1,3,*
Hillsboro City SD	Highland	1
Lynchburg-Clay Local SD	Highland	3
Logan-Hocking Local SD	Hocking	3
East Holmes Local SD	Holmes	3,4
West Holmes Local SD	Holmes	3,4
Bellevue City SD	Huron	3
Monroeville Local SD	Huron	3
New London Local SD	Huron	3
Norwalk City SD	Huron	3
South Central Local SD	Huron	3
Western Reserve Local SD	Huron	3

KEY	CODE
LARGE TELEPHONE COMPANIES	
Ameritech	1
Cincinnati Bell Telephone Company	2
GTE North, Inc.	3
United Telephone Company of Ohio	4
The Chillicothe Telephone Company	5
The Western Reserve TelCo (ALLTEL)	6
ALLTEL Ohio, Inc. (former Mid-Ohio)	7
Century Telephone Company of Ohio	8
SMALL TELEPHONE COMPANIES	
Arcadia Telephone Company	A
Ayersville Telephone Company	B
The Bascom Mutual Telephone Company, Inc.	C
The Buckland Telephone Company	D
The Champaign Telephone Company	E
Columbus Grove Telephone Company	F
The Conneaut Telephone Company	G
Continental Telephone Company	H
Doylestown Telephone Company	I
The Fort Jennings Telephone Company	J
Frontier Telephone of Michigan	K
The Germantown Independent TelCo	L
Glandorf Telephone Company	M
Kalida Telephone Company, Inc.	N
Little Miami Communications	O
The Middle Point Home TelCo	P
Minford Telephone Company	Q
New Knoxville Telephone Company	R
The Nova Telephone Company	S
The Oakwood Telephone Company [TDS]	T
The Orwell Telephone Company	U
The Ottoville Mutual Telephone Company	V
The Ridgeville Telephone Company	W
The Sherwood Mutual Telephone Association	X
Sycamore Telephone Company	Y
Telephone Service Company	Z
United Telephone Company of Indiana	AA
Vanlue Telephone Company [TDS]	BB
More Than One Listing	*
No Listing	**

SCHOOL DISTRICT	COUNTY	TELEPHONE COMPANY
Willard City SD	Huron	3
Jackson City SD	Jackson	3
Oak Hill Union Local SD	Jackson	3
Wellston City SD	Jackson	3
Buckeye Local SD	Jefferson	1,3
Edison Local SD	Jefferson	1,3
Indian Creek Local SD	Jefferson	1,6
Jefferson County JVSD	Jefferson	1
Steubenville City SD	Jefferson	1
Toronto City SD	Jeffeson	1
Centerburg Local SD	Knox	4
Danville Local SD	Knox	4
East Knox Local SD	Knox	4
Fredericktown Local SD	Knox	4
Knox County JVSD	Knox	4
Mount Vernon City SD	Knox	4
Auburn JVSD	Lake	1
Fairport Harbor Ex Vill SD	Lake	1
Kirtland Local SD	Lake	1
Madison Local SD	Lake	6
Mentor Ex Vill SD	Lake	1
Painesville City Local SD	Lake	1
Painesville Local SD	Lake	1
Perry Local SD	Lake	6
Wickliffe City SD	Lake	1
Willoughby-Eastlake City SD	Lake	1
Chesapeake Union Ex Vill SD	Lawrence	3
Dawson-Bryant Local SD	Lawrence	1
Fairland Local SD	Lawrence	3
Ironton City SD	Lawrence	1
Lawrence County JVSD	Lawrence	3
Rock Hill Local SD	Lawrence	1
South Point Local SD	Lawrence	1,3
Symmes Valley Local SD	Lawrence	1,3
Granville Ex Vill SD	Licking	7
Heath City SD	Licking	7
Johnstown-Monroe Local SD	Licking	4
Lakewood Local SD	Licking	4,7
Licking County JVSD	Licking	7
Licking Heights Local SD	Licking	4
Licking Valley Local SD	Licking	7
Newark City SD	Licking	7
North Fork Local SD	Licking	4,7
Northridge Local SD	Licking	4
Southwest Licking Local SD	Licking	4
Bellefontaine City SD	Logan	4
Benjamin Logan Local SD	Logan	4

SCHOOL DISTRICT	COUNTY	TELEPHONE COMPANY
Indian Lake Local SD	Logan	4
Ohio Hi-Point JVSD	Logan	4
Riverside Local SD	Logan	4
Amherst Ex Vill SD	Lorain	8
Avon Lake City SD	Lorain	8
Avon Local SD	Lorain	8
Clearview Local SD	Lorain	8
Columbia Local SD	Lorain	7
Elyria City SD	Lorain	7
Firelands Local SD	Lorain	8
Keystone Local SD	Lorain	3,7
Lorain City SD	Lorain	8
Lorain County JVSD	Lorain	3
Midview Local SD	Lorain	3,7
North Ridgeville City SD	Lorain	7
Oberlin City SD	Lorain	3
Sheffield-Sheffield Lake City	Lorain	8
Wellington Ex Vill SD	Lorain	3
Anthony Wayne Local SD	Lucas	1,4
Maumee City SD	Lucas	1
Oregon City SD	Lucas	1,3
Ottawa Hills Local SD	Lucas	1
Springfield Local SD	Lucas	1
Sylvania City SD	Lucas	3
Toledo City SD	Lucas	1
Washington Local SD	Lucas	1
Central Ohio JVSD	Madison	3
Jefferson Local SD	Madison	1
Jonathan Alder Local SD	Madison	3
London City SD	Madison	1,8
Madison-Plains Local SD	Madison	1,4
Austintown Local SD	Mahoning	1
Boardman Local SD	Mahoning	1
Campbell City SD	Mahoning	1
Canfield Local SD	Mahoning	1
Jackson-Milton Local SD	Mahoning	1,4
Lowellville Local SD	Mahoning	1
Mahoning County JVSD	Mahoning	1
Poland Local SD	Mahoning	1
Sebring Local SD	Mahoning	1
South Range Local SD	Mahoning	1
Springfield Local SD	Mahoning	1
Struthers City SD	Mahoning	1
West Branch Local SD	Mahoning	1,3,4
Western Reserve Local SD	Mahoning	1,4
Youngstown City SD	Mahoning	1
Elgin Local SD	Marion	3

KEY	CODE
LARGE TELEPHONE COMPANIES	
Ameritech	1
Cincinnati Bell Telephone Company	2
GTE North, Inc.	3
United Telephone Company of Ohio	4
The Chillicothe Telephone Company	5
The Western Reserve TelCo (ALLTEL)	6
ALLTEL Ohio, Inc. (former Mid-Ohio)	7
Century Telephone Company of Ohio	8
SMALL TELEPHONE COMPANIES	
Arcadia Telephone Company	A
Ayersville Telephone Company	B
The Bascom Mutual Telephone Company, Inc.	C
The Buckland Telephone Company	D
The Champaign Telephone Company	E
Columbus Grove Telephone Company	F
The Conneaut Telephone Company	G
Continental Telephone Company	H
Doylestown Telephone Company	I
The Fort Jennings Telephone Company	J
Frontier Telephone of Michigan	K
The Germantown Independent TelCo	L
Glandorf Telephone Company	M
Kalida Telephone Company, Inc.	N
Little Miami Communications	O
The Middle Point Home TelCo	P
Minford Telephone Company	Q
New Knoxville Telephone Company	R
The Nova Telephone Company	S
The Oakwood Telephone Company [TDS]	T
The Orwell Telephone Company	U
The Ottoville Mutual Telephone Company	V
The Ridgeville Telephone Company	W
The Sherwood Mutual Telephone Association	X
Sycamore Telephone Company	Y
Telephone Service Company	Z
United Telephone Company of Indiana	AA
Vanlue Telephone Company [TDS]	BB
More Than One Listing	*
No Listing	**

SCHOOL DISTRICT	COUNTY	TELEPHONE COMPANY
Marion City SD	Marion	3
Pleasant Local SD	Marion	3
Ridgedale Local SD	Marion	3
River Valley Local SD	Marion	3,4
Tri-Rivers JVSD	Marion	1
Black River Local SD	Medina	3,S
Brunswick City SD	Medina	3
Buckeye Local SD	Medina	3
Cloverleaf Local SD	Medina	3
Highland Local SD	Medina	3,6
Medina City SD	Medina	3
Medina County JVSD	Medina	1
Wadsworth City SD	Medina	3
Eastern Local SD	Meigs	6
Meigs Local SD	Meigs	3
Southern Local SD	Meigs	3
Celina City SD	Mercer	3
Coldwater Ex Vill SD	Mercer	3,4
Fort Recovery Local SD	Mercer	3
Marion Local SD	Mercer	3
Mendon Union Local SD	Mercer	3
Parkway Local SD	Mercer	3,4
St Henry Consolidated Local SD	Mercer	3
Bethel Local SD	Miami	1
Bradford Ex Vill SD	Miami	4
Covington Ex Vill SD	Miami	7
Miami East Local SD	Miami	1,3,7
Milton-Union Ex Vill SD	Miami	3
Newton Local SD	Miami	7
Piqua City SD	Miami	1
Tipp City Ex Vill SD	Miami	3
Troy City SD	Miami	3
Upper Valley JVSD	Miami	2
Switzerland Of Ohio Local SD	Monroe	1,6
Brookville Local SD	Montgomery	3
Centerville City SD	Montgomery	1
Dayton City SD	Montgomery	1
Huber Heights City SD	Montgomery	1
Jefferson Township Local SD	Montgomery	1,3
Kettering City SD	Montgomery	1
Mad River Local SD	Montgomery	1
Miami Valley Career Tech JVSD	Montgomery	3
Miamisburg City SD	Montgomery	1
New Lebanon Local SD	Montgomery	3
Northmont City SD	Montgomery	1,3
Northridge Local SD	Montgomery	1
Oakwood City SD	Montgomery	1

SCHOOL DISTRICT	COUNTY	TELEPHONE COMPANY
Trotwood-Madison City SD	Montgomery	3
Valley View Local SD	Montgomery	3,L
Vandalia-Butler City SD	Montgomery	1
West Carrollton City SD	Montgomery	1
Morgan Local SD	Morgan	4
Cardington-Lincoln Local SD	Morrow	4
Highland Local SD	Morrow	4
Mount Gilead Ex Vill SD	Morrow	4
Northmor Local SD	Morrow	3
East Muskingum Local SD	Muskingum	1,3
Franklin Local SD	Muskingum	1
Maysville Local SD	Muskingum	1
Mid-East Ohio JVSD	Muskingum	1,3
Tri-Valley Local SD	Muskingum	1,4
West Muskingum Local SD	Muskingum	1,7
Zanesville City SD	Muskingum	1
Caldwell Ex Vill SD	Noble	3
Noble Local SD	Noble	3
Benton Carroll Salem Local SD	Ottawa	3
Danbury Local SD	Ottawa	3
Genoa Area Local SD	Ottawa	3
North Bass Local SD	Ottawa	**
Port Clinton City SD	Ottawa	3
Put-In-Bay Local SD	Ottawa	3
Antwerp Local SD	Paulding	3
Paulding Ex Vill SD	Paulding	7,T
Wayne Trace Local SD	Paulding	3,H
Crooksville Ex Vill SD	Perry	1,4
New Lexington City SD	Perry	1,4
Northern Local SD	Perry	1
Southern Local SD	Perry	1
Circleville City SD	Pickaway	3
Logan Elm Local SD	Pickaway	3,5
Teays Valley Local SD	Pickaway	3,*
Westfall Local SD	Pickaway	3,4
Eastern Local SD	Pike	3,Q
Pike County JVSD	Pike	3
Scioto Valley Local SD	Pike	3
Waverly City SD	Pike	3
Western Local SD	Pike	3
Aurora City SD	Portage	6
Crestwood Local SD	Portage	1,6
Field Local SD	Portage	1
James A Garfield Local SD	Portage	3
Kent City SD	Portage	1
Maplewood Area JVSD	Portage	1
Ravenna City SD	Portage	1

KEY	CODE
LARGE TELEPHONE COMPANIES	
Ameritech	1
Cincinnati Bell Telephone Company	2
GTE North, Inc.	3
United Telephone Company of Ohio	4
The Chillicothe Telephone Company	5
The Western Reserve TelCo (ALLTEL)	6
ALLTEL Ohio, Inc. (former Mid-Ohio)	7
Century Telephone Company of Ohio	8
SMALL TELEPHONE COMPANIES	
Arcadia Telephone Company	A
Ayersville Telephone Company	B
The Bascom Mutual Telephone Company, Inc.	C
The Buckland Telephone Company	D
The Champaign Telephone Company	E
Columbus Grove Telephone Company	F
The Conneaut Telephone Company	G
Continental Telephone Company	H
Doylestown Telephone Company	I
The Fort Jennings Telephone Company	J
Frontier Telephone of Michigan	K
The Germantown Independent TelCo	L
Glandorf Telephone Company	M
Kalida Telephone Company, Inc.	N
Little Miami Communications	O
The Middle Point Home TelCo	P
Minford Telephone Company	Q
New Knoxville Telephone Company	R
The Nova Telephone Company	S
The Oakwood Telephone Company [TDS]	T
The Orwell Telephone Company	U
The Ottoville Mutual Telephone Company	V
The Ridgeville Telephone Company	W
The Sherwood Mutual Telephone Association	X
Sycamore Telephone Company	Y
Telephone Service Company	Z
United Telephone Company of Indiana	AA
Vanlue Telephone Company [TDS]	BB
More Than One Listing	*
No Listing	**

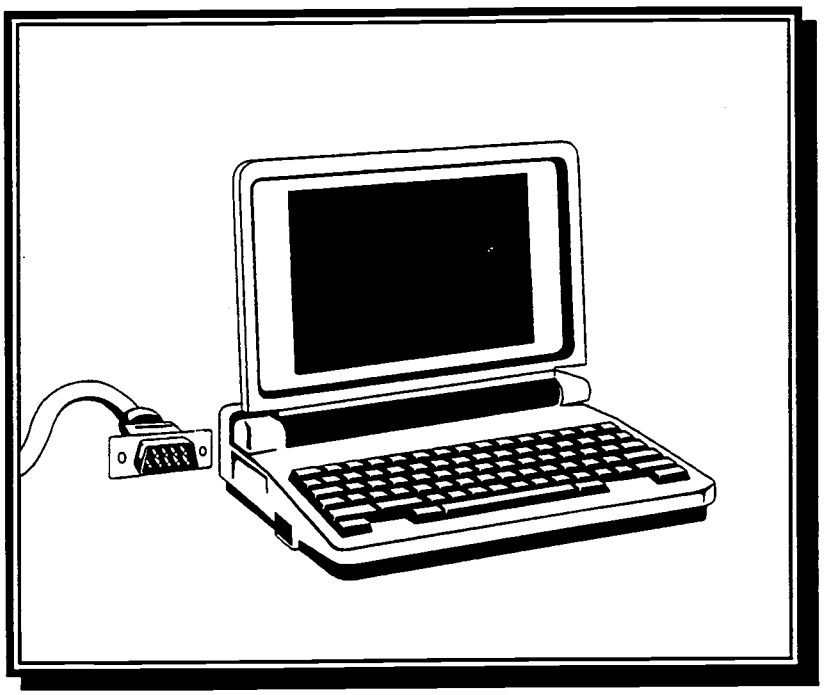
SCHOOL DISTRICT	COUNTY	TELEPHONE COMPANY
Rootstown Local SD	Portage	1
Southeast Local SD	Portage	4
Streetsboro City SD	Portage	1,6
Waterloo Local SD	Portage	1
Windham Ex Vill SD	Portage	4
C R Coblentz Local SD	Preble	4
College Corner Local SD	Preble	1
Eaton City SD	Preble	4
Preble-Shawnee Local SD	Preble	3,4
Tri-County North Local SD	Preble	3
Twin Valley Community Local SD	Preble	3
Columbus Grove Local SD	Putnam	F
Continental Local SD	Putnam	H
Jennings Local SD	Putnam	J
Kalida Local SD	Putnam	N
Leipsic Local SD	Putnam	U
Miller City-New Cleveland Local	Putnam	4,H
Ottawa-Glandorf Local SD	Putnam	4,M
Ottoville Local SD	Putnam	V
Pandora-Gilboa Local SD	Putnam	U
Clear Fork Valley Local SD	Richland	4
Crestview Local SD	Richland	3,4
Lexington Local SD	Richland	4
Lucas Local SD	Richland	4
Madison Local SD	Richland	4
Mansfield City SD	Richland	4
Ontario Local SD	Richland	4
Pioneer JVSD	Richland	4
Plymouth Local SD	Richland	3,4
Shelby City SD	Richland	4
Adena Local SD	Ross	5
Chillicothe City SD	Ross	5
Paint Valley Local SD	Ross	5
Pickaway - Ross County JVSD	Ross	5
Scioto Valley Local SD	Ross	5
Union Scioto Local SD	Ross	5
Zane Trace Local SD	Ross	5
Huntington Local SD	Ross	5
Clyde-Green Springs Ex Vill SD	Sandusky	3,4
Fremont City SD	Sandusky	1
Gibsonburg Ex Vill SD	Sandusky	3
Lakota Local SD	Sandusky	1,3,4
Vanguard-Sentinel JVSD	Sandusky	1
Woodmore Local SD	Sandusky	3,4
Bloom-Vernon Local SD	Scioto	3
Clay Local SD	Scioto	3
Green Local SD	Scioto	3
Minford Local SD	Scioto	Q
New Boston Local SD	Scioto	3
Northwest Local SD	Scioto	3
Portsmouth City SD	Scioto	3
Scioto County JVSD	Scioto	3
Valley Local SD	Scioto	3,Q
Washington - Nile Local SD	Scioto	3
Wheelersburg Local SD	Scioto	3
Bettsville Local SD	Seneca	3
Fostoria City SD	Seneca	1
Hopewell-Loudon Local SD	Seneca	C
New Riegel Local SD	Seneca	1
Old Fort Local SD	Seneca	4
Seneca East Local SD	Seneca	3
Tiffin City SD	Seneca	1,3
Anna Local SD	Shelby	4
Botkins Local SD	Shelby	4
Fairlawn Local SD	Shelby	4
Fort Loramie Local SD	Shelby	4
Hardin-Houston Local SD	Shelby	4
Jackson Center Local SD	Shelby	4
Russia Local SD	Shelby	4
Sidney City SD	Shelby	4
Alliance City SD	Stark	1
Canton City SD	Stark	1
Canton Local SD	Stark	1
Fairless Local SD	Stark	1,3
Jackson Local SD	Stark	1
Lake Local SD	Stark	1
Louisville City SD	Stark	1
Marlington Local SD	Stark	1
Massillon City SD	Stark	1
Minerva Local SD	Stark	3
North Canton City SD	Stark	1
Northwest Local SD	Stark	1
Osnaburg Local SD	Stark	1
Perry Local SD	Stark	1
Plain Local SD	Stark	1
Sandy Valley Local SD	Stark	1
Stark County Area JVSD	Stark	3
Tuslaw Local SD	Stark	1
Akron City SD	Summit	1
Barberton City SD	Summit	1
Copley-Fairlawn City SD	Summit	1,3
Coventry Local SD	Summit	1
Cuyahoga Falls City SD	Summit	1
Green Local SD	Summit	1

KEY	CODE
LARGE TELEPHONE COMPANIES	
Ameritech	1
Cincinnati Bell Telephone Company	2
GTE North, Inc.	3
United Telephone Company of Ohio	4
The Chillicothe Telephone Company	5
The Western Reserve TelCo (ALLTEL)	6
ALLTEL Ohio, Inc. (former Mid-Ohio)	7
Century Telephone Company of Ohio	8
SMALL TELEPHONE COMPANIES	
Arcadia Telephone Company	A
Ayersville Telephone Company	B
The Bascom Mutual Telephone Company, Inc.	C
The Buckland Telephone Company	D
The Champaign Telephone Company	E
Columbus Grove Telephone Company	F
The Conneaut Telephone Company	G
Continental Telephone Company	H
Doylestown Telephone Company	I
The Fort Jennings Telephone Company	J
Frontier Telephone of Michigan	K
The Germantown Independent TelCo	L
Glandorf Telephone Company	M
Kalida Telephone Company, Inc.	N
Little Miami Communications	O
The Middle Point Home TelCo	P
Minford Telephone Company	Q
New Knoxville Telephone Company	R
The Nova Telephone Company	S
The Oakwood Telephone Company [TDS]	T
The Orwell Telephone Company	U
The Ottoville Mutual Telephone Company	V
The Ridgeville Telephone Company	W
The Sherwood Mutual Telephone Association	X
Sycamore Telephone Company	Y
Telephone Service Company	Z
United Telephone Company of Indiana	AA
Vanlue Telephone Company [TDS]	BB
More Than One Listing	*
No Listing	**

SCHOOL DISTRICT	COUNTY	TELEPHONE COMPANY
Hudson Local SD	Summit	6
Manchester Local SD	Summit	1
Mogadore Local SD	Summit	1
Nordonia Hills City SD	Summit	6
Norton City SD	Summit	1
Portage Lakes JVSD	Summit	3
Revere Local SD	Summit	3,6
Springfield Local SD	Summit	1
Stow City SD	Summit	1
Tallmadge City SD	Summit	1
Twinsburg City SD	Summit	6
Woodridge Local SD	Summit	1,6
Bloomfield-Mespo Local SD	Trumbull	6,U
Bristol Local SD	Trumbull	4
Brookfield Local SD	Trumbull	1
Champion Local SD	Trumbull	4
Girard City SD	Trumbull	1
Howland Local SD	Trumbull	1,4
Hubbard Ex Vill SD	Trumbull	1
Joseph Badger Local SD	Trumbull	4
La Brae Local SD	Trumbull	4
Lakeview Local SD	Trumbull	4
Liberty Local SD	Trumbull	1
Lordstown Local SD	Trumbull	4
Maplewood Local SD	Trumbull	4
Mathews Local SD	Trumbull	1,4
McDonald Local SD	Trumbull	1
Newton Falls Ex Vill SD	Trumbull	4
Niles City SD	Trumbull	1
Southington Local SD	Trumbull	4
Trumbull County JVSD	Trumbull	4
Weathersfield Local SD	Trumbull	1
Buckeye JVSD	Tuscarawas	3
Claymont City SD	Tuscarawas	1
Dover City SD	Tuscarawas	3
Garaway Local SD	Tuscarawas	3
Indian Valley Local SD	Tuscarawas	1,3
New Philadelphia City SD	Tuscarawas	3
Newcomerstown Ex Vill SD	Tuscarawas	1
Strasburg-Franklin Local SD	Tuscarawas	3
Tuscarawas Valley Local SD	Tuscarawas	3
Fairbanks Local SD	Union	4
Marysville Ex Vill SD	Union	4
North Union Local SD	Union	3,4
Crestview Local SD	Van Wert	3
Lincolnview Local SD	Van Wert	4,H,P
Van Wert City SD	Van Wert	3,4
Vantage JVSD	Van Wert	4

SCHOOL DISTRICT	COUNTY	TELEPHONE COMPANY
Vinton County Local SD	Vinton	3
Carlisle Local SD	Warren	1
Franklin City SD	Warren	1
Kings Local SD	Warren	4
Lebanon City SD	Warren	4
Little Miami Local SD	Warren	4
Mason City SD	Warren	4
Springboro Community City SD	Warren	1
Warren County JVSD	Warren	4
Wayne Local SD	Warren	4
Belpre City SD	Washington	1
Fort Frye Local SD	Washington	3,4
Frontier Local SD	Washington	1
Marietta City SD	Washington	1
Warren Local SD	Washington	3,4,6
Washington County JVSD	Washington	1
Wolf Creek Local SD	Washington	3
North Central Local SD	Waune	3,4
Chippewa Local SD	Wayne	I
Dalton Local SD	Wayne	1,4
Green Local SD	Wayne	4
Northwestern Local SD	Wayne	3,4
Orrville City SD	Wayne	4
Rittman Ex Vill SD	Wayne	4
Southeast Local SD	Wayne	3,4
Triway Local SD	Wayne	4
Wayne County JVSD	Wayne	4
Wooster City SD	Wayne	4
Bryan City SD	Williams	3
Edgerton Local SD	Williams	3
Edon-Northwest Local SD	Williams	3,K
Millcreek-West Unity Local SD	Williams	3
Montpelier Ex Vill SD	Williams	3
North Central Local SD	Williams	3
Stryker Local SD	Williams	4
Bowling Green City SD	Wood	3
Eastwood Local SD	Wood	3,4
Elmwood Local SD	Wood	3,4
Lake Local SD	Wood	1,3,4
North Baltimore Local SD	Wood	3
Northwood Local SD	Wood	1
Otsego Local SD	Wood	3
Penta County JVSD	Wood	1
Rossford Ex Vill SD	Wood	1
Carey Ex Vill SD	Wyandot	3
Mohawk Local SD	Wyandot	Y
Upper Sandusky Ex Vill SD	Wyandot	1,4,Y

CONNECTING SCHOOLS TO ON-LINE COMPUTER SERVICES



YOUR HELP WITH THIS EFFORT IS GREATLY APPRECIATED !!!

This survey will provide us with a greater understanding of the types of on-line computer services school districts and schools receive. We ask that you take the time to answer the following questions to the best of your ability.

SCHOOL DISTRICTS

Administrative Services	
1. Does your data acquisition site (formerly A-site) provide administrative software programs to its districts?	No (skip to #5) Yes
In terms of administrative services, how would you rate the following:	
2. The speed of the services the data acquisition site provides?	Slow Adequate Fast
3. The user-friendliness of the software the data acquisition site provides?	Unfriendly Adequate Friendly
4. The technical assistance the data acquisition site staff provides?	Poor Adequate Good
Student On-line Services	
5. Does your data acquisition site **currently** provide student access to the Internet or other on-line services?	No Yes (skip to #7)
6. Will your data acquisition site provide student access to the Internet or other on-line services **in the future**?	No (skip to #10) Yes
In terms of student access to on-line services, how would you rate the following:	
7. The speed of the services the data acquisition site provides?	Slow Adequate Fast
8. The user-friendliness of the software the data acquisition site provides?	Unfriendly Adequate Friendly
9. The technical assistance the data acquisition site staff provides? **(skip to #11)**	Poor Adequate Good
10. If your data acquisition site **will not** provide student access to the Internet or other on-line services, who will provide these services to your district? (check all that apply) **(skip to #14)**	____ 1. private vendor or company ____ 2. other (please specify) _____ ____ 3. don't know

System Changes

11.	Do you anticipate increases in the number of students using your data acquisition site's computer system?	No (skip to #14) Yes
12.	Does your data acquisition site need to upgrade its computer system in order to support anticipated increases in the number of students using the system?	No (skip to #14) Yes
13.	.What type(s) of upgrade(s) do you think are necessary? (check all that apply)	____ 1. larger server to increase the speed of the system ____ 2. high speed data-transmission lines to the **district office** ____ 3. high speed data-transmission lines to **schools** in the district ____ 4. other (please specify) ____ 5. don't know
14.	The number of technical support staff in the data acquisition site currently serving your district is:	Inadequate Adequate Don't know
15.	Does your data acquisition site need to increase staff to support anticipated increases in the number of students using the system?	No (skip to #17) Yes Don't know Doesn't apply (skip to #17)
16.	What type(s) of support will the increased staffing provide? (check all that apply)	____ 1. administrative support ____ 2. student support for the Internet or other on-line services ____ 3. teacher assistance with integration of technology into the curriculum ____ 4. other (please specify) _____ ____ 5. don't know
17.	Does your data acquisition site currently provide assistance with the integration of technology into the curriculum?	No Yes Don't know

About You

18.	Your current position is:	____ 1. Superintendent ____ 2. Assistant Superintendent ____ 3. Treasurer ____ 4. Secretary ____ 5. other (please specify) _____
19.	How long have you worked with this district office?	____ year(s)

Please mail the completed survey in the enclosed stamped envelope **by March 29, 1996.**

Thank You

DATA ACQUISITION SITE

Administrative Services			
1. Does your data acquisition site provide administrative software programs to its districts?	No (skip to #5)		Yes
In terms of administrative services, how would you rate the following:			
2. The speed of the services the data acquisition site provides?	Slow	Adequate	Fast
3. The user-friendliness of the software the data acquisition site provides?	Unfriendly	Adequate	Friendly
4. The technical assistance the data acquisition site staff provides?	Poor	Adequate	Good

Student On-line Services			
5. Does your data acquisition site **currently** provide student access to the Internet or other on-line services?	No		Yes (skip to #7)
6. Will your data acquisition site provide student access to the Internet or other on-line services **in the future**?	No (skip to #11)		Yes
7. Is the software used by students to access the Internet or other on-line services text-based or graphical?	Text-based		Graphical
In terms of student access to the Internet or on-line services, how would you rate the following:			
8. The speed of the services the data acquisition site provides?	Slow	Adequate	Fast
9. The user-friendliness of the software the data acquisition site provides?	Unfriendly	Adequate	Friendly
10. The technical assistance the data acquisition site staff provides? **skip to #12**	Poor	Adequate	Good

11. If your data acquisition site **will not** provide student access to the Internet or other on-line services, who will provide these services? (check all that apply) **skip to #27**	_____ 1. private vendor or company _____ 2. other (please specify) _____ _____ 3. don't know

System Changes

12. Do you anticipate increases in the number of students using your data acquisition site's computer system?	No (skip to #17) Yes
13. Will your data acquisition site need to upgrade its computer system in order to support anticipated increases in the number of students using the system?	No (skip to #17) Yes
14. What type(s) of upgrades will be necessary? (check all that apply)	_____ 1. larger server to increase the speed of the system _____ 2. high speed data-transmission lines to the **district offices** _____ 3. high speed data-transmission lines to **schools** in the district _____ 4. other (please specify) _____ _____ 5. don't know
15. What is the estimated cost of the upgrades?	$_____ estimated cost
16. How will these upgrades be funded? (check all that apply)	_____ 1. local or district funds _____ 2. request additional state funds _____ 3. request additional federal funds _____ 4. user fees _____ 5. other (please specify) _____
17. How does your computer system compare to private sector companies offering similar **student-related on-line services**?	Less capable Equivalent More advanced Don't know

Software and Staffing

18. Will the software used by students to access the Internet or other on-line services be redesigned to make it easier to use?	No (skip to #22) Yes
19. Who will redesign the software? (check all that apply)	_____ 1. in-house _____ 2. private company _____ 3. other (please specify) _____
20. What is the estimated cost of redesigning the software?	$_____ estimated cost

21. How will this redesign effort be funded? (check all that apply)	____ 1. local or district funds ____ 2. request additional state funds ____ 3. request additional federal funds ____ 4. user fees ____ 5. other (please specify) _____
22. Will your data acquisition site need to increase staff to support an increase in the number of students using the system?	No (skip to #27) Yes Doesn't apply (skip to #27)
23. How many additional staff will be needed?	_____ person(s)
24. What is the estimated annual cost of increasing the staff?	$_____ estimated annual cost
25. How will the increase in staffing be funded? (check all that apply)	____ 1. local or district funds ____ 2. request additional state funds ____ 3. request additional federal funds ____ 4. user fees ____ 5. other (please specify) _____
26. What type(s) of support will the increased staffing provide? (check all that apply)	____ 1. administrative support ____ 2. student support for the Internet or other on-line services ____ 3. teacher assistance with integration of technology into the curriculum ____ 4. other (please specify) _____
27. What role will your data acquisition site play in supporting the integration of technology into the curriculum?	No role A small role A major role
28. How does your computer system compare to private sector companies offering similar **administrative services**?	Less capable Equivalent More advanced Don't know

About You

29. Your current position is:	____ 1. Director ____ 2. other (please specify)_____
30. How long have you worked with this data acquisition site?	____ year(s)

Please mail the completed survey in the enclosed stamped envelope **by March 29, 1996.**

Thank You

APPENDIX E
Resolution and Motion Handling for Distance Learning Equipment

For both desktop and larger group systems, the quality of the video image distinguishes good systems from poor ones. Resolution and motion handling capability are the two most important factors that affect quality. Resolution refers to the number of picture elements displayed on the screen and motion handling refers to how closely the motion taking place on the screen approximates real life movement.

Motion handling is dependent on two factors: codec maximum frame rate and digital transmission rate (or the bandwidth) used for the video conference. **Codecs** are placed at each end of a transmission line to send and receive the signal, digitize it, and then translate the signal into motion pictures. The **frame rate** is dependent on the motion taking place and is always specified as a maximum number for any vendor's codec equipment. In other words, each video system must have a codec or it will not operate. Increasing the resolution or frame rate generally requires more bandwidth.

All video signals are compressed to some degree to increase the speed of the signal moving across the network. Television broadcast signals are the least compressed. The less compressed the signal, the higher quality the picture. The following exhibit shows the specifications for resolution and maximum frame rates for video equipment manufactured by different vendors.

Index for Measuring Quality Video Equipment

Vendors	Lines (L)	Pixels (P)	Resolution L x P	Frame Rate (F)	Picture Quality Factor (L x P x F)
Home T.V.	480	512	245,760	30	7,372,800
CTX Plus	480	268	128,640	30	3,859,200
FCIF	288	352	101,376	30	3,041,280
Blue Chip 30	288	352	101,376	30	3,041,280
SG3	240	256	61,440	15	921,600
HVQ	240	256	61,440	15	921,600
CTX	240	256	61,440	15	921,600
QCIF	144	176	25,344	15	350,160
Blue Chip	288	352	101,376	10-15	1,013,760 - 1,520,640
CS-3000	240	256	61,440	10-15	614,400 - 921,600

Source: Norstan Communications.

Resolution and frame rates are hardware specifications that each manufacturer provides for its equipment. Video equipment with codecs designed to handle high frame and digital transmission rates cost more than equipment with codecs designed to handle low rates.

High bandwidth must be available to feed into video equipment with high capacity codecs or the quality of the picture will remain poor. Some experts believe the only acceptable quality for distance learning is home television quality at 30 frames per second and 480 lines by 512 pixels, which provides crisp images, and smooth and natural motions. To obtain this quality, a minimum of a T1 line is necessary.

Desktop systems will run over plain telephone lines, but without special technology, the transmission speeds are slow, resulting in very low-quality video and delayed motion. ISDN, the technology that permits high-quality video to be run over telephone lines, produces consistent video quality, and allows the system to be connected to any group system using a similar standard. Unfortunately, the availability of ISDN currently is limited to metropolitan areas.

Most desktop videoconferencing machines support data exchange between similar systems and share the applications and files of programs such as Microsoft Word, a commonly used wordprocessing package. Most offer whiteboarding, which is the ability to write on the shared file with electronic pens or highlighters. Many systems also offer the capability to capture a snapshot of the image on the screen, and some systems offer the ability to save video footage onto a disk. Most of these features only operate over a network. Similar to group systems, bridges allow users to connect to and switch between other sites.

APPENDIX F
Equipment and Costs for Four Distance Learning Systems

A list of the equipment that is required for four models of group videoconferencing systems is provided below. Model A, the least expensive system, is used for business meetings where the full range of movement is limited. The more expensive systems (models B through D) offer higher video resolution and better motion-handling capabilities; these systems could be used for distance learning. Model D is customized specifically for distance learning.

Model A

Cart Model 8300: No Monitor	$23,310
ITU-TSS H.320 - FCIF/QCIF up to 15 fps	
56 Kbps - 384 Kbps operation	
Full duplex qudio with intergrated echo cancellation	
(G.728, G.711, G.722)	
NTSC or PAL	
Self Guide user interface	
Autofocus color camera system	
Pan/tilt/zoom camera with presets	
Multipoint ready	
Picture-in-picture	
Choice of ISDN or Dual Switch 56 interface	
Remote diagnostics capability	
Portable Model 8375: Two 27" Monitors	$26,910
Includes all features listed above	
VCR with wireless remote (VHS format)	$395
Supercam document camera	$2,250
GraphiCam document Camera	$1,200
Additional microphone	$540
Installation	$1,300
Extend Warranty to One Year	$900
Shipping for 8300	$550
Shipping for 8375	$950
Total	**$58,305**

Model B

Cart Model 8400: No Monitor	$32,310
ITU-TSS H.320 - FCIF/QCIF up to 30 fps	
56 Kbps - 384 Kbps operation	
Full duplex audio with intergrated echo cancellation (G.728, G.711, G.722)	
NTSC or PAL	
Self Guide user interface	
Autofocus color camera system	
Pan/tilt/zoom camera with presets	
Multipoint-ready	
Picture-in-picture	
Choice of ISDN or Dual Switch 56 interface	
Remote diagnostics capability	
Portable Model 8475: Two 27" Monitors	$35,910
Includes all features above	
Integrated Switched 56 dual DSU (2 or 4 wire)	$900
VCR with wireless remote (VHS format)	$395
Supercam document camera	$2,250
GraphiCam document camera	$1,200
Installation	$1,300
Extend Warranty to One Year	$900
Shipping for 8400	$550
Shipping for 8475	$950
Total	**$ 76,665**

Model C

System D Model 9075-VL: Dual Monitor	$60,495
Standards Plus H.CTX & H.CTXPlus enhanced video	
TSS H.320-FCIF/QCIF up to 30 fps	
56 Kbps - 2.048 Mbps	
Full duplex audio with integrated echo cancellation	
Self Guide interface w/touchpanel, help functions	
Autofocus color camera with presets	
Multipoint ready	
32" color television monitor(s)	
Picture-in-picture	
Movable Cart	
Still and live video graphics	
Remote diagnostics capability	
Includes 90 day warranty	
VCR controlled from touchpanel	$395
Autofocus auxiliary camera with pan/tilt/zoom, presets	$3,400
SuperCam document camera	$2,125
Elmo 368 with Cable Converter	$3,475
Scan Converter with Cable	$1,695
Additional push-to-talk microphones	$680
Installation	$2,200
Extend Warranty to One Year	$2,500
Shipping for Dual Monitor System	$ 950
Total	**$77,915**

Model D: **Customized Distance Learning Classroom**

Dual Monitor	$60,765
Standards Plus H.CTX & H.CTXPlus enhanced video	
TSS H.320-FCIF/QCIF up to 30 fps	
56 Kbps - 2.048 Mbps	
Full duplex audio with integrated echo cancellation	
4 microphones (table-top, ceiling or push-to-talk)	
Self Guide interface w/touchpanel, help functions	
Autofocus color camera with presets	
Multipoint ready	
32" color television monitor(s)	
Picture-in-picture	
Movable Cart	
Still and live video graphics	
Remote diagnostics capability	
Includes 90 day warranty	
Network Interface: Rs-449/dual V.35 adapter with RS 366 dialing; or RS-449/dual X.21 adapter; or T1/RS-449 adapter	

Accessories:

1 VCR controlled from touchpanel	$395
1 Autofocus auxilliary camera with pan/tilt/zoom, prestes	$3,400
1 Teachers Podium	$ 2,350
1 Wireless Lapel microphone	$985
1 Graphic Preview Monitor JVC 9"	$495
2 27" Auxiliary Monitor	$1,275
1 Wall mount for Monitor/Aux. Camera	$1,905
Backward Compatibility (CTX mode support)	N/C
Dual RS-449 user data ports (backward compatibility)	$2,125
Elmo 368 with CAble Converter	$3,475
2 Wall Mount Speakers	$950
Scan Converter with Cable	$1,695
Smart PC Desktop Software	$225
Miscellaneous Cables/Connectors/Molding	$2,810
Installation	$2,200
Installation/Shipping Custom Room Components	$5,335
Extend Warranty to One Year	$2,500
Shipping for Dual Monitor System	$950
Total	**$ 93,835**

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APPENDIX G
Existing Distance Learning Projects

In 1991, the Ohio General Assembly began funding Tech Equity, an initiative designed to use technology such as distance learning to equalize educational opportunities for students in poor or remote rural areas. As part of this initiative, eight two-way distance learning projects were awarded a total of $1.8 million. The following table lists the projects, the amount of the Tech Equity funding grants, and a short description of each project. A description of several other distance learning projects is provided after the table.

Tech Equity Distance Learning Projects

Project	Tech Equity Funds	Description
Columbia Optic Network of Education (CONE)	$121,912	Adds two schools to the fiber optic video network.
Ansonia & Mississinawa Valley Local Schools	$80,400	Provides greater choice of courses through interactive microwave network.
McDonald Local Schools	$92,526	Provides for a fiber optic line between a rural district and Columbiana County for increase course offerings.
Huron County Public Schools Consortium	$340,257	An interactive network between four local school districts will be created to expand curriculum.
Paint Valley & Scioto Valley Schools Consortium	$64,000	To setup interactive distance learning classrooms at both schools for at-risk students. These classrooms will be linked with the Great Seal Education Network of Tomorrow in Chillicothe, Ohio.
Claymont City Schools	$112,000	Provides satellite-delivered distance learning for the high school.
Clermont County Consortium	$320,000	Installs and connects interactive video/audio labs with an Ohio Bell distance learning project.
East Cleveland City Schools	$625,000	Provides satellite-delivered distance learning for the high school.

Education-related group systems

There are other distance learning projects operating in Ohio that are designed to provide services to elementary and secondary education. Some of these facilities have also received state funding through the Tech Equity program. Several distance learning projects are described below.

The Ohio Educational Telecommunications Network Commission (OET). The 12 public-television stations that OET coordinates are very high-capacity versions of the distance learning facilities located in some schools. These 12 stations have much higher switching capabilities to broadcast their programming to many more sites across the state.

Ohio public television first provided one-way distance learning to Ohio schools in 1954 when the first noncommercial television station, WCET, opened in Cincinnati. One- and two-way distance learning is now offered by the 12 public television stations that use analog microwave technology. The Ohio Educational Telecommunications Network Consortium (formerly Ohio Educational Broadcasting Network Commission) funds and coordinates the services of these 12 public television stations.

The OET, in conjunction with ODE, the 12 Ohio Education Television Stations, and Instruction Television Corporations (ITV), also provide a service called Instructional Television, a nine-month schedule of daytime programming in the eight ITV service regions. The one-way instructional programming is leased from international, national, regional, and local production centers.

ODE and OET are also involved in other distance-learning projects using analog technology. The Satellite Educational Resources Corporation (SERC) provides two-way interactive college-credit courses in foreign languages, math, and science for rural and inner-city schools. SERC also offers professional development seminars to teachers in remote or poorly funded districts.

The Ashtabula County Interactive Television Network. This network, which uses analog technology, began operating in 1992. The network was a joint effort by four local telephone companies serving the county: Alltel Western Reserve; United Telephone; Conneaut Telephone; and Orwell Telephone.

With a dwindling student population, the Ashtabula County School District pursued interactive video because it became difficult to offer certain courses due to insufficient demand. The network consists of 10 interactive classrooms: eight high schools representing seven school districts; a joint vocational school; and Kent State University. At least two fiber optic cables connect each school to the network. Three schools serve as hubs and the remaining seven schools connect to one of these hubs. Analog technology was selected over digital because, at the time the system was created, it was the most cost effective for their needs while providing broadcast quality video.

The system allows two-way interactive audio/video for as many as four interactive (ITV) television classrooms at a time or one-way broadcast to all ten sites. The schools chose to limit the number of classrooms participating in any one subject to four sites. Four separate subjects can be taught simultaneously involving a maximum of 16 classrooms. Teachers can see and hear all of the classrooms through video cameras and a series of microphones. The network can be linked to live or preprogrammed instructional video provided by microwave, satellite, or digital fiber.

Funding to create the network came from the General Assembly, Ashtabula County Civic Development Corporation, the Ohio Department of Education, and the ten member schools. Start-up capital expenses totaled $1.2 million, with each school contributing about $20,000. Each school contributes $6,000 to the network's annual operating budget of $57,000.

The Great Seal Education Network of Tomorrow. The Great Seal network is located in Chillicothe, Ohio. The network began operating

during the 1992-1993 school year and links Ross County high schools, Pickaway-Ross Vocational Center, Pickaway County Schools serviced by the Pickaway-Ross JVSD, and Ohio University Chillicothe. A total of 11 schools are connected to the network that allows for two-way interactive video and audio to be broadcast to multiple classrooms in other schools. The host location can be any classroom within the participating schools. The network is designed for computer distance learning and connection to international computer networks.

The network cost nearly $100,000 per school, although each school contributed only about $23,500 for classroom equipment. Chillicothe Telephone Company donated the fiber optic cable to interconnect the schools and allowed free usage of the fiber for academic purposes for eight years. The estimated cost of Chillicothe Telephone's contribution is approximately $800,000. In addition to each school's contribution, other sources of funding included $640,000 in Tech Equity grants.

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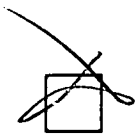

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