REPORT OF THE
DEPARTMENT OF EDUCATION

# TECHNOLOGY NEEDS OF LOCAL SCHOOL DIVISIONS AND GUIDELINES FOR TECHNOLOGY CONNECTIVITY

TO THE GOVERNOR AND
THE GENERAL ASSEMBLY OF VIRGINIA

# HOUSE DOCUMENT NO. 85

COMMONWEALTH OF VIRGINIA
RICHMOND
2000

# COMMONWEALTH *of* VIRGINIA

**DEPARTMENT OF EDUCATION**

P.O. BOX 2120

RICHMOND 23218-2120


January 19, 2000

The Honorable James S. Gilmore, III
Governor of Virginia, and
The General Assembly of Virginia
3rd Floor State Capitol Building
Richmond, Virginia 23219

Dear Governor Gilmore and Members of the General Assembly:

I am pleased to transmit the attached document, *Technology Needs of Local School Divisions and Guidelines for Technology Connectivity,* which was authorized by HJR 176 of the 1998 General Assembly.

The study assessed technology needs within the context of connectivity and developed guidelines for public schools. The Department of Education staff, in conjunction with KPMG Peat Marwick LLP, and public and private sector information technology professionals conducted the study.

Sincerely,

Jo Lynne DeMary

Jo Lynne DeMary
Acting Superintendent of Public Instruction

JLD/ADW/gjm

Enclosure

## Acknowledgments

This study was conducted by the Department of Education, in conjunction with KPMG Peat Marwick LLP, in response to House Joint Resolution No. 176, requesting the Department of Education to assess the technology needs of local school divisions and to develop guidelines for technology connectivity for the public schools. The Department of Education expresses sincere appreciation to the following individuals for their valuable ideas, insights, information, resources and contributions to this study:

The Honorable Linda T. Puller
The Senate of Virginia (effective January, 2000)

KPMG Peat Marwick LLP
Pete Koumalats, Senior Manager
David Feild, Senior Consultant

Virginia Polytechnic And State University
Pat Jackson

Bell Atlantic
James Kennedy

Cisco Systems
Bob Michie

Charlottesville City Public Schools
David Uhlig, Data Processing Coordinator

Virginia Beach City Public Schools
Robert R. Mullen, Technology Director

Virginia Department of Education
Ken Magill
Richard Layman
Lan Neugent
Edna Traylor
Anne Wescott
Bethann Canada
Jay Epperson
Greg Weisiger

Center for Innovative Technology
Anne A. Armstrong, President
Dottie Luther

Department of Technology Planning
Jerry Simonoff, Director
Diane Wresinski

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# Executive Summary

This study was conducted by the Department of Education, in conjunction with KPMG Peat Marwick LLP, and public and private sector information technology professionals, in response to House Joint Resolution No. 176. This resolution requested the Department of Education to assess the technology needs of local school divisions and develop guidelines for technology connectivity for the public schools of Virginia.

Virginia's General Assembly, recognizing that educational technology is critical to ensuring the delivery of quality public school education throughout the commonwealth, established a variety of initiatives to support educational technology. These initiatives have addressed student-to-computer ratios, supported technology resource assistants, and automated library media centers, and have provided network capabilities, administrative hardware and software replacement and retrofitting and upgrading school buildings to accommodate today's technology. Additionally, funds exceeding $49.5 million have been made available to the public schools under the provisions of the Telecommunications Act of 1996.

The Department of Education found that virtually all school divisions and more than 90 percent of Virginia's schools have Internet connections over dedicated (non-modem) circuits capable of transmitting a large volume of information at high speed. While this connectivity is still not available to all teachers within their classrooms, school divisions are continuing to install and expand these connections and other infrastructure to improve access within school buildings and position schools and school division offices to support education initiatives for the 21st century. The Department of Education, in cooperation with public and private sector technology professionals, has developed guidelines to assist school divisions in their continued efforts.

The Department of Education recommends that Virginia school divisions continue the following initiatives:

- Implement and refine their technology plans in cooperation with school boards and county and city governments,

- Follow and adapt to rapidly changing technological advancements,

- Implement infrastructure to support future technological developments in transmission of data, voice, and video,

- Implement infrastructure to support remote communications, interconnecting all school divisions and students,

- Participate to the maximum extent possible in the benefits of the E-Rate program,

- Refine compensation programs and policies to attract and retain needed technical personnel;

- Implement hardware and software systems that are scalable and provide secure Internet access for World Wide Web-based applications, and

- Improve emphasis on training of all personnel.

# Chapter 1 - Introduction

## Origin of the study

Virginia's General Assembly, recognizing that educational technology is critical to ensuring the delivery of quality public school education throughout the commonwealth, established a variety of initiatives to support educational technology. These initiatives have addressed student-to-computer ratios, supported technology resource assistants, and automated library media centers, and have provided network capabilities, administrative hardware and software replacement and retrofitting, and upgrading school buildings to accommodate today's technology.

The demands within public education for integrating technology into the curriculum, using technology to administer the public school system, and providing for informed decision-making have increased commensurately with the advancement of technology itself. The introduction of new educational technology and growing deployment of administrative systems to support education are exceeding the capacity of current network infrastructures. The General Assembly also recognized the need to assess Virginia's progress in accomplishing electronic connectivity among the public schools. House Joint Resolution No. 176 called upon the Department of Education to assess technology needs within the context of connectivity and develop guidelines for the public schools. This report is submitted in response to that request.

## Conduct of the study

The Department of Education contracted with KPMG Peat Marwick LLP for assistance in assessing Virginia's connectivity needs. KPMG surveyed all Virginia school divisions, conducted interviews with numerous stakeholders, and hosted focus group meetings throughout Virginia to receive information from division superintendents, school division technology coordinators, and other interested individuals.

Department of Education Management Information Systems (MIS) professionals, working with public and private sector information systems professionals, expanded upon the work done by KPMG to produce the guidelines included with this report. This work included numerous interviews with key industry leaders and constant monitoring of technological developments over the past two years. Because progress occurs so rapidly in the area of technology, and because school divisions deploy technology at such different rates, the Department of Education conducted an additional state-wide survey of school divisions to reflect the status of connectivity as of September, 1999. This survey was accomplished through a combination of written instruments and follow-up phone interviews with school division technology personnel.

## Study objectives and scope

This study was designed to achieve the following objectives:

1. assess the current status of connectivity in the public schools,

2. identify issues relating to public school connectivity, and

3. develop guidelines that may assist the public schools with electronic connectivity.

## Organization of the report

This report contains two additional chapters providing the Department of Education's findings and recommendations. Connectivity guidelines and results of the fall 1999 survey of school divisions are included as appendices to this report.

# Chapter 2 - Findings

**Status of current technology and connectivity in the public schools**

With the support of funds provided by the General Assembly and money made available under provisions of the Telecommunications Act of 1996 (E-Rate), Virginia's school divisions are deploying the technology necessary to create a connectivity infrastructure to support education initiatives for the 21st century. The Department of Education found that:

1. With more than $200 million provided by the General Assembly to support educational technology, school divisions are continuing to procure and deploy classroom computers, local and wide area networks, instructional software and other equipment in support of their local technology plans.

2. All but two of Virginia's school divisions applied for E-Rate funding during the first year of the initiative. All but 12 applicants were approved for support ranging from $25 to $400 per student. Currently, the discounts provided by the E-Rate program are being applied to various telecommunication and Internet access services throughout Virginia. In two years, this program has generated savings of more than $49.5 million to Virginia's public schools.

3. All Virginia school divisions have Internet capability via dial-up modem connection. Virtually all school divisions and more than 97 percent of Virginia's schools have Internet connections over dedicated (non-modem) circuits capable of moving larger volumes of information at higher speeds than is possible with modem connections. While this connectivity is still not available to all students within their classrooms, school divisions are continuing their installation and expansion of these connections to improve access within school buildings.

4. All school divisions have approved technology implementation plans on file with the Department of Education. Technology expenditures associated with funds administered by the Department of Education are reviewed and approved in accordance with these plans. School divisions update these plans annually. Most technology plans of school divisions are developed in cooperation with, and approved by, local boards of education. In localities where resources are shared (e.g. mainframe computers), school divisions' plans typically are integrated with county and city government technology plans.

5. School divisions continue to identify training, recruiting and retaining technical personnel, and the associated costs of procuring, deploying, and maintaining computer systems as barriers to the full potential of technology's promise.

**Current initiatives impacting technology and connectivity**

Since passage of House Joint Resolution No. 176, the General Assembly approved creation of the position, Secretary of Technology and the Council on Technology Services (COTS). The Department of Education is represented on the council and continues to work with the state's technology leaders in technology planning for the commonwealth at-large. This planning inevitably will affect the public schools and school division personnel are briefed regularly on developments that may have an impact on their local planning efforts.

As the physical structure of Virginia's connectivity is being installed, the Department of Education is seeking to improve the way in which that structure is used. Upgrading of the Department's public education network is scheduled for late November 1999. This upgrade will provide an Internet-based method of communicating with local school divisions, and position the Department to improve network communication with schools and school division offices. The Department's Management Information Systems (MIS) office is beginning work to convert all education data collection activities to the Internet.

Critical to the successful implementation of automated reporting is the development of standards for collecting and maintaining data. A new data administration unit within MIS has begun work on developing data standards. This initiative is expected to reflect standards developed by the Council of Chief State School Officers (CCSSO) in cooperation with the National Center on Education Statistics (NCES).

The Department of Education's Technology Division is working with the Virginia Society for Technology in Education (VSTE) to develop joint strategies for making the Internet's best resources and capabilities available to classroom teachers. It is anticipated that these instructional resources will be correlated with Virginia's Standards of Learning.

# Chapter 3 - Recommendations

Virginia's fundamental goal should be to develop a suitable network infrastructure that will support current and future technology applications. Such a system will provide the foundation for improved student learning, better service to the education community, and improved decision-making and greater efficiency in school administration. This infrastructure must harness the current value and potential of the Internet and World Wide Web for Virginia, its schools and its students, to remain competitive in our global society.

"It (the Internet) is the most transforming technological development since the Industrial Revolution" -Governor James S. Gilmore, November 9, 1999.

The Department of Education recommends that Virginia school divisions continue the following initiatives:

- Implement and refine school division technology plans in cooperation with boards of education and county and city governments,
- Follow and adapt to rapidly changing technological advancements,
- Implement infrastructure to support future technological developments in transmission of data, voice, and video,
- Implement infrastructure to support remote communications, interconnecting all school divisions and students,
- Participate to the maximum extent possible in the benefits of the E-Rate program,
- Refine compensation programs and policies to attract and retain needed technical personnel,
- Implement hardware and software systems that are scalable and provide secure Internet access for World Wide Web-based applications, and
- Improve emphasis on training of all school division personnel.

## Appendix A - Guidelines for Connectivity in Virginia's Public Schools

VIRGINIA DEPARTMENT OF EDUCATION

# Guidelines for Connectivity

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# 1 Document Overview

## 1.1 Background and Objectives

The purpose of this document is to assist the Virginia Department of Education and Virginia school divisions in making decisions to move forward with network architectures which will support the ever-increasing technology needs of Virginia's students, its community of educators, and the public.

The demands within public education for integration of technology into the curriculum and the use of technology for business applications and informed decision-making have increased commensurately with advancements and developments in technology itself. Educators and administrators are struggling with the problem of how to apply technology that is continually moving forward, how to plan for future technology and at the same time to educate Virginia's students to meet the changing demands of society, business, and education itself.

The introduction of new educational technology, expansion of existing educational technology, and/or the replacement of old administrative applications are placing demands that will exceed the capacity of current network infrastructures. How to build a network infrastructure which meets the current and future requirements of Virginia's schools is a matter of concern for the Virginia Department of Education and school divisions.

Thus, the major objective of this document is to provide the guidelines for constructing an infrastructure to meet technology requirements of projected applications. The components suggested in this document are contained within the technical infrastructure of the schools, school divisions, and the Virginia Department of Education, comprising a virtual education network for Virginia. Applying the strategic use of this virtual statewide network will facilitate technology applications such as:

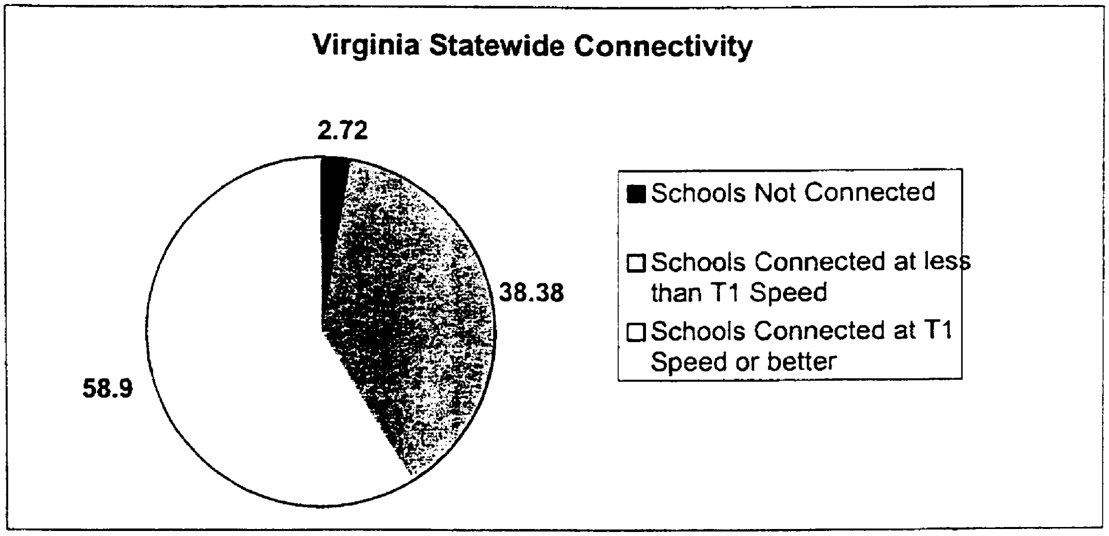
- Student Information Systems
  *Attendance, Grade Reporting, Scheduling*
- Business/Financial Systems
  *Payroll, Budget, Revenue and Expenditure Reporting*
- Access to the Internet
  *Research, Instructional Support, Parental Involvement, Personnel Recruiting, Information Dissemination*
- Distance learning
  *Statewide Availability of Specialized Courses*
- Voice applications
  *IP Telephony, Conference Calls, Ad-hoc Meetings*

As school divisions implement infrastructure and systems to meet their individual needs, they should remain aware of the developing enterprise architecture for the Commonwealth of Virginia. Under the leadership of the Secretary of Technology, Council on Technology Services, and Department of Technology Planning we may expect to see continued updating of connectivity guidelines and system architecture recommendations. The Department of Education expects to update its plan and recommendations on a periodic basis to reflect these future developments.

# 2 Connectivity in Virginia Schools

The KPMG Virginia school division survey of 1998 indicated that a variety of hardware and software are used to support administrative and instructional technology needs across the Commonwealth. The hardware/software environment ranges from single stand-alone administrative and instructional applications on personal computers, to networked client-server based systems, to extensive mainframe environments. The survey further showed that 60 – 70 percent of the school divisions have some kind of data network connectivity. Ninety percent of those divisions have connectivity at 56k or higher.

One year later, a Department of Education survey indicated that virtually all school divisions and over 90 percent of Virginia's schools have connectivity to the Internet over dedicated (non-modem) circuits. Of these schools, almost 60 percent have connectivity at T1 speeds or better. Ninety four percent of the connected schools receive their service via a division or local Wide Area Network. This rapid increase in connectivity from one year to the next is likely the result of significant state funding for school building infrastructure as well as discounts from the federal E-rate program.




• Figure 1 – Connectivity to the Internet (1999)

## 2.1 New Client/Server Applications

Not unlike other industries, educational systems are faced with the problem of limited resources to maintain out-of-date applications. The solution promoted widely by industries is to replace the older applications with new client/server applications that have expanded features to meet organizational requirements. The solution capitalizes on the processing capabilities of the client, normally a personal computer, for graphics (GUI) presentation and some business logic. The intention is to promote ease of use via its GUI presentation and provide flexibility through its ability to adapt processing logic to changing business requirements. The server side of a client/server architecture contains the bulk of the business logic and all the database functionality.

The solution is also intended to reduce costs associated with maintenance since it is perceived that skills required for maintaining client/server systems are much more abundant than the skills required for the use of older systems. However, factors such as economic expansion, the Y2K issue, and the search for competitive advantage have caused industries to upgrade or replace applications. These factors have drained a large pool of technically skilled talent from public sector positions to private industry.

The introduction of client/server computing has placed major emphasis on network connectivity. Since client/server applications produce heavier network traffic requirements as compared to their predecessor applications, there is a much greater dependence on the network. This dependence has caused network architectures and speeds to change at a rapid pace. Thus, specialized connectivity options are required to meet the application bandwidth demands. Specialized skills are required to design and manage today's networks. In addition, specialized hardware and software management platforms are required to support today's networks effectively.

### 2.1.1 Student Information Systems

Over eighty Virginia school divisions representing 800 schools use the DOS-based software called "The School System" (TSS) at one or more schools. This system is primarily used for tracking and reporting student-related information such as attendance and grades, as well as for applications such as scheduling. The 1999 Legislature appropriated $14 million in bonds to assist school divisions in replacing outdated student information systems such as TSS.

The architectures of two popular Student Information Systems that could possibly be selected as replacements by Virginia school divisions were reviewed by KPMG. In both cases, the systems were primarily a 2-tiered client/server based model – meaning the database and business logic functions were on the same server. The current trend for client/server architectures is 3-tier involving separate database and application servers. Information from the software manufacturers was not available at the time of this report to determine if newer versions of their applications were being designed for 3-tiered computing.

The advantages to the 3-tier architecture are the following:

- Increased response-time or throughput
  - Server processor cycles and memory are dedicated to either database or application functions, as opposed to a single server having to manage the contention for its shared resources.
  - Network traffic is decreased by reducing the application's communication logic between the client and server. (See Figure 2)
  - Less dependence on workstation processing power by moving the bulk of the application code to the application server.

➢ Management of application updates is reduced
  - Fewer resources are required to update the client workstation since most of the code is on the application server.
  - Application functions are segmented into modules – thereby, allowing code updates or features to be implemented more efficiently than in earlier client/server architectures.

Studies by KPMG have concluded that 3-tier client/sever architecture requires 6–8 Kbps per user during a session. A typical 2-tier client/server architecture requires up to 28 kbps per user during a session.

Figure 2 below, provided by KPMG's Enterprise Infrastructure practice, compares the impact on the network of 25 and 100 concurrent users.

| | Bandwidth Usage by Number of Concurrent User Sessions In ( Kbps) | | | | |
|---|---|---|---|---|---|
| | 1 User | | 25 Users | | 100 Users |
| Client/Server Model | | | | | |
| 2-Tiered | 28 | | 700 | | 2800 |
| | | | | | |
| 3-Tiered | 8 | | 200 | | 800 |

• **Figure 2 - KPMG Enterprise Infrastructure Practice**

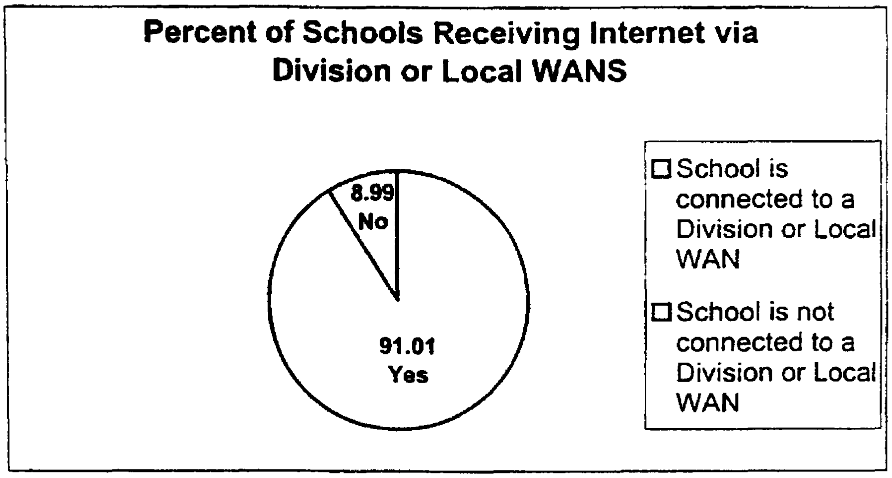
## 2.1.2 Other Business Applications

Virginia schools and school divisions use a variety of software packages for business functions such as General Ledger, Accounts Payable, Payroll and Human Resources. Given that replacement of these applications may also take place, school divisions will need to prepare a network infrastructure to meet the requirements of these applications as well. The infrastructure requirements of the new business applications will be similar to that of the SIS applications since most new systems will utilize some type of client/server architecture. Thus, infrastructure components such as workstations, servers, network devices, and cabling will likely be shared across all applications, including the Student Information System.

## 2.2 Expanded Internet Access

Educators are utilizing the Internet in new and dramatic ways to help students solve problems, conduct research, and communicate with others. Making the Internet accessible to students, teachers, and administrators is a critical need in all Virginia schools.

As stated previously the majority of Virginia schools have a dedicated connection to the Internet. Of these, approximately 450 public schools have dedicated connections to the statewide network known as Network Virginia, which provides, as one of its services, Internet access. Internet access via a WAN can be obtained if a school has a circuit, proper network devices, and routes established to another school connected to Network Virginia or another Internet Service Provider (ISP).




• Figure 3- Schools Receiving Internet via WAN (1999)

The practice of intra-connecting to another institution or entity to gain Internet access is performed by VDOE. The VDOE provides a third-party connection to the State Council on Higher Education (SCHEV). This connection uses Network Virginia to gain access to the Internet.

VDOE's Internet connection coupled with Virginia's Public Education Network (VA.PEN) provides free Internet access via dial-up as well as e-mail accounts to a large number of Virginia's public educators. VA.PEN is accessed via local dial-up in 89 locations across the Commonwealth and serves approximately 12,000 users. Most of VA.PEN's dial-up components exist within the Virginia Department of Health's network infrastructure.

Network bandwidth requirements depend on the type of application being used as well as the number of users at any given time. Intranet or Internet applications that primarily provide field updates similar to legacy on-line applications require 3-5 Kbps per user session. Constant web browsing can generally take 20-25Kbps per user session. Bandwidth requirements for browsing depend on the available bandwidth of the smallest circuit in the path to the Internet. For example, if a high school has a T1 connection to Internet and the session originated from a student in another school that is connected via a 56K circuit to the high school, then the user's session-load could be 56Kbps or all of the available bandwidth of the circuit. If the session originated directly from a student at the high school, then the user's maximum session-load could be 1.5Mbps or all of the bandwidth of the T1 circuit.

Newer network applications such as IP Telephony (voice over the network) and network video delivery are even more bandwidth intensive than web browsing, requiring high speed connections, additional resources and monitoring.

### 2.2.1 Two-Way Distance Learning

Community colleges and institutions of higher education in Virginia are currently employing two-way distance learning to enhance general classroom instruction, provide cost-effective access to specialized instruction, train staff, and hold ad-hoc meetings.

Network Virginia manages the network infrastructure that connects these institutions. The success and benefits gained from the use of this technology has prompted many educators and administrators in Virginia to promote its deployment statewide. The creation of two-way distance learning capabilities for Virginia's public schools requires a high bandwidth infrastructure that can also guarantee a certain quality of service for video applications.

Currently, the Network Virginia backbone utilizes ATM (Asynchronous Transfer Mode) switches that require end-point hardware (also ATM switches) at each location. The ATM switches communicate via SVCs (Switched Virtual Circuits) as opposed to PVCs (Permanent Virtual Circuits). PVCs were required until recently and were used since the network's inception. However, SVCs have become more stable while PVC's have become more burdensome due to PVC administration and its wasteful nature of allocating bandwidth. Thus, the evolution of ATM technology has, on its own, caused changes to the requirements for the specialized high-speed network devices.

Establishing two-way distance learning requires specialized equipment within each end point location - video servers, cameras, TVs, and personnel to support the video systems. In addition, connection to an MCU (Multipoint Conferencing Unit) is required to participate in broadcasts of distance learning sessions (point to multipoint). Virginia Tech, with the assistance of a grant from Bell Atlantic, has purchased an MCU for use by K-12 education. The Virginia Community College System also employs an MCU to broadcast its classes to other sites. Point-to-point distance learning sessions do not require the use of an MCU.

# 3 Infrastructure Requirements Summary

Virginia's fundamental goal should be to develop a suitable network infrastructure which will support future applications, enabling these applications to be more efficient, and providing better service to students and education professionals throughout the commonwealth. Features of the infrastructure foundation should include:

- Local data communications infrastructure, allowing reliable and manageable access to local resources
- Remote communications infrastructure, interconnecting all school divisions and students
- Secure Internet access for World Wide Web-based applications
- Scalability for future application requirements
- Ability to integrate with <u>video</u> systems, as appropriate
- Ability to integrate with <u>voice</u> systems, as appropriate

# 4 Architectural Guidelines and Models for School Connectivity

This section of the report contains general guidelines or minimal requirements for Virginia's schools and school divisions as they upgrade their information technology infrastructure over the next few years. Recommendations are made in the following areas:

- Facilities
- Local Area Networks
- Wide Area Networks
- OSI Protocols
- Computing Platforms
- Infrastructure Management

The connectivity recommendations and guidelines described below are only suggestions for use by the Department of Education and school divisions as they move forward with information technology initiatives. They are not intended to be interpreted as statewide standards.

Several general rules should be kept in mind as Virginia school divisions make investments in the various IT infrastructure components. These rules include:

- Networks must be **modular** to accommodate growth and change. The implementation of technology components should not hamper the implementation of future infrastructure. In addition, new technology components should be able to leverage the current technical infrastructure and grow with future computing demands.

- In moving forward, schools should consider networking technology that is at least 6 – 10 months proven in the market. Though Virginia students must have the best available tools to support them, availability and support are far more important than having the absolute latest technology.

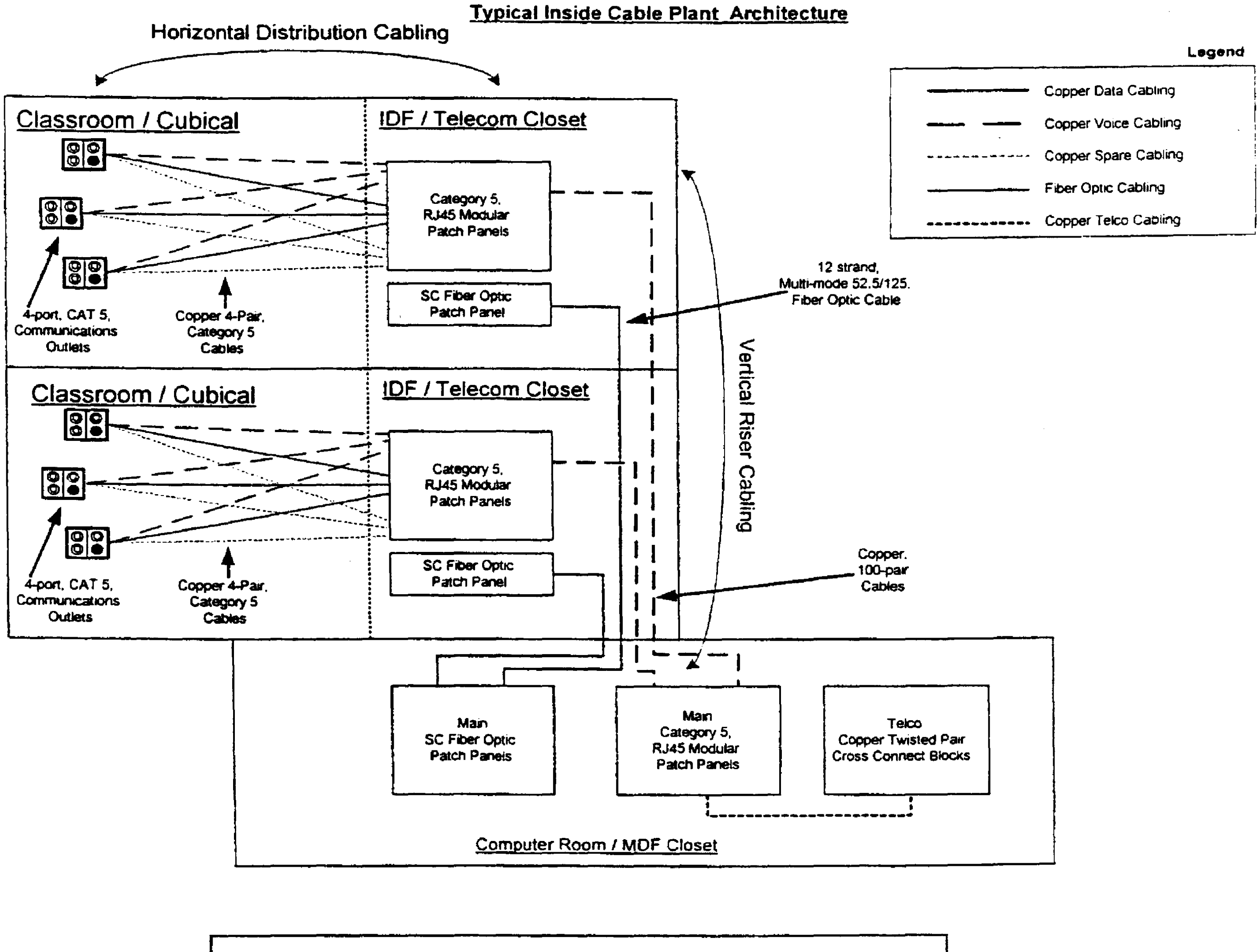
## 4.1 Facilities

Facilities can be characterized as the most basic building blocks, which support all of the other infrastructure components. These building blocks include copper and fiber optic cabling and building environmentals. New cabling implementations should be designed with a 5 –7 year life span in mind.

### 4.1.1 Inside Plant Cabling

Inside plant cabling can simply be described as all of the cabling within a building. It generally includes two separate cabling systems, which are interconnected with telecommunications or wiring closets. Horizontal Distribution can be described as all of the cabling traversing a building horizontally, which interconnects the individual user devices (e.g., workstation, telephone, etc.) to a telecommunications closet. Vertical Riser cabling can be described as all of the cabling traversing a building vertically, interconnecting all of the telecommunications closets within a building. Small locations may not require Vertical Riser cabling, or more than one telecommunications closet.

The interconnection closets are typically described as either the Main Distribution Frame (MDF) Closet, or an Intermediate Distribution Frame (IDF) Closet. There is typically a single MDF Closet per building, which is the point from which all Vertical Riser cabling emanates to all other IDF Closets. There are typically one or more IDF Closets throughout larger buildings, generally one per floor. IDF Closets serve as the interconnection point between Horizontal Distribution cabling and Vertical Riser cabling. Telecommunications electronics (e.g., LAN hubs/switches/routers, Voice PBXs, etc.) are also typically located within MDF and IDF closets. Small schools or Administration Buildings may utilize a single telecommunications closet for the combined functionality of IDF and MDF. Figure 4 depicts a typical inside plant cabling system.




• Figure 4 - Inside Cable Plant

The following connectivity guidelines should be followed for Inside Plant Cabling Facilities:

- Cabling should conform to EIA Standard 568 A/B Specifications, which is almost universally considered "the standard" to follow. This standard specifies cable plant which is application generic, in that it is suitable for most voice, video, and data applications.

- Where financially and physically feasible, spare cable runs should be employed for redundancy purposes.

- Horizontal Distribution cabling should be architected as a "physical star" between the IDF Closet, and each of the associated communications outlet receptacles where devices (e.g., workstations, network printers, telephones, etc.) will be located.

- Horizontal Distribution cabling should be copper twisted pair (Category 5), and each device should utilize a separate cable.

- Horizontal Distribution cabling should be semi–permanently terminated on both ends, to provide effective cable management. Modular patch panels and/or cross-connect devices should be used in the IDF Closets, and modular communications outlet receptacles should be used at the device locations.

- Vertical Riser cabling should be architected as a "physical star" between the MDF Closet and each of the IDF Closets.

- Vertical Riser cabling should be copper twisted pair for current voice applications, and fiber optic for data, video, and potential future voice applications.

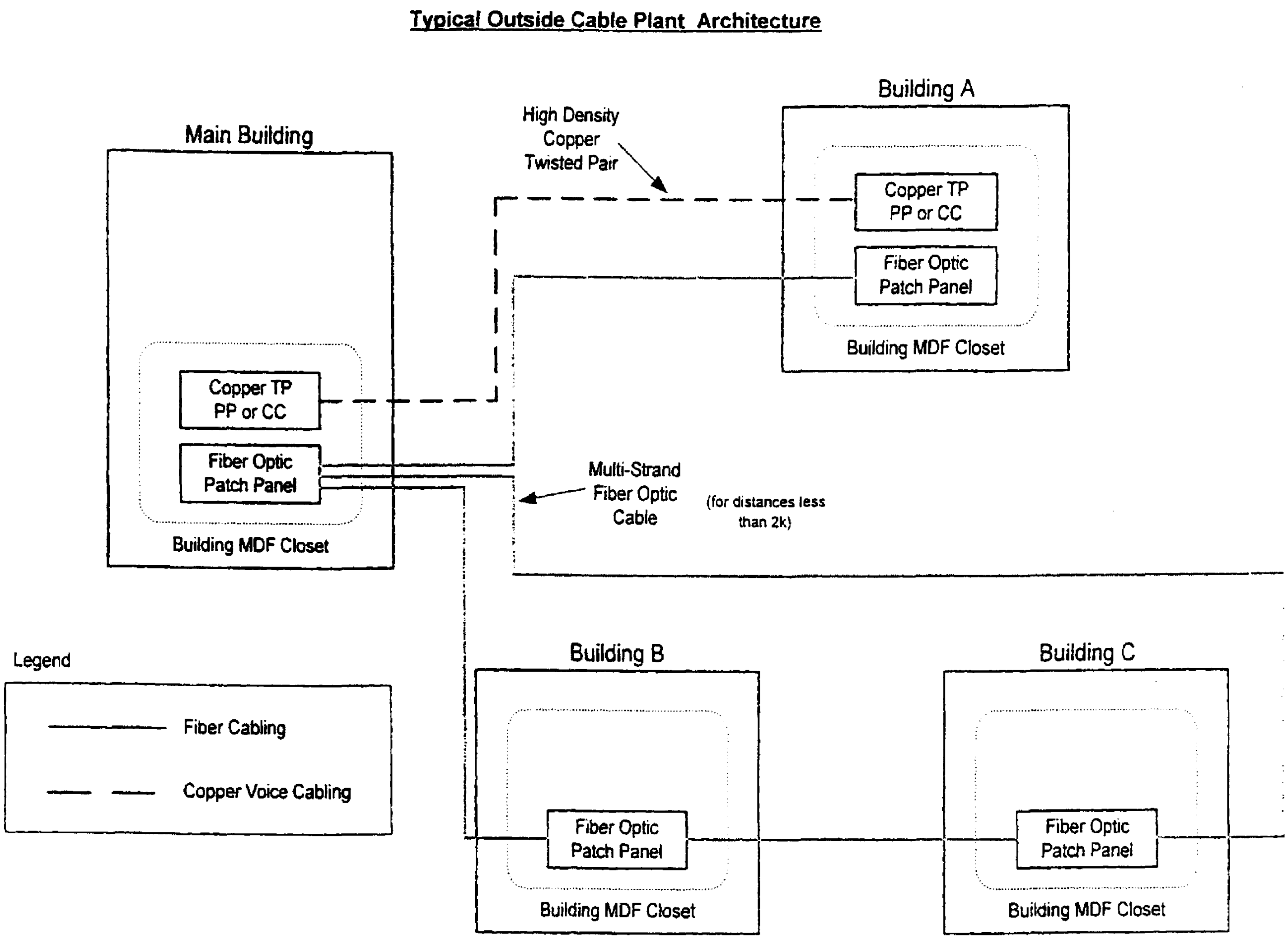
- Vertical Riser cabling should be semi–permanently terminated on both ends using modular patch panels and/or cross–connect devices, to provide effective cable management.

- For CATV distribution, copper coaxial cabling may be required for both the Horizontal Distribution and Vertical Riser.

- Fiber Optic cabling should conform to 62.5/125 microns multi-mode standard for distances under 2 kilometers.

## 4.1.2 Outside Plant Cabling

Outside plant cabling can simply be described as all of the cabling exterior to a building, generally used to interconnect buildings which are adjacent or in a multi–building campus. Outside plant cabling presents specialized requirements due to the harsh environment (e.g., extreme temperature, water-filled conduits, electrical surge suppression, backhoe encounters, aerial lashing, etc.). Outside plant cabling extends into the building, typically terminating in the main telecommunications (MDF) closet. Figure 5 depicts a typical outside cable plant.




• Figure 5 – Outside Cable Plant

The following connectivity recommendations should be followed for Outside Plant Cabling Facilities:

- School divisions should implement outside plant cabling under the following conditions:

  - Costs to install and maintain cabling and required electronics is less than the costs to procure the associated services
  - Bandwidth or service requirements are so large or customized that appropriate services are not available
  - Significant redundancy requirements

- School divisions should attempt to leverage the existing networks (e.g., schools, cities, counties, etc.) and CATV facilities when possible. If these organizations have fiber optic cable plant which traverses between school locations, and they are willing to provide "dark fiber" to the schools, then it may be advantageous to utilize these resources.

- Fiber-optics should generally be used for outside plant cabling (as opposed to copper) due to the virtually unlimited bandwidth potential, support for nearly all applications, and immunity to electrical surge and interference.

- Copper twisted pair cabling may be utilized for the distribution of analog or digital voice, or for delivered carrier services (e.g., voice and data circuits), but should have both the proper surge suppression and shielding installed, as required.

- Coaxial cabling may be utilized for delivered services (e.g., CATV, DS–3 circuit from a carrier), but should have the proper surge suppression installed.

- Fiber-optic cabling should conform to 62.5/125 microns multi-mode standard for distances under two kilometers. Single mode fiber should be used for distances greater than two kilometers.

- Where financially and physically feasible, spare cable runs should be employed for redundancy purposes. Fiber-optic cable should have allotted, at a minimum, 25 percent spare strands.

### 4.1.3 Environmentals

In addition to the connectivity guidelines listed above, school divisions should be aware of certain environmental considerations. Without the proper consideration and attention to environmental conditions, even the most well designed infrastructure can be easily compromised. All components, which provide a critical school business function, should be located in a suitable environment. Environmental considerations include HVAC (heating and cooling), power conditioning, space, and cleanliness.

The type and extent of environmental consideration given to a particular network component is directly related to the impact on the school or school division should that component fail or be compromised. The bigger the impact, the more worthwhile the expense on environmental requirements. The actual cost of the impact may vary between organizations, since each will have different priorities. Impact costs can be measured in the following ways:

- $ Direct cost of replacing failed equipment
- $ Direct cost of lost school data (e.g., attendance, grades, test scores, etc.)
- $ Indirect cost of adverse publicity

#### 4.1.3.1 *Power*

- Under most circumstances, computer and network equipment should not be plugged into switched electrical outlets. Many network problems have been resolved when it has been found that conscientious employees were turning out the lights (and the equipment) at the end of the day.

- To alleviate the impact of loss of primary electrical power fluctuations, uninterruptible power supply (UPS) equipment with power conditions should be used. UPS systems come in an extremely wide range of capabilities, from a personal system for a single workstation, to very large systems for entire data centers. Backup power can be provided from an alternate primary source, standby generator, or battery. A UPS will automatically switch to the next available power source in a matter of electrical cycles, thereby prohibiting a failure of the protected devices.

- UPS should be installed for any new file or application servers. Schools may also use UPS for voice systems. Minimally, 30 minutes of battery backup should be provioed for these systems, which should be enough to allow for an orderly shutdown in the event of an extended power loss. Ideally, an alternative power source or a standby generator can be utilized for longer-term power outages of isolated, critical systems.

- UPS should also be included for all primary LAN communications equipment, including WAN routers, core switches, and hubs. This will prevent unnecessary network outages due to brief power outages (causing equipment re–boot), and will enhance the orderly shutdown of hosts and servers when necessary. Fifteen minutes of battery backup is generally sufficient.

#### 4.1.3.2 *Surge Suppression*

- Surge suppression devices should be dedicated to the network and computer equipment they protect. Extra outlets should not be used for pencil sharpeners, vacuum cleaners and copiers.

- Schools should utilize electrical surge suppression devices on all sensitive electronics to reduce the cost of repair or replacement of its technology investment. This minimally includes all workstations and monitors. Printers are less prone to electrical surge damage, although it is a good idea to include these as well. Not all surge suppressors are alike, or perform equally, and commercial-grade surge suppressors should be used. Some manufacturers will provide a guarantee to replace damaged equipment protected by their surge suppressors.

- Electrical surge suppression should be installed on all copper plant cabling (e.g., analog phone lines for fax and modem, DID and DOD, analog and digital data circuits, CATV, etc.), at the demarcation point inside the building.

#### *4.1.3.3 Heating/Cooling*

- Infrastructure electronics (e.g., servers, switches, routers, etc.) have strict tolerances for operating temperature, both hot and cold. Infrastructure electronics should only be operated in an environment with the proper ventilation, cooling and/or heating systems. Manufacturers generally specify the proper operating temperatures, the BTU heat output, and ventilation requirements. This information should be taken into account to ensure that new installations do not overload existing HVAC systems, and that sealed closets or rooms without ventilation are not used.

#### *4.1.3.4 Cleanliness/Space*

- Although both the cleanliness and aesthetics of the infrastructure environment would seem somewhat trivial, they can have a major impact on both reliability and time for repair. Most electronic devices have cooling fans that can fail due to excessively dusty or dirty environments. Sharing IDF closets with janitor's supplies is also bad practice, as corrosive chemicals, mop handles, and the storage of boxes on top of ventilation holes can cause significant damage. Additionally, a planned, organized, orderly, aesthetically pleasing installation is far easier to troubleshoot and repair. This is especially true of cabling installations, where cable management devices and color-coded cables can help tremendously.

- Adequate space should be provided for any repair technician or technologist to gain easy access to network electronics and servers. Racks and cabinets should be utilized whenever possible.

#### *4.1.3.5 Physical Security*

- All of the infrastructure components should generally be secured from anyone other than those directly responsible for support. This includes keeping hosts and servers in a locked, limited-access computer area, and locked IDF and MDF closets. A single person with unrestricted access to a single component can inadvertently cause widespread outages, lost computing/instructional time, lost revenue, unlawful access to data, or potential lawsuits. Problems resulting from inadequate security measures at a particular school could affect the entire school and the school division.

## 4.2 Local Area Networks (LAN)

Local Area Networks are the data communications conduits within the confines of a building or campus. LANs are generally comprised of hubs, switches, and/or routers used to provide interface connections for devices (servers, workstations, etc.). LAN components, and the associated devices, are all interconnected via the physical infrastructure cabling within the confines of a building or campus. The interconnection of multiple LANs via a WAN, is referred to as an Enterprise Network.

The following connectivity recommendations and standards may be adopted for Local Area Networks:

- Ethernet should be the communication medium throughout the LAN. Ethernet is recommended for the following reasons:

  - ➢ Ethernet is a defacto industry standard. Many devices are sold standard with Ethernet interfaces.
  - ➢ Overall network design using Ethernet is relatively easy due to the simple nature of the technology.
  - ➢ Ethernet supports a wide range of "speeds and feeds".
  - ➢ An enormous number of Ethernet products are available.
  - ➢ Ethernet products generally represent the least expensive of all alternatives.
  - ➢ Almost all manufacturers develop Ethernet products first.
  - ➢ There is a high probability of future product enhancements using Ethernet.

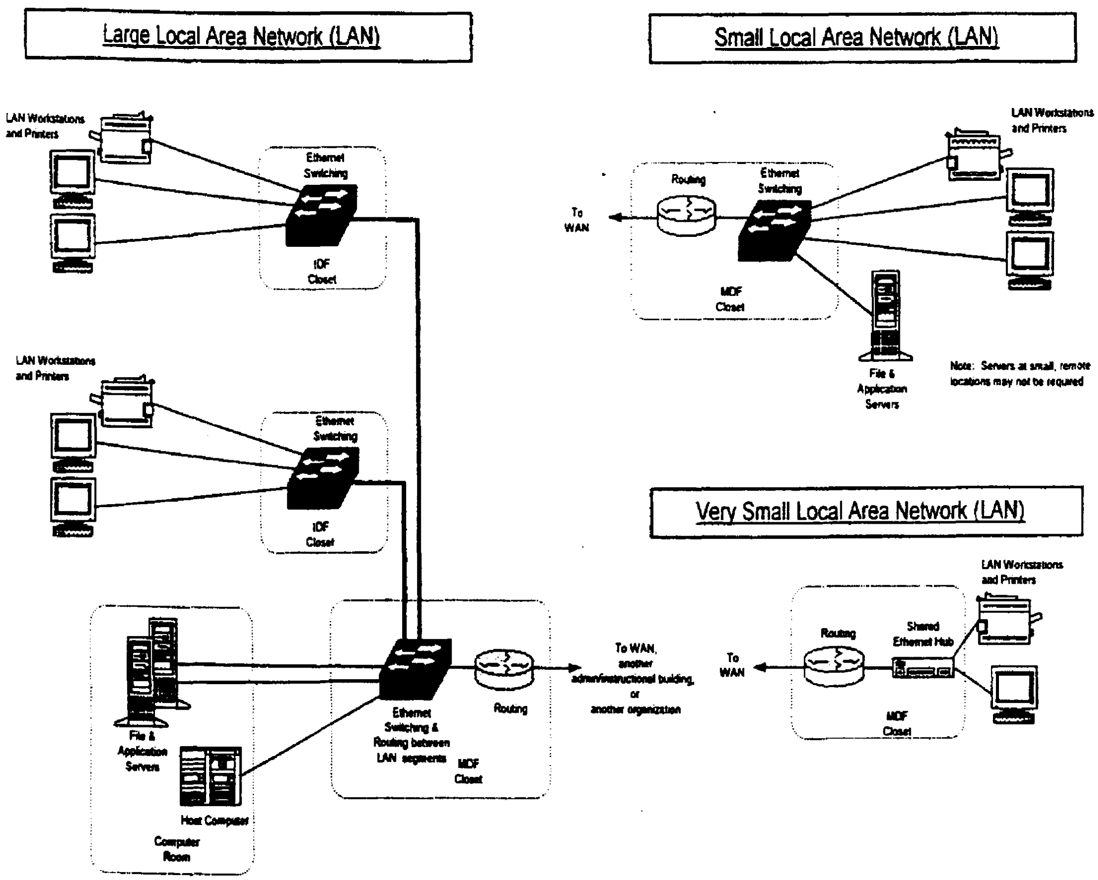
- Ethernet switching (10/100 autosense) should be used for every device that connects to the LAN. Ethernet switching provides a fast, lean environment and provides scalability for future bandwidth increases.

- Shared hubs should only be considered as a more economical solution for very small locations. Shared hubs also can be connected to a large Ethernet switch so several (1 – 4) low bandwidth consuming workstations can share one port on the switch.

- OSI Layer 3 routing services provide network isolation between organizations and may be used as a traffic control within the LAN, as needed.

Figure 6 depicts typical Local Area Networks for large, small, and very small sites (schools).

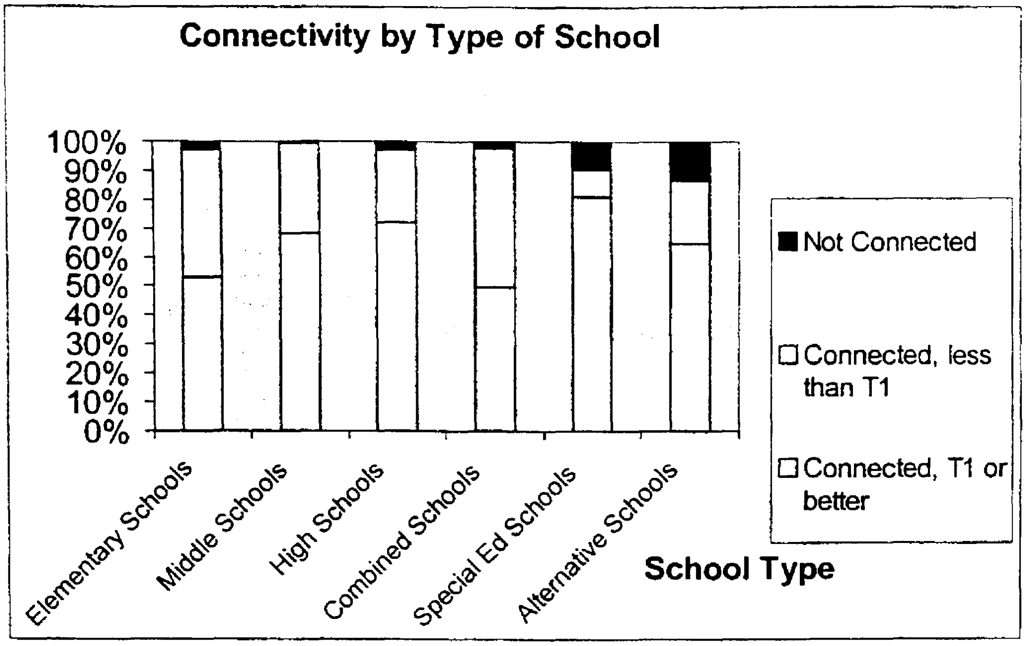
**Typical Local Area Network (LAN) Architecture**




• **Figure 6 – Typical LANs**

## 4.3 Phase I: Developing Wide Area Networks (WAN) for Data-Only Applications

This section provides guidelines for the first phase of Wide Area Network (WAN) connectivity: meeting the requirements for access to data-only applications such as Student Information Systems, Business Applications, and the Internet. In addition, this section provides the basis for moving to Phase II (WAN : Distance Learning and other ATM applications) by use of the same core infrastructure components. Planning well for Phase I will enable school divisions to progress into Phase II with fewer problems and less expense.




• Figure 7 – Connectivity by School Type

Wide Area Networks are the data communications conduits between distant buildings, where it is impractical to use outside plant cabling, as described previously. WANs are generally comprised of routers, switches, and/or communications servers utilized to provide interface connections for telecommunications services (circuits from public carriers). WAN architecture will also take into consideration the potential integration of the Internet and provide for the ability of remote access.

The following connectivity recommendations may be adopted for Wide Area Networks:

- School divisions should plan to move to ATM (Asynchronous Transfer Mode) as the WAN protocol of choice, but may chose to adopt Frame Relay in Phase I, with an option to move to ATM in Phase II. ATM and Frame Relay services are available in Virginia from Network Virginia.
  - Frame Relay service is available for Phase I implementation.
  - Currently, NetworkVirginia provides a unique opportunity for Virginia's public education system – not many states have a statewide network that

incorporates distance learning (video), data, Internet, and voice services over the same infrastructure.

- ➢ Procurement/lease of network devices is provided through a state procurement contract with Bell Atlantic and Sprint.

- ➢ Network Management may be provided by third party as part of the lease arrangement.

- ➢ ATM is generally less expensive than traditional private, dedicated circuits.

- ➢ ATM provides relative ease in overall network design due to the flexibility of the technology.

- ➢ Moves, adds, and changes to ATM networks are performed with relative ease.

- ➢ ATM provides support for moving to video and voice services of Phase II.

- Routing (OSI Layer 3) should be used to provide network isolation between school divisions.

- Internet access may be provided by NetworkVirginia or a local ISP.

- Schools and school divisions should be isolated effectively from the Internet using appropriate security measures.

  - ➢ A router with IP address filtering should be used as a minimum, however, a security firewall may be more appropriate. A firewall may consist of a router and special device that can filter incoming and outgoing Internet addresses or even filter content within Web pages.

  - ➢ Other firewall devices include proxy servers and SMTP/mime gateways. A proxy server may provides an address translation feature called Network Address Translation (NAT) that shields the school's internal network from the Internet. NAT "hides" internal addresses and reduces the risk of scans and attacks from outsiders.

  - ➢ Proxy servers can also filter IP addresses and cache Web pages, thereby reducing overall Internet traffic.

  - ➢ A SMTP/mime gateway may be configured to filter e-mail content from the Internet.

- Remote access for educators, students, and administrators to a school, school division, or state resource should be provided by a communications server providing dial-up connectivity through the Public Switched Telephone Network (PSTN). Once connected, remote users would simply log-in to their server, or launch network applications, just as if they were at the school or school division. Appropriate security (authentication and authorization) measures will be required to control access to sensitive data files.

- Carrier access speeds should be T1 speeds with higher speeds (DS3, OC3), if required, at a central location.

  - T1 = 1.544 Mbps
  - DS3 = 45 Mbps
  - OC3 = 155 Mbps

- Routers may have ATM interfaces (or Frame Relay interfaces upgradeable to ATM) with the appropriate matching speeds (T1, DS3, or OC3).

- Routers should have 10 Mbps Ethernet interfaces at remote sites that have T1 connections.

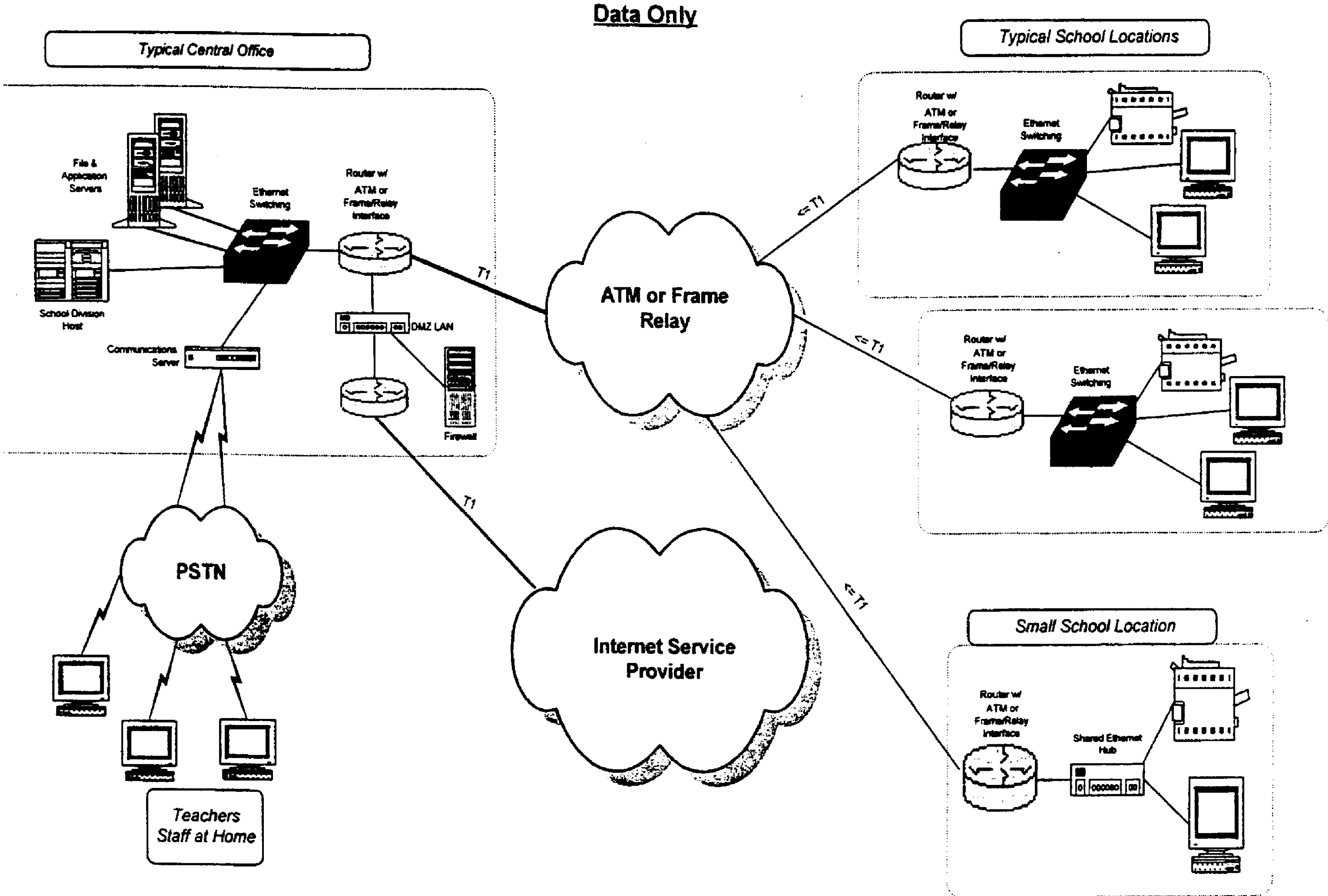
- Routers should have 100 Mbps Ethernet interfaces at locations with DS3 or higher carrier speeds.

More information on information security specifically for schools may be found in the publication *Safeguarding your Technology*, developed by the National Forum on Education Statistics. An electronic version of this document is available on the form web site www.nces.ed.gov/forum.

Figure 8 depicts a typical Wide Area Network configuration that supports the movement of data (not video) between remote locations. The inclusion of video and its supporting architecture is detailed in section 4.4.

## Phase I Wide Area Network (WAN) Architecture

### Data Only




• Figure 8 – Wide Area Networks for Data-only Applications

## 4.4 Phase II: Developing Wide Area Networks (WAN) for Data & Distance Learning

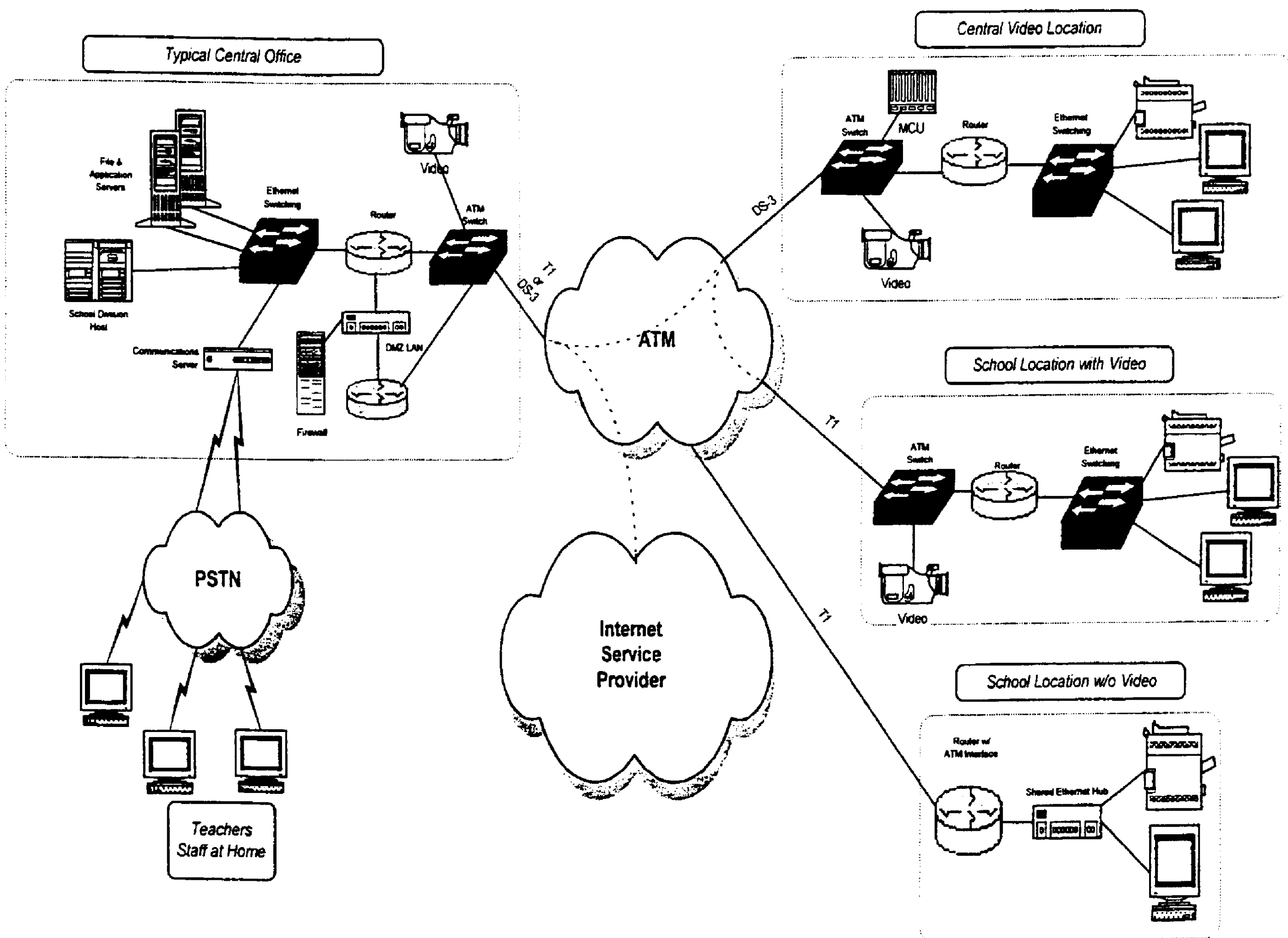
This section describes Phase II, a next logical step in wide area networking, providing a recommended method for applying Distance Learning to the network architecture developed in Phase I. The configuration developed in Phase II utilizes the inherent capabilities of an Virginia's ATM network.

The guidelines below utilize the architecture developed in Phase I, adding the required components to support the addition of multimedia applications.

- Multimedia equipment, such as Codecs, should conform to the H.320 and H.323 (video over IP) standards.
- ATM switches, either on school or division premises, should conform to PNNI (Private Network-to-Interface) Phase 1, and IISP (Interim Interswitch Signaling Protocol) protocols for routing techniques. This standard is required to insure interoperability with other ATM switches deployed within the ATM network.
- ATM switches should provide interfaces to the Wide Area Network with a range of speeds and feeds, such as :
    - DS1 or T1
    - DS3
    - OC3
- ATM switches should provide interfaces to the Local Area Network with a range of speeds and feeds, such as the following:
    - T1 emulation, DS1
    - 25 Mbps
    - DS3
    - OC3
- An MCU (Multipoint Conferencing Unit) may be deployed to support multi-point broadcast of video feeds. Typically, the site selected to house the MCU should be the originator of videoconferences, and/or have the resources and knowledge to administer the multimedia equipment and applications.
- If a router is used at a smaller location, then it should meet the same PNNI and IISP standards as ATM switches.

Figure 9 depicts a typical Wide Area Network configuration that supports the movement of data and video between remote locations.

**Typical Wide Area Network (WAN) Architecture with Distance Learning Capability**




• **Figure 9 – Wide Area Networks for Distance Learning**

## 4.5 Open Systems Interconnect (OSI) Protocols

OSI Layer 3 Protocols such as IP and IPX are used to merge LANs and WANs into integrated communications systems. These protocols provide the higher level language, which spans the entire data communications system. Each protocol must employ a structured address scheme in order to provide proper communications. In addition, OSI Layer 5 Protocols such as Domain Name Service (DNS), and Dynamic Host Configuration Protocol (DHCP) which automatically assigns individual addresses may be employed.

The following connectivity recommendations should be considered for OSI Protocols:

- Protocol Selection:
  - ➢ Ideally, the IP protocol suite should be the only OSI Layer 3 protocol used in both the LAN and WAN environment because:
    - IP is the best, most efficient, and common protocol suite available today.
    - IP can provide communications for nearly all applications (Internet, Mainframe, Client/ Server).
    - Services for each additional protocol creates unwanted WAN bandwidth overhead.
    - Multiple protocols cause higher complexity and administration costs.
- IP Addressing:
  - ➢ A well-planned IP addressing scheme allows for future growth of the network. School divisions may consider implementing NAT (Network Address Translation) on a proxy server to conserve IP addresses. Where possible, joining with the county or city to develop a growth-oriented scheme may prove beneficial.
  - ➢ The IP protocol, just as all other Layer 3 protocols, requires every device to have a unique two-part address. One part represents the device's "host address", and the other part is the associated "Layer 3 network" address.
  - ➢ The key to understanding Layer 3 address requirements is to recognize that each router interface represents a separate "network" address. Each "network" contains a variable number of "hosts", which are typically physically isolated by the router interface. The details of the IP address scheme, including an actual numbering plan, will be determined as part of the Infrastructure Design.

- IP Protocol Enhanced Services:

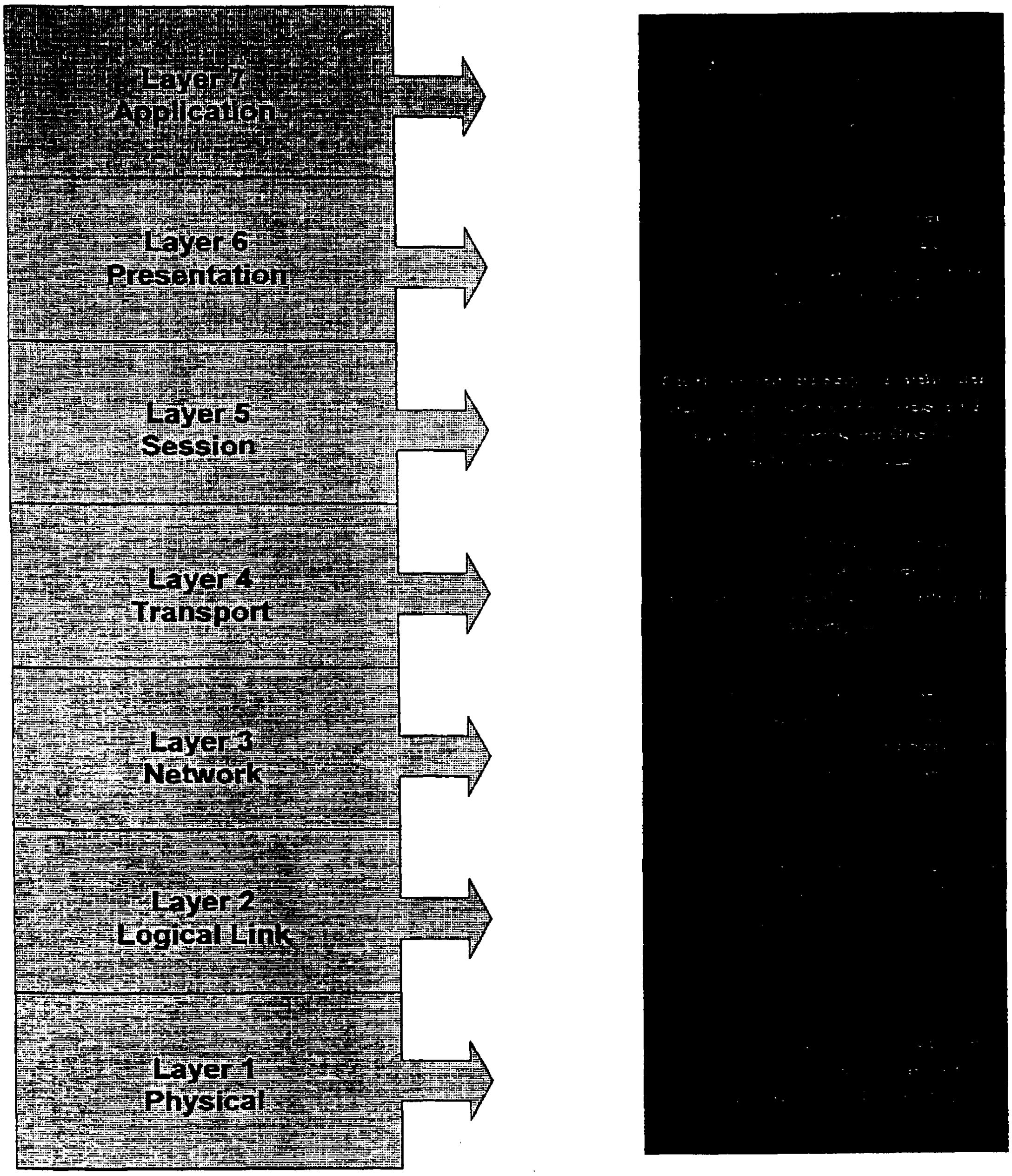
  - Routing information protocols are typically used to reduce the administrative burden of maintaining route tables. The larger the network, the greater the number of routes, and the greater the associated administrative burden. Routing algorithms provide this service at a price – overhead, which reduces data carrying capacity. While on a LAN this is insignificant, however, on smaller WAN circuits it can be very significant. For small, static WAN environments, such as a typical school division, static routes (no algorithm) may make the most sense. OSPF and EIGRP are current OSI Layer 3 enhanced routing services. RIP is an older protocol and should be avoided.

  - DHCP (OSI Layer 5) may be used to automatically configure the user workstations and printers upon boot up. DHCP services are typically included as a utility application on file server operating systems (OS). Without DHCP, each device must be individually, and manually, configured with an IP address, IP Subnet Mask, and IP Default Gateway. If the utilized IP address space is ever modified, reconfiguring devices manually can be extremely time consuming and error prone. DHCP utilities are provided as part of the NetWare 5.0, UNIX, and Windows NT Server OS.

  - DNS (OSI Layer 5) provides resolution between fully qualified domain names (i.e., Internet URL addresses) and IP addressing, which will be required to support Internet connectivity. While a DNS is included as a utility application on nearly all UNIX OS file serves, and in NetWare 5.0, it is less common in many other file server OS.

Figure 10 depicts the layers of the Open Systems Interconnect Reference Model.

# OSI Model



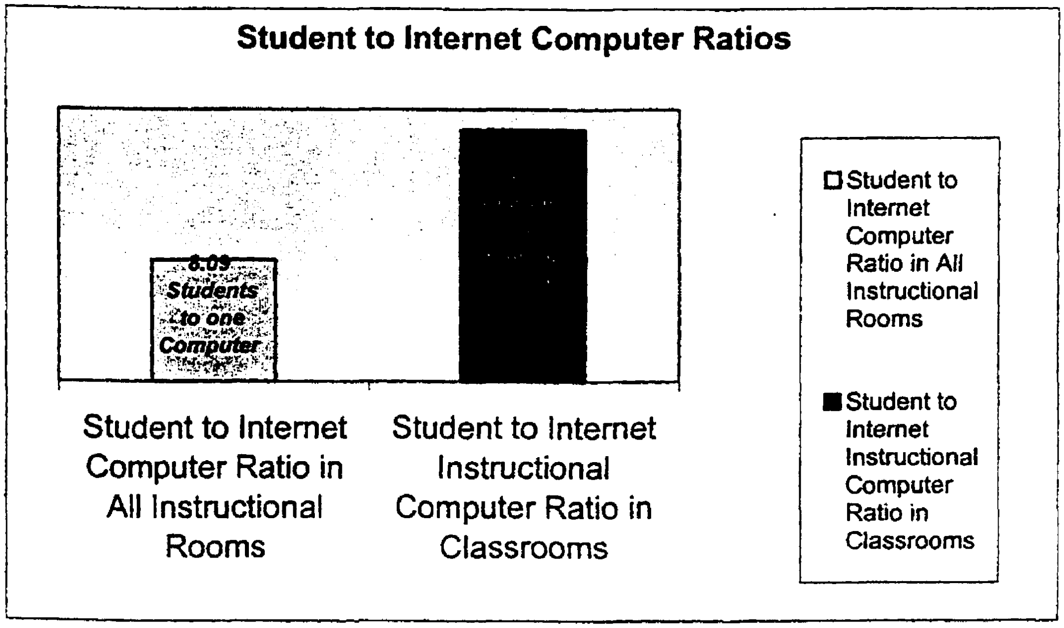

• Figure 10 OSI Reference Model

## 4.6 Computing Platforms

Computing Platforms consist of the hardware and software which applications use for operation. This includes the hardware platform, the software operating system (OS), and utility services (anti–virus, tape backup, disk maintenance, etc.) for both servers and clients. The Network Operating System (NOS), which may be tightly integrated into the server OS, is also included in this section.

Minimums are not provided in these guidelines because specifications for workstations, servers and operating systems are easily out-dated because of rapid changes in technology. School divisions should purchase widely available computing platforms with the most powerful components they can afford in order to increase the useful lifetime of the device. Thin client technology is being evaluated as a complement to high-end computing platforms.

Hardware for both servers and workstations should be procured from major providers or their designated representatives. These providers use commercial grade components with lower failure rates, but more importantly, provide greater consistency in product offerings and extended on-site warranties. Over time, a consistent product base will reduce administration and support significantly. Contracted maintenance services are also more readily available for major manufacturer's products.




• **Figure 11 – Virginia Student to Internet Computer Ratios**

School divisions should consider the work of the Southern Regional Education Board (SREB) in its report, *Guidelines for Technology Equipment and Use: An SREB Model for Schools and Campuses*. The SREB report is available at www.sreb.org. SREB recommends a minimum of one computer to every five students in the classroom. Virginia's student to computer ratio is depicted in Figure 11. The statewide student to Internet-connected computer ration is 16.67 to one.

## 4.6 Infrastructure Management

Services, tools, procedures, and personnel are required to effectively manage the overall infrastructure. Effective management is critical for both minimizing the administrative burden of the infrastructure, and for maximizing reliability and good performance. The school division technology budget should reflect the ongoing cost of their investment in connectivity in order to most effectively utilize this resource.

The following connectivity recommendations may be adopted for Infrastructure Management:

- Total Cost of Ownership (TCO) projections should be considered in the budget as well as start-up costs.
- Appropriate staffing should be deployed for administration of the servers and data network.
- Technology support positions should be dedicated to the operation and maintenance of the resource. Unique strategies should be developed to recruit and retain qualified information technology staff.
- Workstations should be refreshed on a regular basis. School divisions should plan for a three to five-year lifecycle.
- Equipment leasing and seat management options should be evaluated as an alternative to buying. Equipment leasing can be used as a method to refresh technical components as the lease expires.
- Infrastructure management tools to configure, monitor, troubleshoot, and report on the infrastructure environment should be available. Basic configuration and monitoring tools from the manufacturer should be supplemented with other applications and utilities as required.
- Selective outsourcing of specific tasks, such as stocking of spare parts and break/fix maintenance is generally advantageous and should be explored. Each task should be evaluated for overall cost.
- A security policy should be available detailing the establishment of user accounts, gaining secure access, and procedure for dealing with violations.
- Acceptable use policies should be in place and enforced.

Total Cost of Ownership as it relates specifically to schools and school divisions is discussed in the publication entitled *Taking TCO to the Classroom: A School Administrator's Guide to Planning for the Total Cost of New Technology* developed by the Consortium for School Networking (CoSN). This publication is available at the CoSN web site: www.cosn.org.

# 5 Summary

In summary, the recommendations for network connectivity are depicted in the following tables:

| Infrastructure | | Recommendations |
|---|---|---|
| Wide Area Networks | Switches | ATM should conform to PNNI and IISP protocols and routing techniques. |
| | Routers | Routers with ATM interfaces should be used to provide network isolation between school divisions. |
| | Communication Servers | Communication servers should be employed to provide remote access to educators, students, and administrators. |
| | Carrier Services | ATM should be the WAN service/protocol of choice. |
| OSI Protocols | Network Layer | Ideally, the IP protocol suite should be the OSI layer 3 protocol used in both the LAN and WAN environment. |
| | DHCP, DNS Services | Enhanced OSI Layers 5 services such as DHCP, DNS whenever appropriate. |
| | Other Protocols | Routing algorithms such as OSPF, IGRP, and EIGRP should be employed whenever appropriate. |
| Computing Platforms | Clients | Intel-based (PIII-IV, 333MHz/64Mb RAM/4GB HD) / Apple (PowerPC G3, 266Mhz / 32 Mb RAM / 6 GB HD)/ thin client |
| | Servers | Intel-based (PIV,XEON, 450 MHz / 512Mb RAM / 9 GB HD) / Apple (PowerPC G3, 450 MHz / 256 Mb RAM / 9 GB HD) |
| Infrastructure Management | Management Tools | Tools should be available to monitor, troubleshoot and report on the infrastructure environment. |
| | Security Policy | A security policy should be available detailing methods of establishing user accounts, gaining secure access, and policy for violations. |

| Infrastructure | | Recommendations |
|---|---|---|
| | **Inside Cable Plant** | All copper cabling should meet EIA standard 568 A/B specifications. |
| | | Fiber must meet the 62.5/125 microns multimode standard for distances under 2 kilometers. |
| | | Horizontal cabling – copper twisted pair (Category – 5) |
| | | Vertical riser cabling – copper twisted pair (Category- 5) for voice, fiber optics for data & video |
| | Outside Cable Plant | Fiber optics should be generally used. |
| | | Fiber must meet the 62.5 microns multimode standard for distances under 2 kilometers. |
| | | Have spare cable runs whenever possible. Fiber optic cable should have, at a minimum, 25% spare strands. |
| | Environments | Uninterruptible power supply (UPS) equipment should be used for servers and communication devices. |
| | | Electrical server suppression devices on all sensitive electronics, where feasible (includes workstations and monitors). |
| | | Operate infrastructure electronics within appropriate heating/cooling environment. |
| | | Operate infrastructure electronics with appropriate cleanliness and space conditions. |
| | | All infrastructure components should be physically secured. |
| Local Area Networks | Hubs | Shared hubs should be used as a more economical solution only for very small locations. |
| | Switches | Ethernet switching (10/100 Mbps autosense) should be used for every device which connects to the LAN. |
| | Routers | OSI Layer-3 routing services should be employed to provide network isolation between organizations and traffic control within LAN, as needed. |

## Appendix B - Internet Connectivity Survey, September 1999

## VIRGINIA DEPARTMENT OF EDUCATION

DIVISION OF

# Technology

## Key Questions about Internet Connectivity in Virginia Schools

***Information about this survey***

***What is the student to Internet connected computer ratio?***

Statewide Numbers

Ratios by type of school

Ratios by region

Ratios by percent of students on Free and Reduced Lunch

Ratios by percent of students on Free and Reduced Lunch for each region

Ratios by school size

***Where are Internet Computers used in Virginia Schools?***

Average number in each type of room

***Are Virginia Schools Connected to the Internet?***

Statewide

Connectivity by type of school

Connectivity by region

Connectivity by percent of students on Free or Reduced Lunch

Connectivity by school size

***Is filtering used?***

Schools using Internet filtering by region

***Are WANs in place?***

Schools connected to Division or Local WANs

***Are Internet Computers available for Administrative use?***

Administrative Use Information

***Who provides Internet service to Virginia schools?***

Virginia Internet Service Providers

**S[illegible]ber 1999**

## Information About this Survey

The connectivity survey was conducted in August and September, 1999 by the Virginia Department of Education.

## Who Responded

| | |
|---|---|
| Number of Divisions Reporting | 130 |
| Number of Schools Included | 1,803 |
| Number of Students Represented | 1,117,098 |

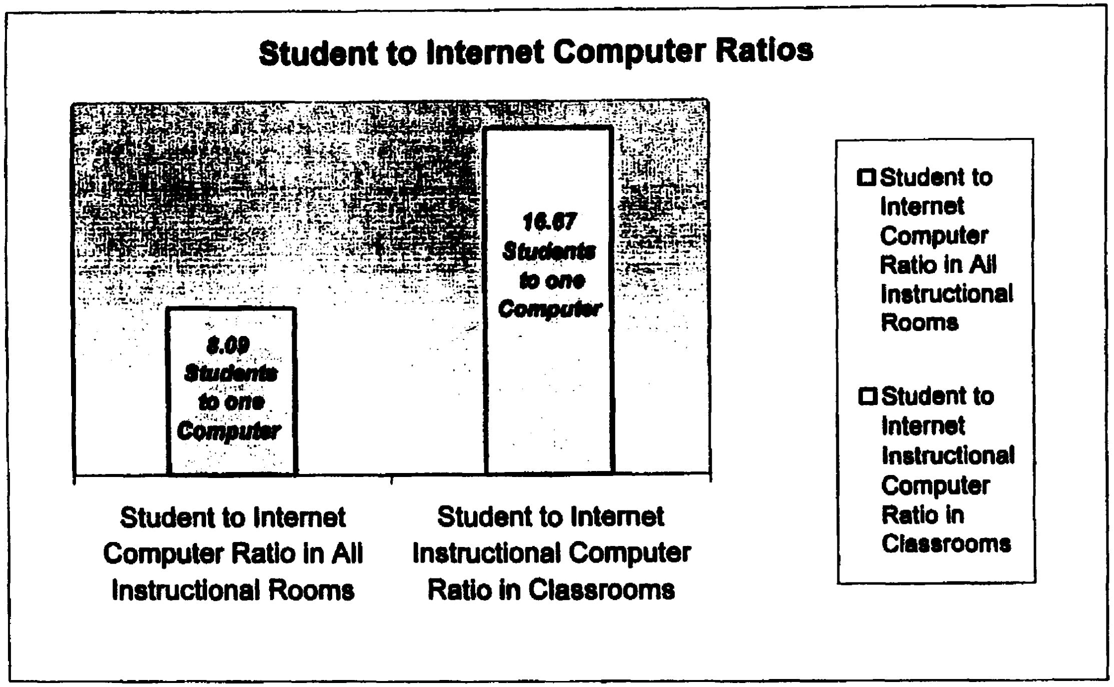
## For More Information

Please contact Lan Neugent or Bethann Canada at the Virginia Department of Education (lneugent@pen.k12.va.us, bcanada@pen.k12.va.us), or visit the Department of Education's web site at www.pen.k12.va.us.

**STUDENT TO INTERNET COMPUTER RATIOS**

Virginia schools have an overall ratio of 8.09 students to one Internet-connected computer in all instructional rooms.

In the classroom only, however, the ratio increases to 16.67 students to one Internet-connected computer. This ratio falls short of the recommended ideal ratio of four to five students to one connected computer.

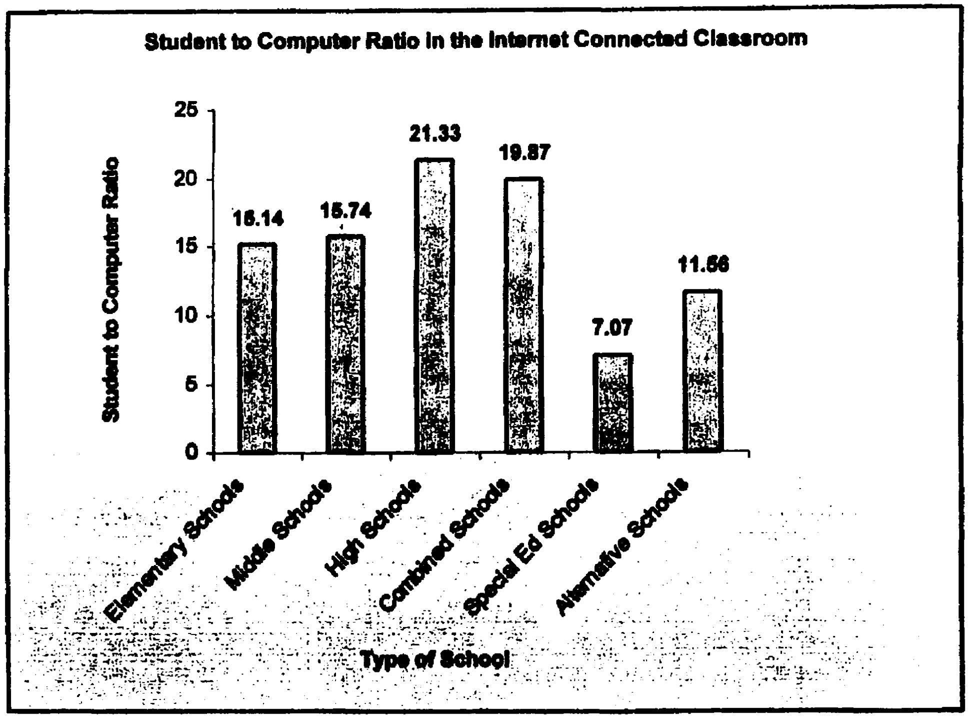



**Statewide Student to Internet Computer Ratios**

| Number of Internet Capable and Connected Computers in Instructional Rooms | Number of Internet Capable and Connected Computers in Labs | Number of Internet Capable and Connected Computers in Library Media Centers | Total Internet Capable and Connected Computers for Instructional Use | Number of Students | Student to Internet Computer Ratio in All Instructional Rooms | Student to Internet Instructional Computer Ratio in Classrooms |
|---|---|---|---|---|---|---|
| 53022 | 45131 | 11117 | 109270 | 884107 | [illegible] | [illegible] |

**STUDENT TO INTERNET CONNECTED COMPUTER RATIO IN THE CLASSROOM**

In Virginia's classrooms, the student to Internet-connected computer ratio ranges from 15.14 students to one computer in elementary schools to 21.33 students to one computer in high schools. Special Ed and Alternative schools have low student to Internet-connected computer ratios.

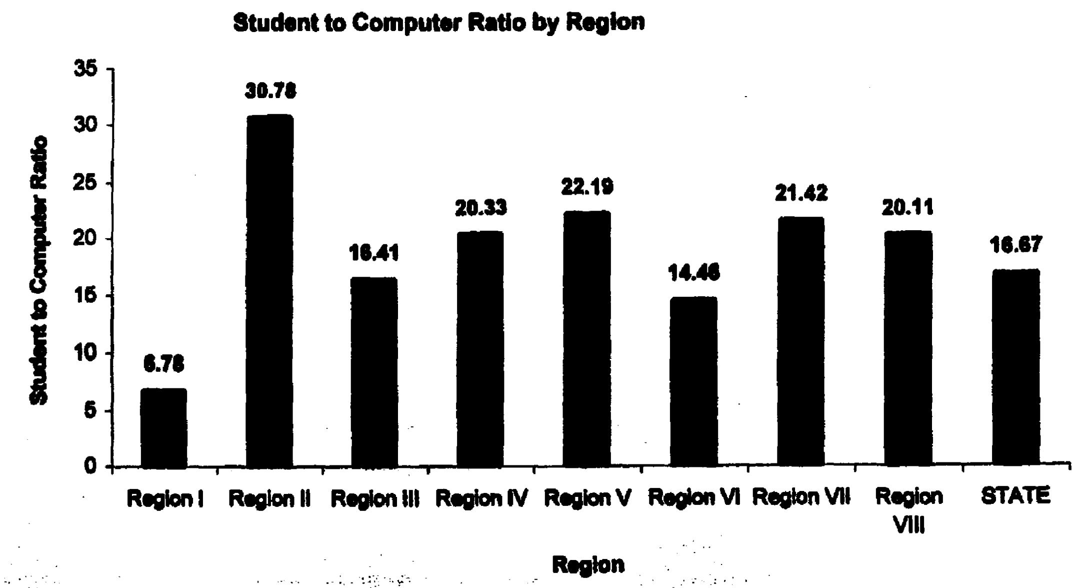



| Internet Computers in the Classroom by Type of School | | | | | |
|---|---|---|---|---|---|
| *Type of School* | Number of Students | Instructional Rooms | Total Number of Internet Computers in All Instructional Rooms | Student to Internet Instructional Computer Ratio in Classrooms only | Average Number of Internet Computers in Classrooms |
| Elementary Schools | 433932 | 25669 | 28655 | 15.14 | 1.12 |
| Middle Schools | 180577 | 10709 | 11471 | 15.74 | 1.07 |
| High Schools | 246181 | 13522 | 11544 | 21.33 | 0.85 |
| Combined Schools | 19630 | 1391 | 988 | 19.87 | 0.71 |
| Special Ed Schools | 665 | 124 | 94 | 7.07 | 0.76 |
| Alternative Schools | 3122 | 340 | 270 | 11.56 | 0.79 |
| TOTAL | 884107 | [illegible] | [illegible] | 16.67 | [illegible] |

Virginia Department of Education Internet Connectivity Survey
September 1999

## STUDENT TO INTERNET CONNECTED COMPUTER RATIO BY REGION

In the classroom, the student to Internet-connected computer ratio ranges from a low of 6.78 students to one computer in Region I to a high of 30.78 students to one computer in Region II. The statewide ratio is 16.67 students to one Internet-connected computer in Virginia's classrooms. Within any given region, the student to computer ratio varies widely from school to school

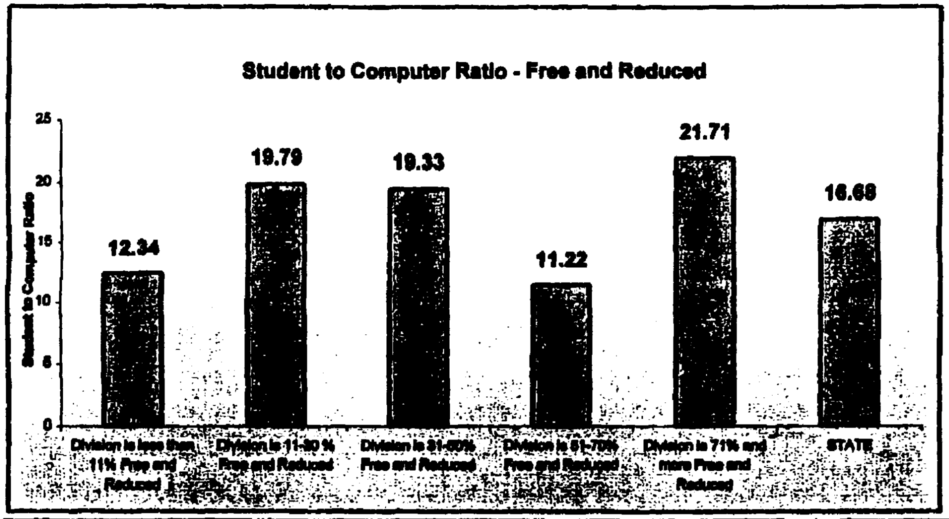



**Internet Computers in the Classroom by Region**

| Region | Number of Students | Number of Classrooms | Internet Computers in Classrooms | Student to Internet Instructional Computer Ratio in Classrooms | Average Number of Internet Computers in Classrooms | Lowest ratio this region | Highest ratio this region |
|---|---|---|---|---|---|---|---|
| Region I | 117845 | 6623 | 17385 | 6.78 | 2.62 | 4.73 | 1222.00 |
| Region II | 243702 | 13801 | 7917 | 30.78 | 0.57 | 8.22 | 588.53 |
| Region III | 66947 | 3904 | 4079 | 16.41 | 1.04 | 3.87 | 665.60 |
| Region IV | 160860 | 9365 | 7913 | 20.33 | 0.84 | 5.65 | 931.50 |
| Region V | 100207 | 5989 | 4516 | 22.19 | 0.75 | 8.44 | 3434.33 |
| Region VI | 90578 | 5448 | 6263 | 14.46 | 1.15 | 3.94 | 544.60 |
| Region VII | 72701 | 4465 | 3394 | 21.42 | 0.76 | 6.68 | 305.92 |
| Region VIII | 31267 | 2160 | 1555 | 20.11 | 0.72 | 9.83 | 2686.00 |

## STUDENT TO INTERNET-CONNECTED COMPUTER RATIOS – FREE AND REDUCED LUNCH PERCENTAGES

The student to Internet-connected computer ratio is similar in school divisions with a low percentage of students eligible for free and reduced lunches and school divisions with a high percentage of eligible students. This suggests that this measure of wealth is not directly related to student access to the Internet in schools.




**Internet Computers - Free and Reduced Lunch Students**

| *Percent Students on Free/Reduced Lunch* | Number of Students | Number of Classrooms | Internet Computers in Classrooms | Student to Internet Instructional Computer Ratio in Classrooms | Average Number of Internet Computers in Classrooms |
|---|---|---|---|---|---|
| Division is less than 11% Free and Reduced | 58253 | 3413 | 4720 | 12.34 | 1.38 |
| Division is 11-30 % Free and Reduced | 419852 | 23236 | 21211 | 19.79 | 0.91 |
| Division is 31-50% Free and Reduced | 241783 | 15357 | 12510 | 19.33 | 0.81 |
| Division is 51-70% Free and Reduced | 162721 | 9935 | 14502 | 11.22 | 1.46 |
| Division is 71% and more Free and Reduced | 1498 | 108 | 69 | 21.71 | 0.64 |
| STATE | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

# Virginia Department of Education Internet Connectivity Survey
September 1999

## Internet Computers in the Classroom by Region

| Region | Number of Students | Number of Classrooms | Internet Computers in Classrooms | Students to Internet Instructional Computer Ratio in Classrooms | Average Number of Internet Computers in Classrooms |
|---|---|---|---|---|---|
| **Region I** | | | | | |
| Division is less than 11% Free and Reduced | 15831 | 845 | 3347 | 4.73 | 3.96 |
| Division is 11-30 % Free and Reduced | 56035 | 3070 | 7356 | 7.62 | 2.4 |
| Division is 31-50% Free and Reduced | 9297 | 602 | 657 | 14.15 | 1.09 |
| Division is 51-70% Free and Reduced | 35184 | 1998 | 5956 | 5.91 | 2.98 |
| Division is 71% and more Free and Reduced | 1498 | 108 | 69 | 21.71 | 0.64 |
| **Region I Totals** | **117845** | **6623** | **17385** | **6.78** | **2.62** |
| **Region III** | | | | | |
| Division is less than 11% Free and Reduced | 0 | 0 | 0 | — | — |
| Division is 11-30 % Free and Reduced | 49783 | 2762 | 2189 | 22.74 | 0.79 |
| Division is 31-50% Free and Reduced | 14124 | 908 | 1504 | 9.39 | 1.66 |
| Division is 51-70% Free and Reduced | 3040 | 234 | 386 | 7.88 | 1.65 |
| Division is 71% and more Free and Reduced | 0 | 0 | 0 | — | — |
| **Region III Totals** | **66947** | **3904** | **4079** | **16.41** | **1.04** |

| Region | Number of Students | Number of Classrooms | Internet Computers in Classrooms | Students to Internet Instructional Computer Ratio in Classrooms | Average Number of Internet Computers in Classrooms |
|---|---|---|---|---|---|
| **Region II** | | | | | |
| Division is less than 11% Free and Reduced | 2436 | 142 | 143 | 17.03 | 1.01 |
| Division is 11-30 % Free and Reduced | 133645 | 7381 | 2888 | 46.28 | 0.39 |
| Division is 31-50% Free and Reduced | 42680 | 2659 | 1493 | 28.59 | 0.56 |
| Division is 51-70% Free and Reduced | 64941 | 3619 | 3393 | 19.14 | 0.94 |
| Division is 71% and more Free and Reduced | 0 | 0 | 0 | — | — |
| **Region II Totals** | **243702** | **13801** | **7917** | **30.78** | **0.57** |
| **Region IV** | | | | | |
| Division is less than 11% Free and Reduced | 26091 | 1448 | 160 | 163.07 | 0.11 |
| Division is 11-30 % Free and Reduced | 93380 | 5012 | 4433 | 21.06 | 0.88 |
| Division is 31-50% Free and Reduced | 30566 | 2066 | 1473 | 20.76 | 0.71 |
| Division is 51-70% Free and Reduced | 10603 | 839 | 1847 | 5.85 | 2.2 |
| Division is 71% and more Free and Reduced | 0 | 0 | 0 | — | — |
| **Region IV Totals** | **160660** | **9366** | **7913** | **20.33** | **0.84** |

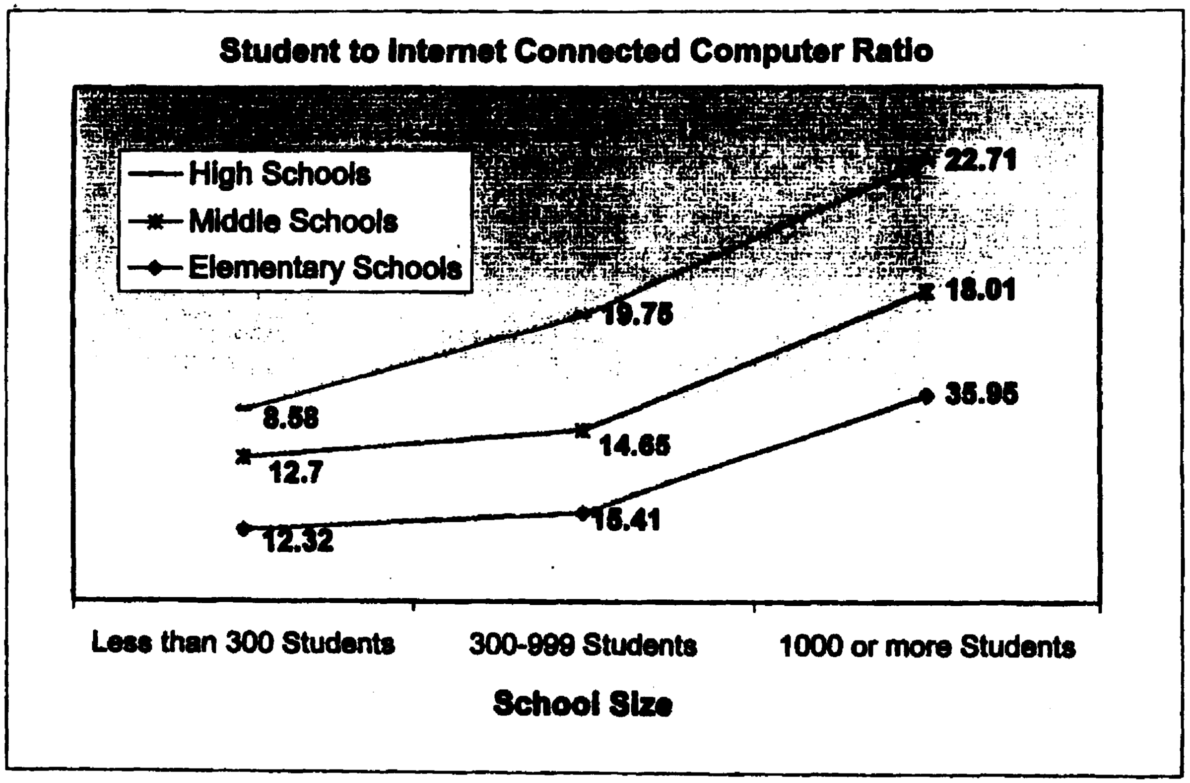
Virginia Department of Educa' 'nternet Connectivity Survey
Septe 1999

| Region | Number of Students | Number of Classrooms | Internet Computers in Classrooms | Student to Internet Instructional Computer Ratio in Classrooms | Average Number of Internet Computers in Classrooms |
|---|---|---|---|---|---|
| **Region V** | | | | | |
| Division is less than 11% Free and Reduced | 0 | 0 | 0 | — | — |
| Division is 11-30 % Free and Reduced | 66920 | 3816 | 2911 | 22.99 | 0.76 |
| Division is 31-50% Free and Reduced | 33287 | 2157 | 1595 | 20.87 | 0.74 |
| Division is 51-70% Free and Reduced | 0 | 0 | 0 | — | — |
| Division is 71% and more Free and Reduced | 0 | 0 | 0 | — | — |
| **Region V Totals** | **100207** | **5973** | **4506** | **22.24** | **0.75** |
| **Region VII** | | | | | |
| Division is less than 11% Free and Reduced | 0 | 0 | 0 | — | — |
| Division is 11-30 % Free and Reduced | 1564 | 101 | 113 | 13.84 | 1.12 |
| Division is 31-50% Free and Reduced | 59702 | 3454 | 3119 | 19.14 | 0.9 |
| Division is 51-70% Free and Reduced | 11435 | 910 | 162 | 70.59 | 0.18 |
| Division is 71% and more Free and Reduced | 0 | 0 | 0 | — | — |
| **Region VII Totals** | **72701** | **4465** | **3394** | **21.42** | **0.76** |

| Region | Number of Students | Number of Classrooms | Internet Computers in Classrooms | Student to Internet Instructional Computer Ratio in Classrooms | Average Number of Internet Computers in Classrooms |
|---|---|---|---|---|---|
| **Region VI** | | | | | |
| Division is less than 11% Free and Reduced | 13895 | 978 | 1070 | 12.99 | 1.09 |
| Division is 11-30 % Free and Reduced | 18525 | 1094 | 1321 | 14.02 | 1.21 |
| Division is 31-50% Free and Reduced | 36780 | 2434 | 1940 | 18.96 | 0.8 |
| Division is 51-70% Free and Reduced | 21378 | 1236 | 1932 | 11.07 | 1.56 |
| Division is 71% and more Free and Reduced | 0 | 0 | 0 | — | — |
| **Region VI Totals** | **90578** | **5742** | **6263** | **14.46** | **1.09** |
| **Region VIII** | | | | | |
| Division is less than 11% Free and Reduced | 0 | 0 | 0 | — | — |
| Division is 11-30 % Free and Reduced | 0 | 0 | 0 | — | — |
| Division is 31-50% Free and Reduced | 15327 | 1077 | 729 | 21.02 | 0.68 |
| Division is 51-70% Free and Reduced | 15940 | 1099 | 826 | 19.3 | 0.75 |
| Division is 71% and more Free and Reduced | 0 | 0 | 0 | — | — |
| **Region VIII Totals** | **31267** | **2176** | **1555** | **20.11** | **0.71** |

**STUDENT TO INTERNET CONNECTED COMPUTER RATIO**

Small schools tend to have the lowest student to Internet-connected computer ratios. The student to computer ratio increases with the size of the school, regardless of school type.



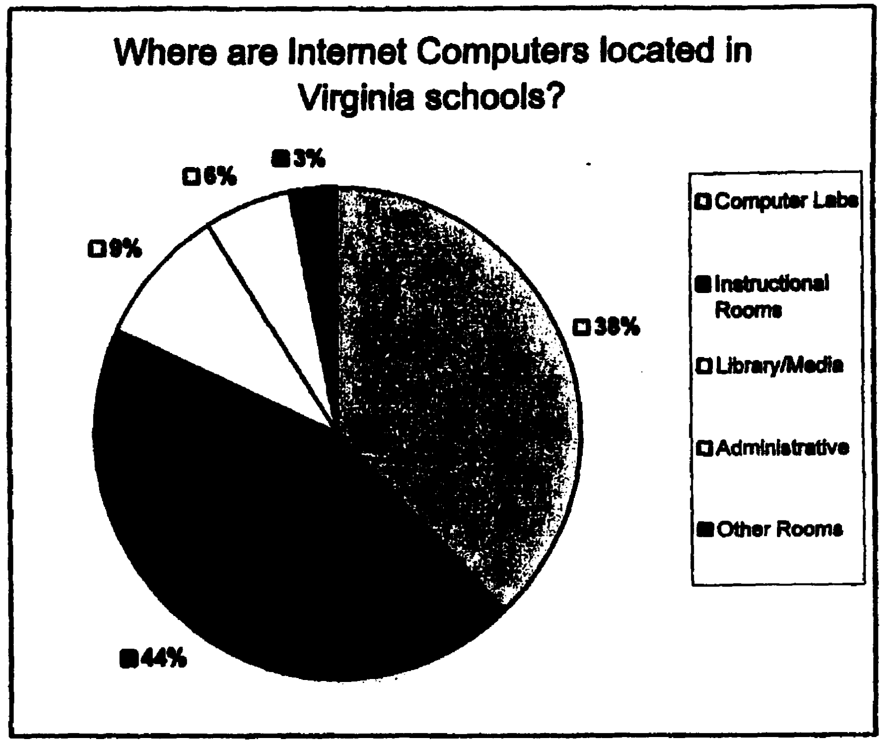

Additional data on next page

## Student to Internet Computer Ratio - School Size

| *School Type* | *School Size* | Number of Students | Number of Classrooms | Internet Computers in Classrooms | Student to Internet Instructional Computer Ratio in Classrooms | Average Number of Internet Computers in Classrooms |
|---|---|---|---|---|---|---|
| **Elementary Schools** | | | | | | |
| | Less than 300 Students | 46271 | 3269 | 3757 | 12.32 | 1.15 |
| | 300-999 Students | 380687 | 22036 | 24704 | 15.41 | 1.12 |
| | 1000 or more Students | 6974 | 364 | 194 | 35.95 | 0.53 |
| **Middle Schools** | | | | | | |
| | Less than 300 Students | 2870 | 185 | 226 | 12.7 | 1.22 |
| | 300-999 Students | 108027 | 6678 | 7376 | 14.65 | 1.1 |
| | 1000 or more Students | 69680 | 3846 | 3870 | 18.01 | 1.01 |
| **High Schools** | | | | | | |
| | Less than 300 Students | 2470 | 217 | 288 | 8.58 | 1.33 |
| | 300-999 Students | 79596 | 4817 | 4030 | 19.75 | 0.84 |
| | 1000 or more Students | 164115 | 8488 | 7226 | 22.71 | 0.85 |
| **Combined Schools** | | | | | | |
| | Less than 300 Students | 2354 | 240 | 166 | 14.18 | 0.69 |
| | 300-999 Students | 16088 | 1095 | 766 | 21 | 0.7 |
| | 1000 or more Students | 1188 | 56 | 56 | 21.21 | 1 |
| **Special Ed Schools** | | | | | | |
| | Less than 300 Students | 665 | 124 | 94 | 7.07 | 0.76 |
| | 300-999 Students | 0 | 0 | 0 | — | — |
| | 1000 or more Students | 0 | 0 | 0 | — | — |
| **Alternative Schools** | | | | | | |
| | Less than 300 Students | 2169 | 241 | 227 | 9.56 | 0.94 |
| | 300-999 Students | 953 | 99 | 43 | 22.16 | 0.43 |
| | 1000 or more Students | 0 | 0 | 0 | — | — |
| | STATE | 884107 | 61756 | [illegible] | 16.67 | 1.02 |

## INTERNET COMPUTERS BY LOCATION IN THE SCHOOL

In Virginia, an average of 15 Internet-connected computers, or 38 percent, are in each computer lab. An average of 7 computers, or 9 percent, are in each library/media center. Virginia classrooms have an average of only 1 Internet-connected computer in the classroom. Internet computers in the classroom represent 44 percent of the total number of Internet computers in Virginia schools.




**Internet Computers by Location in the School**

| *Type of Room* | Count | Internet Computers | Average Number in Room | Percent |
|---|---|---|---|---|
| Computer Labs | 2920 | 45131 | 15.46 | 38 |
| Instructional Rooms | 51755 | 53022 | 1.02 | 44 |
| Library/Media | 1538 | 11117 | 7.23 | 9 |
| Administrative | 5956 | 6793 | 1.14 | 6 |
| Other Rooms | 4929 | 3204 | 0.65 | 3 |
| **TOTAL** | 67098 | 119267 | 1.78 | 100 |

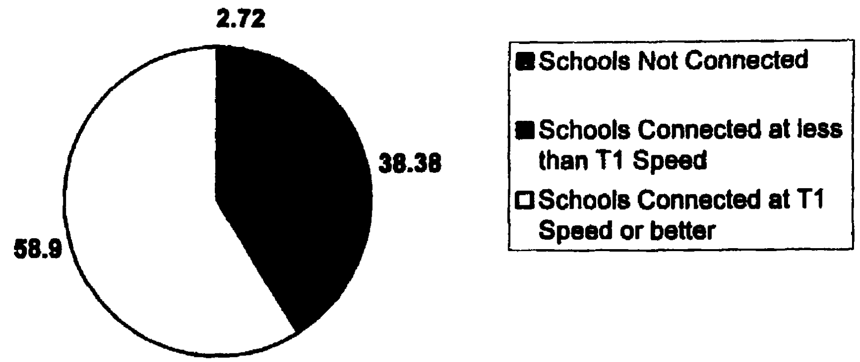
## STATEWIDE INTERNET CONNECTIVITY

58.9 percent of Virginia schools are connected to the Internet at T1 speeds (1.544 megabits per second) or better. 38.38 percent are connected, but at less than T1 speed. Only 2.72 percent of Virginia schools have individual modem connections to the Internet or no connection at all.

T1 speeds allow schools to take advantage of the many new bandwidth-intensive applications available on the Internet.

To illustrate the speed of a T1 connection, all things being equal, the graphic below would take 5 seconds to download using a high speed modem connection and less than one second using a T1 line.


**Virginia Statewide Connectivity**




| Who's Connected? | | |
|---|---|---|
| *Connectivity Status* | *Number* | *Percent* |
| Schools Not Connected | 49 | [redacted] |
| Schools Connected at less than T1 Speed | 692 | |
| Schools Connected at T1 Speed or better | 1062 | 58.9 |

Virginia Department of Education Internet Connectivity Survey
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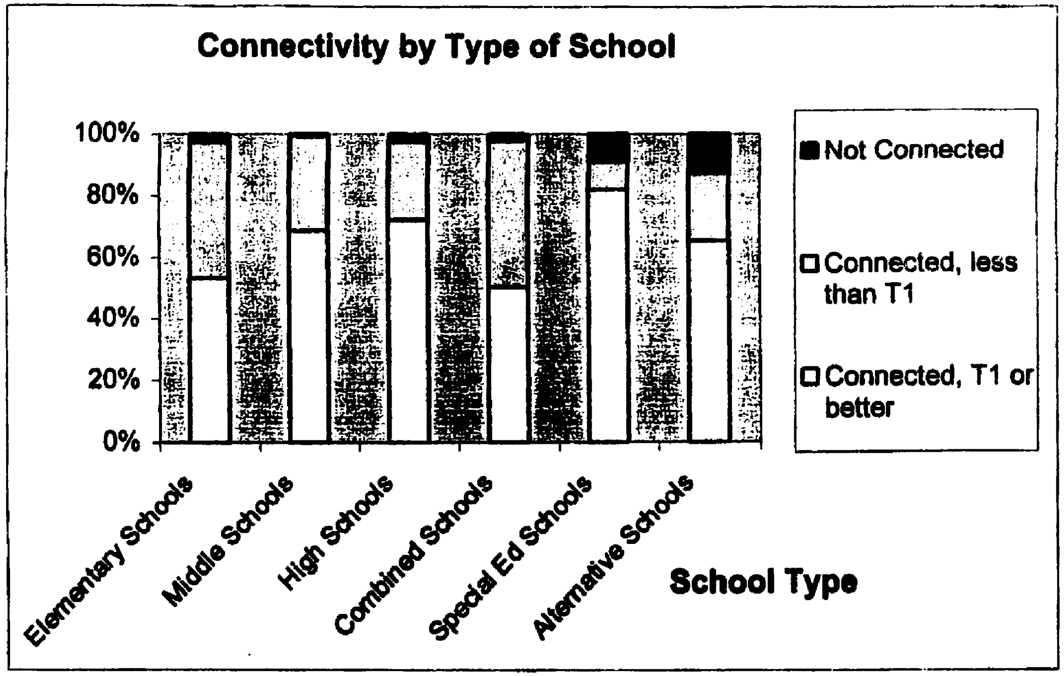
**INTERNET CONNECTIVITY BY TYPE OF SCHOOL**

The vast majority of Virginia schools are connected to the Internet, most with high-speed T1 lines. The percentage of high schools with high-speed T1 connections is slightly higher than any other type of school.



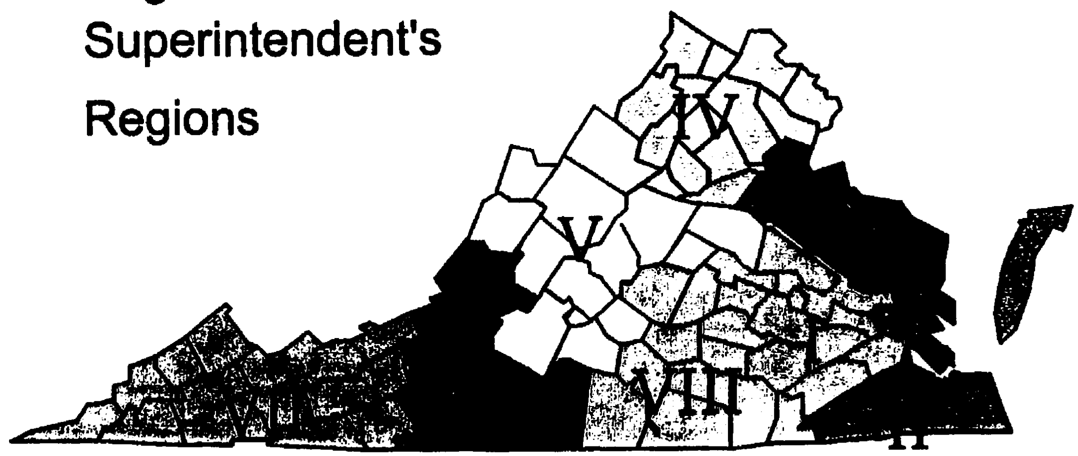

| *Type School* | Total Number of Schools | Number not Connected | Number Connected less than T1 | Number Connected T1 or better | Percent Connected T1 or better | Total Connected | Total Percent Connected |
|---|---|---|---|---|---|---|---|
| Elementary Schools | 1136 | 31 | 503 | 602 | 52.99 | 1105 | 97.27 |
| Middle Schools | 275 | 2 | 85 | 188 | 68.36 | 273 | 99.27 |
| High Schools | 275 | 7 | 70 | 198 | 72 | 268 | 97.45 |
| Combined Schools | 48 | 1 | 23 | 24 | 50 | 47 | 97.92 |
| Special Ed Schools | 32 | 3 | 3 | 26 | 81.25 | 29 | 90.63 |
| Alternative Schools | 37 | 5 | 8 | 24 | 64.86 | 32 | 86.49 |
| STATE | 1803 | 49 | 692 | 1062 | 58.93 | 1754 | 97.28 |

**INTERNET CONNECTIVITY BY REGION**

The percent of schools connected to the Internet with high speed T1 connections ranges from a low of 28 percent in Region III to a high of 89.96 percent in Region IV.

The percent of schools not connected to the Internet ranges from a low of zero (all schools connected) in Region VI to a high of 11.29 percent in region VII.

# Virginia Superintendent's Regions




| Connectivity by Region | | | | |
|---|---|---|---|---|
| *Region* | Percent Not Connected | Percent Connected < T1 | Percent Connected T1 or Better | Percent Connected |
| Region I | 1.05 | 42.93 | 56.02 | 98.95 |
| Region II | 0.82 | 42.58 | 56.59 | 99.18 |
| Region III | 2.00 | 70.00 | 28.00 | 98.00 |
| Region IV | 0.67 | 9.38 | 89.96 | 99.33 |
| Region V | 8.16 | 53.06 | 38.78 | 91.84 |
| Region VI | 0.00 | 68.42 | 31.58 | 100.00 |
| Region VII | 11.29 | 50.00 | 38.71 | 88.71 |
| Region VIII | 2.82 | 22.54 | 74.65 | 97.18 |

Virginia Department of Education Internet Connectivity Survey
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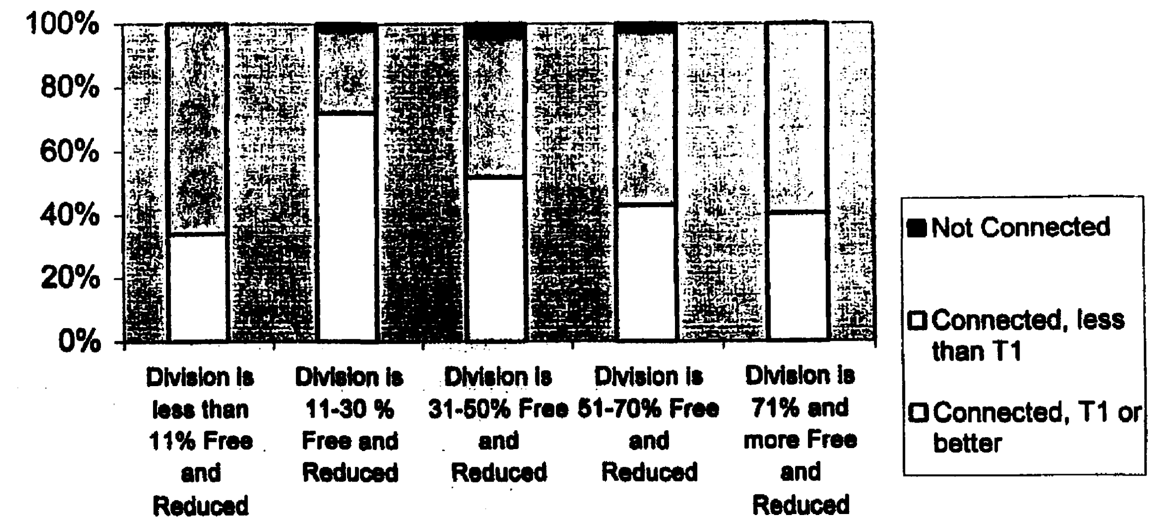
### INTERNET CONNECTIVITY BY PERCENT OF STUDENTS ON FREE/REDUCED LUNCH

As with the student to Internet-connected computer ratio previously discussed, a school's Internet connection speed does not appear to be directly related to the percent of students in the division eligible for free or reduced lunch.

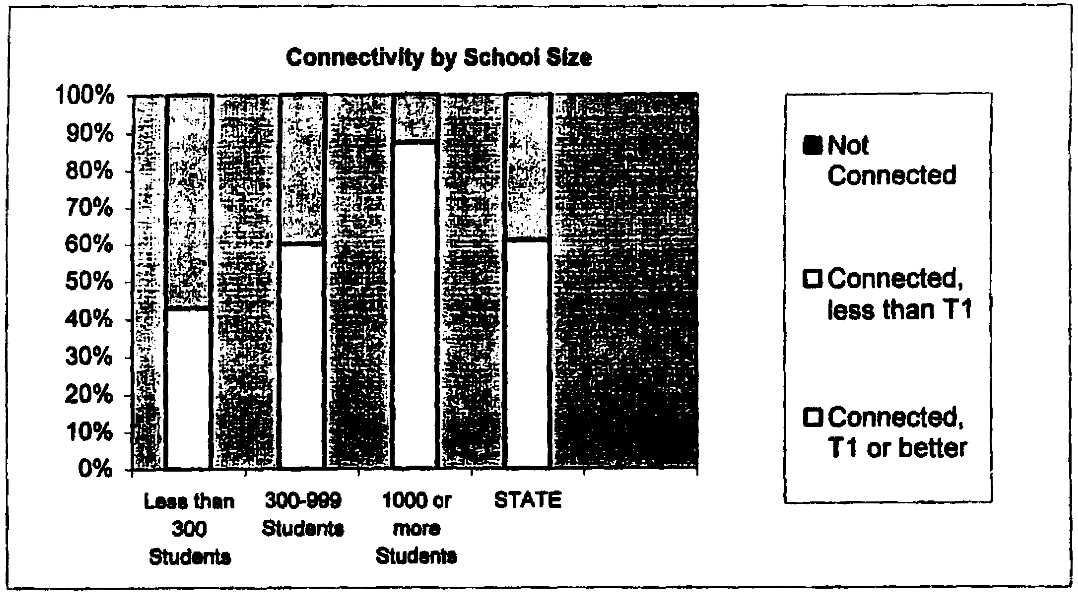



**Connectivity by Percent of Students on Free/Reduced Lunch**

| *Percent Students on Free/Reduced Lunch* | Total Number of Schools | Number not Connected | Number Connected < T1 | Number Connected T1 or better | Total Connected | Percent Connected |
|---|---|---|---|---|---|---|
| Division is less than 11% Free and Reduced | 89 | 0 | 59 | 30 | 89 | 100 |
| Division is 11-30 % Free and Reduced | 872 | 18 | 229 | 625 | 854 | 97.94 |
| Division is 31-50% Free and Reduced | 530 | 23 | 233 | 274 | 507 | 95.66 |
| Division is 51-70% Free and Reduced | 307 | 8 | 168 | 131 | 299 | 97.39 |
| Division is 71% and more Free and Reduced | 5 | 0 | 3 | 2 | 5 | 100 |
| TOTAL | 1803 | 49 | 692 | 1062 | 1754 | 97.28 |

**CONNECTIVITY BY SCHOOL SIZE**

Larger schools in Virginia are more likely to have high-speed Internet connections.




Additional data on next page

**Connectivity by School Size**

| School Size | Total Number of Schools | Number not Connected | Number Connected < T1 | Number Connected T1 or better | Percent Connected T1 or better | Total Connected | Percent Connected |
|---|---|---|---|---|---|---|---|
| Less than 300 Students | 319 | 29 | 166 | 124 | 38.87 | 290 | 90.91 |
| 300-999 Students | 1253 | 20 | 496 | 737 | 58.82 | 1233 | 98.4 |
| 1000 or more Students | 231 | 0 | 30 | 201 | 87.01 | 231 | 100 |
| STATE | 1803 | 49 | 692 | 1062 | 58.9 | 1754 | 97.28 |

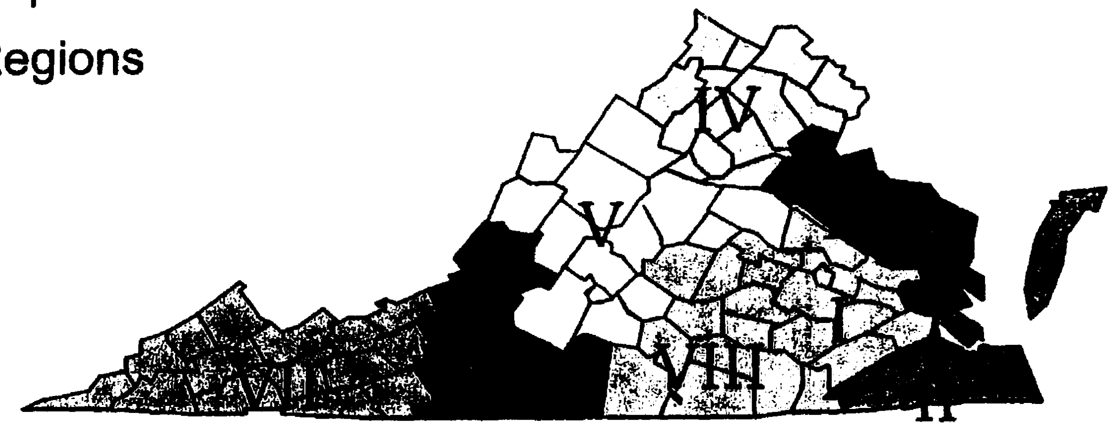
## Virginia Department of Education Internet Connectivity Survey
## September 1999

| Connectivity by School Size | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***School Type*** | ***School Size*** | Total Number of Schools | Number not Connected | Number Connected < T1 | Number Connected T1 or better | Percent Connected T1 or better | Total Connected | Percent Connected |
| **Elementary Schools** | Less than 300 Students | 411 | 18 | 159 | 234 | 56.93 | 393 | 95.62 |
| | 300-999 Students | 719 | 13 | 343 | 363 | 50.49 | 706 | 98.19 |
| | 1000 or more Students | 6 | 0 | 1 | 5 | 83.33 | 6 | 100 |
| | | **1136** | **31** | **503** | **602** | **52.99** | **1105** | **97.27** |
| **Middle Schools** | Less than 300 Students | 51 | 0 | 14 | 37 | 72.55 | 51 | 100 |
| | 300-999 Students | 167 | 2 | 68 | 97 | 58.08 | 165 | 98.8 |
| | 1000 or more Students | 57 | 0 | 3 | 54 | 94.74 | 57 | 100 |
| | | **275** | **2** | **85** | **188** | **68.36** | **273** | **99.27** |
| **High Schools** | Less than 300 Students | 46 | 3 | 11 | 32 | 69.57 | 43 | 93.48 |
| | 300-999 Students | 125 | 4 | 43 | 78 | 62.4 | 121 | 96.8 |
| | 1000 or more Students | 104 | 0 | 16 | 88 | 84.62 | 104 | 100 |
| | | **275** | **7** | **70** | **198** | **72** | **268** | **97.45** |
| **Combined Schools** | Less than 300 Students | 16 | 0 | 10 | 6 | 37.5 | 16 | 100 |
| | 300-999 Students | 31 | 1 | 13 | 17 | 54.84 | 30 | 96.77 |
| | 1000 or more Students | 1 | 0 | 0 | 1 | 100 | 1 | 100 |
| | | **48** | **1** | **23** | **24** | **50** | **47** | **97.92** |
| **Special Ed Schools** | Less than 300 Students | 32 | 3 | 3 | 26 | 81.25 | 29 | 90.63 |
| | 300-999 Students | 0 | 0 | 0 | 0 | — | 0 | — |
| | 1000 or more Students | 0 | 0 | 0 | 0 | — | 0 | — |
| | | **32** | **3** | **3** | **26** | **81.25** | **29** | **90.63** |
| **Alternative Schools** | Less than 300 Students | 35 | 5 | 8 | 22 | 62.86 | 30 | 85.71 |
| | 300-999 Students | 2 | 0 | 0 | 2 | 100 | 2 | 100 |
| | 1000 or more Students | 0 | 0 | 0 | 0 | — | 0 | — |
| | | **37** | **5** | **8** | **24** | **64.86** | **32** | **86.49** |

**SCHOOLS USING INTERNET FILTERING BY REGION**

Statewide, over 80 percent of schools use some type of Internet filtering technology. The use of filtering technology varies regionally, from 55 percent of schools in Region IV to 99 percent of schools in Region II. The percent of schools using filtering technology does not vary significantly by type of school.

# Virginia Superintendent's Regions



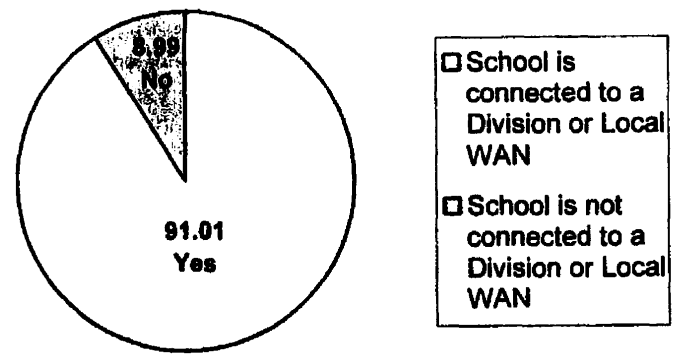

**Percent of Schools using Internet Filtering by Region**

| *Region* | Elementary Schools using | Middle Schools | High Schools using | Combined Schools | Special Ed Schools | Alternative Schools | Schools using |
|---|---|---|---|---|---|---|---|
| Region I | 98.69 | 100.00 | 95.00 | 50.00 | 80.00 | 100.00 | 97.58 |
| Region II | 100.00 | 100.00 | 100.00 | 100.00 | 33.33 | 100.00 | 99.45 |
| Region III | 98.11 | 95.00 | 95.24 | 100.00 | — | 50.00 | 96.00 |
| Region IV | 55.29 | 58.62 | 60.38 | 75.00 | 41.67 | 16.67 | 54.91 |
| Region V | 61.60 | 66.67 | 70.97 | 75.00 | — | 33.33 | 63.78 |
| Region VI | 80.47 | 82.76 | 92.31 | 100.00 | — | 100.00 | 83.16 |
| Region VII | 80.95 | 93.75 | 76.74 | 81.82 | — | — | 81.18 |
| Region VIII | 100.00 | 100.00 | 100.00 | 100.00 | — | 0.00 | 97.18 |
| STATE | 80.02 | 84.73 | 83.64 | 83.33 | 46.88 | 59.46 | 80.37 |

**SCHOOLS RECEIVING INTERNET SERVICE VIA WANS**

Over 93 percent of schools in Virginia receive their Internet service via a school division or other local Wide Area Network. A single Internet connection providing service to multiple locations over a WAN is a cost-effective way to provide service to multiple locations.

**Percent of Schools Receiving Internet via Division or Local WANS**

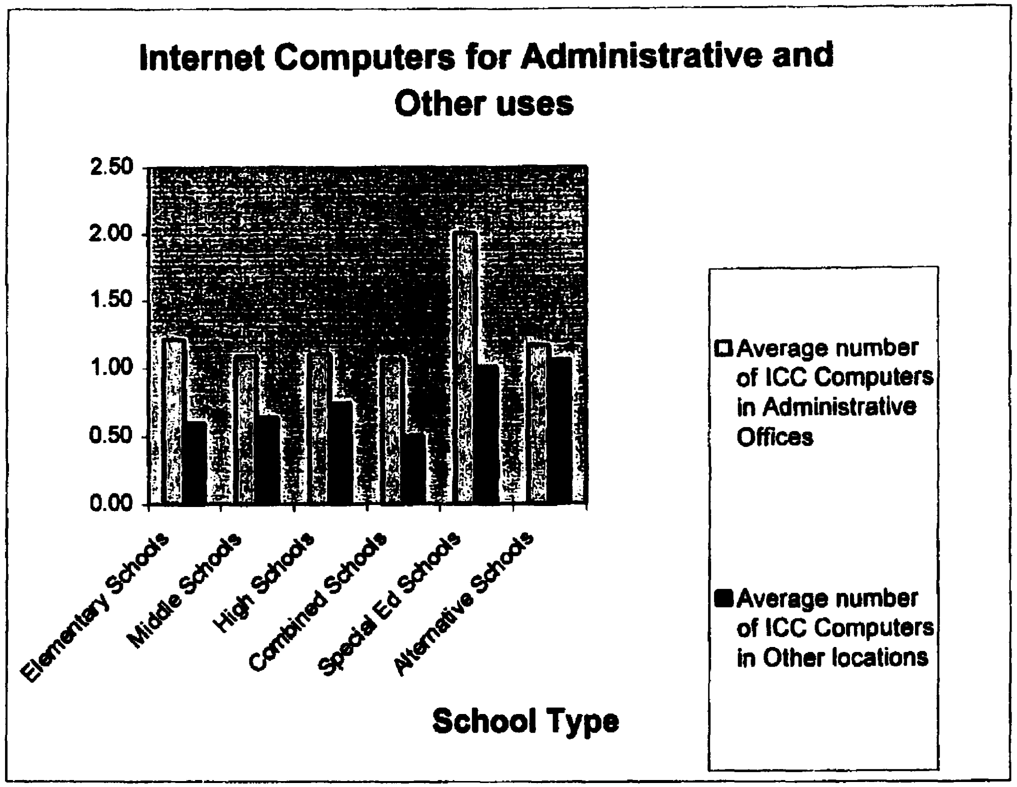



**Are WANS in place?**

| Schools connected to Division or Local WAN | Number | Percent |
|---|---|---|
| School is connected to a Division or Local WAN | 1641 | 91.01 |
| School is not connected to a Division or Local WAN | 162 | 8.99 |

**INTERNET CONNECTED AND CAPABLE COMPUTERS FOR ADMINISTRATIVE AND OTHER USES**

There is at least one Internet connected and capable computer in all administrative offices in each school regardless of school type.




**Administrative Computing**

| Type of School | Number of Administrative Offices | Internet Computers in Administrative Offices | Average number of ICC Computers in Administrative Offices | Number of Other locations | Internet Computers in Other locations | Average number of ICC Computers in Other locations |
|---|---|---|---|---|---|---|
| Elementary Schools | 2529 | 3057 | 1.21 | 2214 | 1321 | 0.60 |
| Middle Schools | 1295 | 1398 | 1.08 | 1002 | 635 | 0.63 |
| High Schools | 1858 | 2029 | 1.09 | 1615 | 1185 | 0.73 |
| Combined Schools | 198 | 209 | 1.06 | 72 | 36 | 0.50 |
| Special Ed Schools | 14 | 28 | 2.00 | 6 | 6 | 1.00 |
| Alternative Schools | 62 | 72 | 1.16 | 20 | 21 | 1.05 |
| TOTAL | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.65 |

Virginia Department of Education Internet Connectivity Survey
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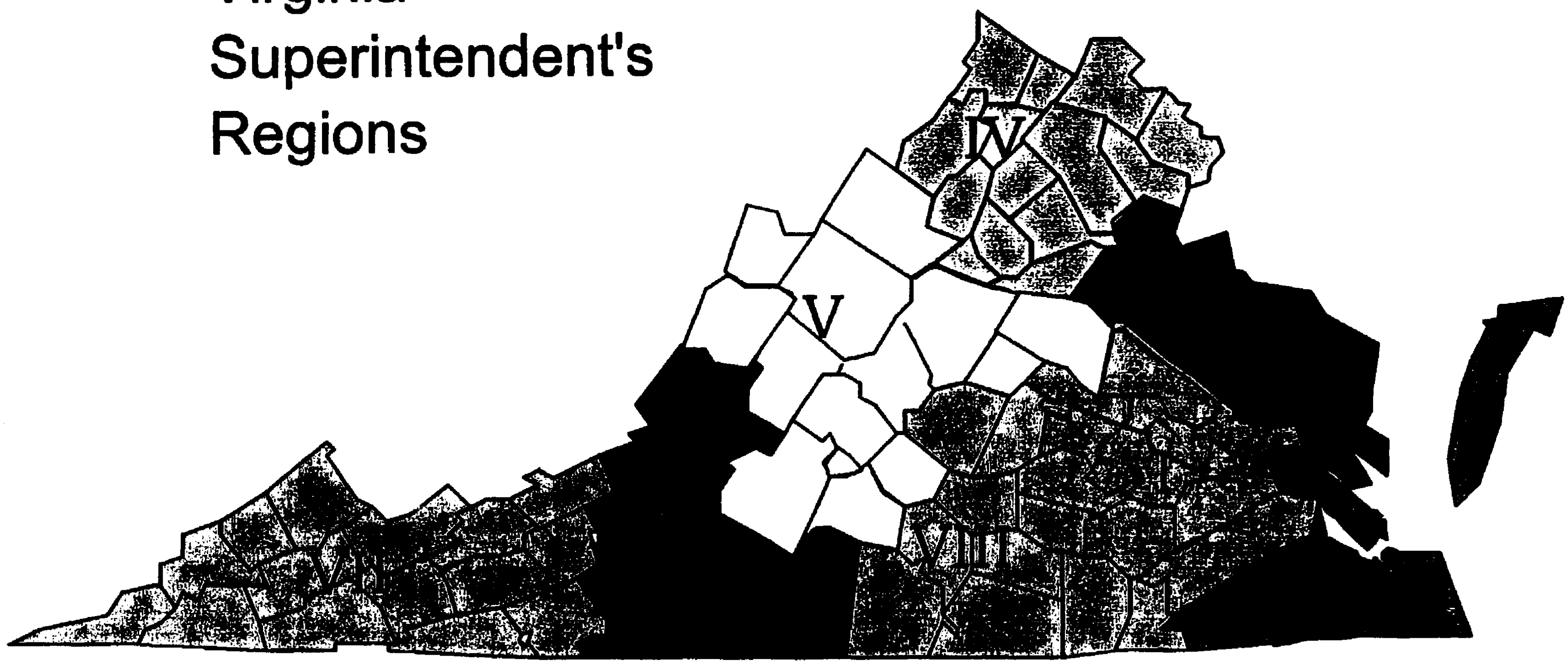
**Internet Service Providers to Virginia Schools**

| Internet Service Provider | Number of Schools Using this Provider | Internet Service Provider | Number of Schools Using this Provider |
|---|---|---|---|
| ATT WORLD NET | 7 | Nesbee Cable | 1 |
| BBN PLANET | 57 | Net Access | 13 |
| Bealenet | 6 | Network VA | 451 |
| Bealnet | 3 | PECPS | 3 |
| Bedford Cable | 4 | R& B Internet | 10 |
| Bell Atlantic | 70 | regional consortium of school divisions and public library | 3 |
| Bell Atlantic Internet Service | 251 | Rivernet | 3 |
| CableVision Communications | 21 | Rockbridge Area Networking Group | 2 |
| CFW Communications | 34 | SBO | 21 |
| Citizen's Telephone Cooperative | 5 | Shenandoah Tel Co | 9 |
| ComCast (Local Cable Provider) | 17 | shentel.net | 6 |
| Cox Cable | 53 | Sprint | 232 |
| Currently DIT. Changing to Bell Atlantic ASAP | 7 | Sprint link | 6 |
| Danville Public Schools | 14 | Summit Communications | 2 |
| Edge Computers DBA: Northern Neck Networks | 1 | swva.net | 6 |
| Erols | 5 | swva.net & neocom.net | 1 |
| Erol's Virginia Pen | 1 | Sylvan Information Services | 5 |
| Frederick Co. Schools | 15 | Tazewell y Public Schools | 16 |
| Gemlink | 3 | TDS.NET | 3 |
| GTE | 7 | Techcom | 19 |
| Halifax County Schools | 17 | U.S. West | 5 |
| Ideation World, Inc. | 10 | Unknown | 1 |
| InfiNet | 61 | UUnet | 57 |
| Intermedia | 18 | Virginia Pen | 2 |
| MountaiNet | 15 | WCS Dept IS&MP | 15 |
| | | WHRO | 140 |

**51 Internet Service Providers -- 1784 Schools Connected**

Virginia
Superintendent's
Regions



**Appendix C - House Joint Resolution No. 176**

## HOUSE JOINT RESOLUTION NO. 176

*Requesting the Department of Education to assess the technology needs of local school divisions and to develop guidelines for technology connectivity for the public schools.*

Agreed to by the House of Delegates, March 12, 1998
Agreed to by the Senate, March 10, 1998

WHEREAS, recognizing that "educational technology is one of the most important components, along with highly skilled teachers, in ensuring the delivery of quality public school education throughout the Commonwealth" and that "education technology can only be successful if teachers and administrators are provided adequate training and assistance," the General Assembly established a variety of initiatives to support educational technology in the public schools in 1995, pursuant to §22.1-199.1 of the Code of Virginia; and

WHEREAS, these initiatives addressed funding for educational technology and set priorities to support technology resource assistants, automate library media centers, provide network capabilities in Virginia's public schools, ensure access to the statewide library and other information networks, and address the retrofitting and upgrading of existing school buildings to efficiently use educational technology; and

WHEREAS, supporting this commitment to educational technology is Standard 5 of the Standards of Quality, which directs the Board of Education to assist local school boards in ensuring that instructional personnel are "proficient in the use of educational technology" consistent with this Plan pursuant to the Standards of Quality; and

WHEREAS, these educational technology initiatives will enhance classroom learning capabilities through distance learning opportunities that are critical to smaller and more remote school divisions; and

WHEREAS, the recently revised Standards of Learning for mathematics, English, social studies, and science incorporate curriculum standards for computer skills and technology and state that "the teaching of these skills should be the shared responsibility of teachers of all disciplines"; and

WHEREAS, acknowledging that the "efficient use of state resources dedicated to the acquisition of technology to provide . . . access to the electronic classroom throughout the Commonwealth requires a comprehensive examination of the state's educational technology infrastructure," the General Assembly created the Commission on Educational Infrastructure pursuant to House Joint Resolution No. 135 (1996) to "develop and recommend, in collaboration with the Select Committee on School Construction and the Select Committee on Educational Technology, an educational technology master plan which incorporates current networking and funding initiatives and provides a vision for meeting future school construction and educational technology needs as Virginia embarks upon the 21st century"; and

WHEREAS, to provide an educational program of the highest quality for all students, it is essential to build upon the efforts of these special studies and to continue to support the Commonwealth's commitment to improving educational technology in the public schools; and

WHEREAS, while some school divisions have updated local technology plans to establish connectivity with Net.Work.Virginia, the Commonwealth's precedent-setting high-speed network, a technology needs assessment and appropriate guidelines for connectivity will promote uniformity and expanded access to educational technology throughout Virginia's public schools; now, therefore, be it

RESOLVED by the House of Delegates, the Senate concurring, That the Department of Education be requested to assess the technology needs of local school divisions and to develop guidelines for technology connectivity for the public schools. Such guidelines shall include school local area networks, architectural models, definitions for local and shared services, and leveraging volume purchase agreements, and shall be designed to help ensure that the Commonwealth is connected through a network infrastructure to support K through 12 school initiatives for the 21st century, provide access for voice, video, and data telecommunications, and enhance the educational quality and experience for students across the Commonwealth. In developing these guidelines, the Department shall collaborate with the Center for Innovative Technology, the Council on Information Management, and high-technology companies in the Commonwealth, and shall consider the work of the Commission on Infrastructure and such other issues as it deems appropriate.

All agencies of the Commonwealth shall provide assistance to the Department, upon request.

The Department shall complete its work in time to report its findings and recommendations to the House Committees on Education and Appropriations and the Senate Committees on Education and Health and Finance by December 1999 and shall submit such findings and recommendations to the Governor and the 2000 Session of the General Assembly as provided in the procedures of the Division of Legislative Automated Systems for the processing of legislative documents.