FINAL REPORT

OF THE

MINNESOTA TELEFUTURES STUDY GROUP (MTSG)

TO THE

MINNESOTA PUBLIC UTILITIES COMMISSION

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EXECUTIVE SUMMARY

BACKGROUND

The Minnesota Telefutures Study Group (MTSG) was formed in 1990 at the request of the Minnesota Public Utilities Commission (Commission). Its purpose was to describe the telecommunications infrastructure required to further enhance Minnesota's leadership in telecommunications beyond the year 2000 and to develop a comprehensive set of recommendations, including industry and government actions, required to further position the State's telecommunications industry to deliver the latest enhanced telecommunications services required by the citizens of Minnesota. The study group was composed of representatives from the telecommunications industry, state agencies, public interest and customer groups.

The MTSG surveyed and analyzed the telecommunications infrastructure activities of some thirty other states, as well as industry initiatives and general information and data on the subject. This report contains the findings of the MTSG and its recommendations to the Minnesota Public Utilities Commission.

ACTIVITIES OF OTHER STATES

The MTSG found several objectives that were consistent throughout the various state plans they reviewed, including digital switching and fiber optic transmission facilities; redefinition of universal service to include technological advancements; examination of regulatory policies and practices; utilization of telecommunications to deliver educational, medical and government services more efficiently; promotion of telecommuting; facilitation of economic development opportunities through business cost reductions via telecommunications; and preparation of a detailed inventory of the existing telecommunications infrastructure.

The different approaches to infrastructure and alternative regulatory policies examined by the MTSG have been introduced into various jurisdictions in recent years. The MTSG believes that it is premature to conclude that any single approach provides superior results.

INDUSTRY SURVEY/MINNESOTA NETWORK CURRENT STATUS

To determine the current status of the network and local exchange carriers' (LECs') future infrastructure plans, the MTSG surveyed all Minnesota LECs in late 1991. Respondents serve 96 percent of all Minnesota access lines. Alternative data sources were reviewed, and those companies serving the remaining four percent of access lines were contacted, to complete the survey. The survey addressed services that the MTSG believes are most important to the development of a modern telecommunications infrastructure, including planned investment in facilities and systems.

The current telecommunications network in Minnesota consists of 94 local exchange companies, approximately 100 long distance companies, one local exchange competitor, and about 900 payphone companies. The local exchange carriers vary in size from 1.8 million access lines in 122 exchanges to 36 access lines in one exchange. The quality of service of even the smallest local companies in Minnesota is among the best and 70 percent of the State's access lines are served by a digital switching vehicle. Currently, 89 percent of all trunking facilities in Minnesota carry digital transmission and over two-thirds of the interoffice facilities are fiber.

ESTABLISHMENT OF MTSG GOALS

The MTSG developed short term, intermediate and long term goals for the provision of specific facilities and services that it believes are essential for an advanced telecommunications infrastructure in Minnesota. Phased goals were adopted in order to establish workable and achievable target dates for the study group's recommendations.

The short term goals include ubiquitous availability of the following by 1998: digitally switched access lines, digital interoffice facilities, single party service, touchtone calling, custom calling features, and interLATA equal access.

The intermediate goals cover Signalling System 7 (SS7), Integrated Services Digital Network (ISDN) and Custom Local Area Signalling Services (CLASS). SS7 is the next generation of signalling, providing out-of-band signalling which allows for more signalling information, fraud reduction and the opportunity for new service offerings. ISDN is a digital architecture that allows for an integrated voice/data capability over the end user loop facility. CLASS is an enhanced offering of nine central office based services and is available in offices equipped to provide these services.

The long term goal is deployment of a broadband network capable of supporting advanced services as dictated by market demand, competition, and technology development. Full evolution may take two decades due to evolving standards and technology. Current expected costs of deployment, excluding loop electronics, may range from $4,800 to $23,100 per access line.

These goals, and the technologies they encompass, are described in detail in this report, as are the associated applications and benefits. Potential regulatory issues related to the long term goal are also discussed.

RECOMMENDATIONS

The MTSG unanimously adopted the following recommendations:

Short Term

- All exchanges must be served by digital switches by January 1, 1998.

- All exchanges must be interconnected by digital interexchange facilities by January 1, 1998.

- All providers of basic local service must offer single party lines to customers upon request by January 1, 1995.

- All providers of basic local service must equip all lines with touchtone and provide touchtone to all subscribers without separate charge by January 1, 1995.

- All providers of basic local service must offer basic custom calling features to all subscribers by January 1, 1998.

- All subscribers should have access to multiple long distance providers on a presubscribed (1+) basis for interLATA calls by January 1, 1998. An intraLATA equal access recommendation was deferred pending the current docket before the Commission.

Intermediate

- SS7 trunk signalling for call set up should be deployed ubiquitously throughout the State by the year 2000.

- Information on ISDN features and availability should be provided, with further deployment and penetration in the State left to customer demand and individual company offering.

- In extended area service (EAS) markets, where one of the exchanges obtains CLASS services, the exchanges with EAS to that exchange should also obtain CLASS services within three years, with certain exceptions.

Long Term

- The MTSG broadband recommendation is dependent upon which factors are given the most weight (i.e., economic efficiency, governmental and budgetary constraints or societal and economic benefits).

- A broadband/broadband-like services tracking mechanism should be instituted so that policymakers can track the advancement of the infrastructure over time. Depending upon the type of market structure that develops in the future, certain regulatory issues will need to be addressed.

Section I: Introduction

Information is one of the most important commodities in today's global society, and the movement of information has become crucial to our social and economic vitality. Therefore, the telecommunications infrastructure and industry is important to the State in a number of ways. Advanced telecommunications capabilities and an array of new services have improved our quality of life in the areas of education, health care, safety and security, private and governmental services, and entertainment. Likewise, both large and small businesses are more reliant on advanced telecommunications services to operate more effectively and efficiently in order to remain competitive.

Modern telecommunications services can extend the ability of all citizens to access our nation's information resources. Interactive video is a prime example of this phenomenon. Interactive video, which allows face-to-face, two-way communication between equipped facilities, has a wide variety of uses. For example, interactive video can transmit specialty courses, such as foreign languages and advanced mathematics, to high schools whose enrollment and budget would not otherwise support such courses. As a result, some rural schools, perhaps candidates for consolidation with resulting loss of community identity, can remain viable. Eventually, this technology may bring education directly into the home. This technological breakthrough could be especially important to older, non-traditional students.

Similarly, interactive video will enhance the delivery of medical services. Rural patients and doctors will be able to consult with specialists in metropolitan areas without the necessity of expensive, stressful and, perhaps, life threatening trips to the city for diagnosis and treatment. Medical residents at rural hospitals will be able to receive the type of training heretofore available only at metropolitan hospitals via advanced communications services.

Advanced services will also bring increasing opportunities for telecommuting. The ability to simultaneously transmit voice, image and data will make telecommuting increasingly efficient for some employees. Telecommuting not only increases efficiency and helps reduce environmental externalities, it also makes possible lifestyle choices which would be otherwise unavailable.

In the market for home entertainment, video on demand will free consumers from current programming constraints and allow customers to pick and choose what they watch and when they watch it.

Telecommunications contributes directly to the economic activity in the State. In order to promote Minnesota's economic competitiveness and service the telecommunications needs of all Minnesotans well into the 21st century, advanced telecommunications services and capabilities will require a modern telecommunications infrastructure. The focus of this report is the analysis of how to meet the developing telecommunications needs of all Minnesotans.

In 1990, the Minnesota Public Utilities Commission (Commission) chartered the Minnesota Telefutures Study Group (MTSG) to examine the development of an advanced telecommunications infrastructure in the State of Minnesota. The study group, which was composed of representatives from the telecommunications industry, state agencies, public interest and customer groups (Appendix I) was to inform the Commission of the current status of the State's telecommunications infrastructure and recommend a wide range of service offerings consistent with customer requirements and for which there is a demonstration of current or future demand.

The MTSG-developed charter appears in this document as Appendix II. The charter identifies the following study group tasks:

- Develop a comprehensive set of recommendations regarding industry and government actions that will enable the State's telecommunications industry to deliver enhanced telecommunications services required by Minnesota citizens;
- Develop recommendations for the appropriate future deployment of telecommunications networks in Minnesota;
- Develop recommendations for the Commission, the Minnesota Legislature and other State regulatory agencies consistent with study group proposals; and
- Propose a comprehensive framework for implementation of study group proposals.

This report contains the findings of the MTSG and its recommendations to the Minnesota Public Utilities Commission. (For the reader's convenience, a glossary of terms is provided in Appendix XIII at the very end of this document.)

A. Objectives

After an assessment of the current status of the telecommunications infrastructure in Minnesota and an analysis of the facilities and services that other states have identified as important, the study group developed objectives for the specific facilities and services that it believes are essential for an advanced telecommunications infrastructure in Minnesota. As these items were identified, it became clear that a strategic implementation plan for the deployment of the specific components would be necessary. Some of the issues that the study group identified as important to a modern infrastructure are more time sensitive than others. Thus, the MTSG developed short term, intermediate and longer range objectives to facilitate implementation dates and recommendations.

In the process of its goal establishment, the MTSG considered the following factors:

- Accelerated infrastructure deployment costs and payment mechanism;
- Social and economic needs;
- Regulatory incentives and alternatives to encourage accelerated modernization;
- Shareholder risks and benefits;
- Statewide access to information;
- Representative modernization programs in other states; and,
- Customer benefits and impacts.

B. Infrastructure Development Activities Around the Nation

The MTSG surveyed and analyzed the telecommunications infrastructure activities of some thirty other states. (A list of documents and reference materials that were reviewed by the MTSG is attached as Appendix III.) Many of these states are addressing the same infrastructure issues as is the MTSG, although in most of these jurisdictions the proceedings are company-specific and involve considerations of the financial implications associated with any infrastructure modernization efforts. In some states the process began with an inventory of the existing infrastructure. In this way it is possible to identify the baseline level of resources that are available and the incremental investment opportunities that are required in order to achieve the desired objectives.

The study group reviewed specific plans from nineteen states. Several objectives appeared consistently throughout these documents. They were:

- Development of a telecommunications network comprised of digital switches and fiber optic transmission facilities;
- Redefinition of universal service to include technological advancements resident in the local exchange network;
- Examination of regulatory policies and practices;
- Utilization of telecommunications services for educational and/or medical services delivery;

- Utilization of telecommunications services to provide government services more effectively and efficiently;

- Promotion of telecommuting;

- Promotion of telecommunications as a means to reduce the costs of production and the costs of doing business so that economic development opportunities are facilitated; and,

- Preparation of a detailed inventory of the existing telecommunications infrastructure.

C. Representative State Experiences

The MTSG identified three approaches now being tried by various states to promote network upgrades: regulatory directives; eased competitive entry; and, incentive regulation compacts between regulators and local exchange carriers.

Tennessee

Some states have implemented notable programs that directly impact infrastructure decisions by allowing regulated earnings or depreciation expenses to rise or remain at high levels in return for which network improvements will be made. Among these approaches is the plan undertaken by the Tennessee Public Service Commission, "FYI Tennessee", that requires 100 percent deployment of Signalling System 7 (SS7), Custom Local Area Signalling Services (CLASS), and fiber optic interoffice facilities for most telephone companies in the state by 1993. The plan also calls for basic rate interface Integrated Services Digital Network (ISDN) to be made available on 60 percent of all telephone lines by 1995, with 100 percent availability by 1998. Currently, South Central Bell has made ISDN available in central offices that serve about half of its two million access lines. According to Tennessee Public Service Commission staff, a market penetration rate of from 50,000 to 100,000 ISDN customers by 1995 represents an ambitious but reachable goal. There continues to be disagreement between the company and other parties to the proceeding about the manner in which South Central Bell's excess earnings should be used, as well as the magnitude of those earnings.

Finally, the plan specifies deployment of broadband services to certain metropolitan locations by the year 2000, with a commitment to eventually serve the entire state.

The FYI Tennessee plan, like plans in Texas and Vermont, requires local exchange carriers to engage in significant investment programs prior to evidence of demand for the enhanced services. In Vermont, for example, where it serves approximately 264,000 access lines, New England Telephone invested some $300 million in new technology. During 1991, however, the company received only about $1.8 million in new service revenues. New England

Telephone subsequently filed for an increase in rates to compensate for the earnings erosion that it had experienced. Tennessee, on the other hand, has not experienced local rate increases.

As these cases illustrate, unless sufficient demand for new services already exists, or the local exchange carrier has sufficient earnings to fund large investments in the network, the funding may require increased local telephone rates.

New York and Michigan

A second approach used by states to impact the network infrastructure within their boundaries has been to permit the entry of alternative service providers into local and interexchange markets.

The New York Public Service Commission has allowed Teleport and Metropolitan Fiber Systems to provide certain services in major cities of that state. In Michigan, the state legislature passed a telecommunications deregulation bill (notwithstanding vigorous objections raised by the Michigan Public Service Commission) that, among other things, allows the Michigan commission the authority to grant more than one certificate of authority within the same service area. Further, the commission may authorize flexible regulation for a service if the market is found to be competitive and if cross subsidization will not occur. These rules do not apply to local exchange service.

Illinois

The Illinois Commerce Commission allows local competition and has been authorized by its legislature to order the unbundling of the monopoly bottleneck features of the incumbent local service provider.

Reliance upon competitive entry to achieve network modernization, such as represented by the Illinois example, may confer less risk upon monopoly ratepayers than will a supply driven plan. However, it should be recognized that the simple removal of legal barriers to entry, or the mere presence of a competitive service provider in a market currently dominated by a regulated common carrier is, on its face, insufficient to demonstrate the existence of a competitive market, nor should that criterion alone be used to fashion regulatory policy.

New Jersey

A third approach, related somewhat to the first, is one which provides reduced regulatory scrutiny and greater pricing flexibility in return for specific network investments. At least thirteen states, including Minnesota, use this mechanism as part of a so-called "incentive regulation" program for one or more local exchange carriers. It is important that any alternative regulatory approach provide a balanced sharing of risks and benefits.

New Jersey is an example of a state with a plan that links both alternative regulation and the deployment of network technology. New Jersey Bell has proposed an aggressive eight year plan for the accelerated deployment of technology. The New Jersey Board of Public Utilities approved the plan with modifications. New Jersey Bell is expected to spend $1.5 billion on infrastructure through the year 2000 and between $3 billion and $5 billion over the life of the entire plan. The plan calls for 100 percent deployment of an Advanced Intelligent Network (AIN) by 1998, 100 percent deployment of narrowband by the year 2000 and 100 percent deployment of broadband by 2010.

The New Jersey plan includes a sharing provision, but according to company projections, there will not be any sharing during the eight year plan. Further, in addition to the absence of sharing, the company has projected a minimum of five years of rate increases.

Summary of State Experiences

All three of these different approaches to infrastructure and alternative regulatory policies have been introduced in recent years. For that reason, it is premature to conclude that any single approach provides superior results over another.[1] However, non-traditional modernization plans pose risks to ratepayers and shareholders because either the local exchange ratepayer will be required to cover the costs or the shareholders will be required to absorb the costs resulting from the absence of sufficient demand for anticipated service offerings. The Minnesota Commission is presently involved in a proceeding in which it will measure the success of U S WEST's current incentive regulatory plan. Other states undoubtedly will do the same for programs conducted within their jurisdictions in the near future.

D. Telecommunications Industry Survey

As part of the effort to document existing industry capabilities and plans, the MTSG surveyed all LECs in Minnesota in late 1991 (Appendix IV). Responses were returned in January 1992 from nearly every LEC in the State. The companies responding serve 96 percent of all access lines in Minnesota. Alternative data sources were reviewed, and those companies serving the remaining four percent of access lines were contacted, to complete the survey.

The survey queried each company about its present investment plans, assuming that existing regulatory and economic conditions continued to prevail. The survey addressed services the MTSG believed were most important to the development of a modern telecommunications infrastructure: touchtone, custom calling features, equal access for both interLATA and intraLATA service, CLASS, and ISDN. In addition, the survey gathered information concerning investment in facilities and systems, such as digital switches, SS7, interoffice digital facilities,

[1]The National Regulatory Research Institute (NRRI) expects to issue a comprehensive report on the various state experiences in the Spring of 1994.

and broadband services. Annual penetration rates were estimated for each service. The survey results will be discussed more completely later in this report.

E. Current Status of the Telecommunications Network in Minnesota

The telecommunications industry that has developed under traditional regulatory procedures in Minnesota consists of 94 local exchange companies, approximately 100 long distance companies (interexchange carriers or IXCs), one local exchange competitor, and about 900 payphone companies. Since the Minnesota Commission endorses a policy of encouraging the entry of responsible and reliable competitors, the number of companies changes frequently throughout any year. In the past decade, Minnesota's citizens have enjoyed reliable telecommunications service provided at stable or declining rates for some telephone services, from both local and interexchange carriers. Rate stability may be one factor that has caused Minnesota to continually rank among the top four states in the nation in terms of the percentage of households with a telephone. (FCC Monitoring Report, 1992.)

The size of the local monopoly exchange carriers in Minnesota varies from the largest company with 1.8 million access lines in 122 exchanges to the smallest company with 36 access lines in 1 exchange. Figure 1-1 provides one description of the range of local companies in the State, shown as a distribution of local exchange carriers by number of access lines served.

MINNESOTA TELEPHONE COMPANIES BY SIZE

# Access Lines	0-1000	1000-5000	5000-10000	10000-30000	30000-1000000	1000000 +
# LECs	30	40	15	5	3	1

Figure 1-1

While the number of companies serving fewer than 1000 access lines appears quite high when compared with other states, it must be noted that the quality of service provided by the smallest local companies in Minnesota is among the best in the nation. In 1992, for example, all but one percent of the access lines supplied by these small companies were receiving service from a digital central office. Furthermore, the entire industry has been deploying the newest technology. As shown below in Figure 1-2, approximately 81 percent of the State's exchanges, serving about 70 percent of the access lines, now are served by a digital switching vehicle. The proportion of lines receiving local service through a digital switch is lower in the Twin Cities than elsewhere in the State. This does not imply that service is inferior in the largest metropolitan area of the State; rather, the electronic analog switches in Minneapolis and St. Paul are capable of providing most of the services that come with a new digital switch. It is not always necessary to have a digital switch to perform such functions as touchtone, custom calling, equal access or CLASS. At this time, 97 percent of the central office switches in Minnesota can perform or be modified to perform these types of functions.

CENTRAL OFFICE SWITCHES IN MINNESOTA

		ANALOG	ANALOG-ELEC	DIGITAL	TOTAL
GREATER MN	EXCHANGES	105	11	514	630
	ACCESS LINES	65,758	70,304	878,642	1,014,704
METRO AREA	EXCHANGES	0	20	56	76
	ACCESS LINES	0	581,320	758,441	1,339,761
TOTAL	EXCHANGES	105	31	570	706
	ACCESS LINES	65,758	651,624	1,637,083	2,354,465

(Year End 1993)

Figure 1-2

Every county in Minnesota has at least one fiber route available for use by any customer that requires high speed capacity. Over 11,000 fiber route miles were in service in 1993, representing two-thirds of the total transmission facilities in the State. As indicated in Figure 1-3, optical fiber is pervasive, connecting small towns and metropolitan areas alike.

Although optical fiber is the medium of choice for most new construction, digital microwave and copper facility are also capable of digital service transmission. Currently, 89 percent of trunking facilities in Minnesota carry digital transmission.

With the continual, gradual expansion of equal access throughout the State, most Minnesotans can obtain interexchange services that previously had been available only in urban areas. The entry of new competitors has accompanied a trend of facility modernization by interexchange carriers, with approximately 85 percent of all transmission plant being fiber optic at this time.

Minnesota's cellular industry is now providing wireless communications throughout the State. Today, over 90 percent of the State's population and 80 percent of its land area have access to cellular communications. Every community in the State with a population over 1,500 has cellular service available. Rural Minnesota, served by Cellular 2000, is uniquely served. The rural cellular companies have linked together to form a seamless system encompassing most of Greater Minnesota. Minnesota was the first state in the nation to provide this seamless coverage, eliminating roaming charges between rural service areas as well as toll charges within this expanded service area.

The cable television industry in Minnesota has also expanded. Over 400 communities in Minnesota are served by cable television systems. Nonetheless, cable television subscriber levels have remained relatively low. In 1992, only four states had lower penetration levels. Approximately 750,000 households in Minnesota, representing a penetration rate of 46 percent of the households with a television, subscribe to cable television. Notwithstanding these levels of subscribership, Minnesota leads the nation in providing local public access programming. The cable industry in Minnesota is rapidly deploying fiber optic transmission technology in its systems, down to the neighborhood level. It is also in the process of linking rural cable systems together with fiber optics in order to eliminate numerous "head ends" and provide a high level of technical quality for subscribers.

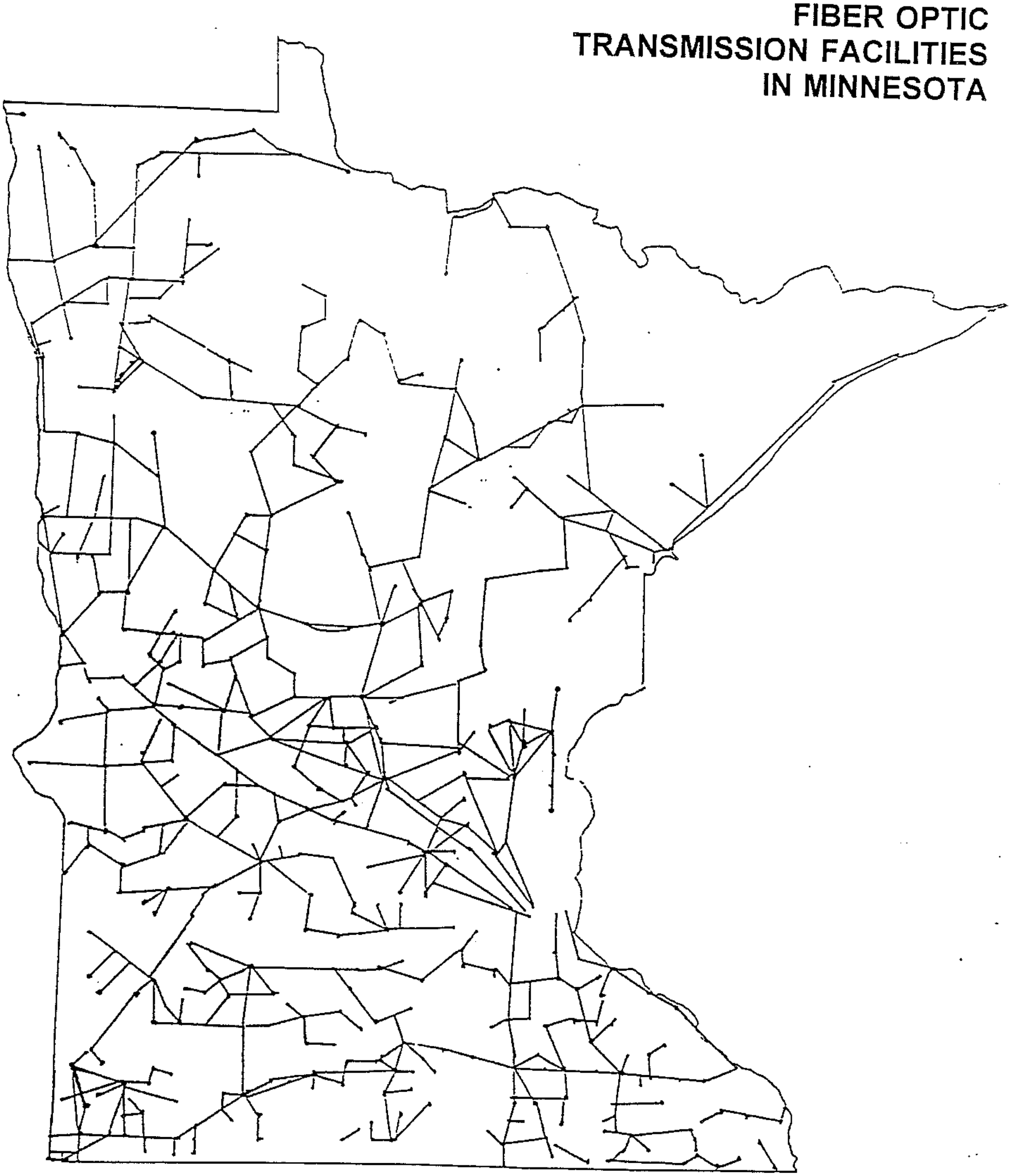

Figure 1-3

(May 1993)

Section II: Short Term Goals

In the short term (1994-1998 time frame), the Minnesota Telefutures Study Group (MTSG) believes it is important to have the following attributes available to all Minnesota subscribers and supported by digital switching and interoffice facilities: single party service, equal access, touchtone, and custom calling features. These features will allow all Minnesota customers to take advantage of new technology and the services supported by this new technology. For example, these features provide greater privacy and better access to 911, touchtone activated services, and long distance carriers.

For comparison purposes, Figure 2-1 indicates the current industry plans for the provision of these features.

CURRENT INDUSTRY PLANS

Features	% Capability	Year
Digitally Switched Access Lines	94%*	2001
Digital Inter-office Facilities	97%**	1994
Single Party	100%***	1994
Touchtone	100%***	1991
Custom Calling Features	100%***	1997
Equal Access - InterLATA	98%***	2001
Equal Access - IntraLATA	8%****	1992

* Remaining 6% are analog-electronic with stored program control.
** Route miles.
*** Percent of access lines.
**** Represents percent of access lines in exchanges served by MEANS. Further deployment is pending final disposition of Docket No. P-999/CI-87-697.

Figure 2-1

Each of these important attributes, and their recommended implementation dates, will be described more fully later in this section. However, it is important to first describe the need for ubiquitously deployed digital switching and digital interoffice facilities as an infrastructure platform for the State of Minnesota.

A. Digital Switching and Digital Interoffice Facilities

Background:

A telephone call typically travels along twisted copper pairs from the subscriber's premise to the LEC central office switch. The switch automatically "switches" the call by connecting the calling party to the called party.

The local central office switch also performs a number of other functions in addition to completing the connection between the calling and called parties. These auxiliary functions are collectively referred to as signalling. Signalling includes generation of dial tone, ringing and busy tones, pulse or touchtone dialing, recognition of busy and off hook conditions, and recording of billing information.

Local central offices have limited capacity. In other words, they can provide service to a discrete number of subscribers. Thus, in larger communities and metropolitan areas, local calling areas are served by multiple local central offices. These local central offices are interconnected by interoffice transmission facilities. In a large metropolitan area, such as the Twin Cities metropolitan calling area, these local interoffice transmission facilities may be connected to a local tandem switch. (A tandem switch is a switch that connects switches to other switches.)

Long distance calls are typically carried by LECs to a long distance carrier's network. This point of interconnection with a long distance carrier is typically referred to as a point of presence (POP). The long distance carrier or interexchange carrier (IXC) then carries the call to another POP on the far end of the call. The LEC on the far end then carries the call from the POP to the called party. Since IXCs will generally have a very limited number of POPs within a state, it is economically efficient for LECs to deploy interoffice transmission facilities to access tandem switches. The access tandem switches then direct the call to the local central office where the POP has a network interconnection.

As is evident from this background discussion, there exists a "hierarchy" of switching. The hierarchy extends from local central offices to local tandems to access tandems to IXC switching systems and other provider switching systems (i.e. cellular, information providers, etc.).

There are two types of telecommunications network transmission. They are analog transmission and digital transmission.

Analog transmission employs an electronic "analog" of the sound pressures created by speech. Speech sound pressures can be translated into a varying electrical voltage by the vibrations of the carbon granules in the microphone of your telephone handset. The grooves in a phonograph record are an example of a speech analog.

The quality of analog transmission depends on the accuracy of each copy of the speech analog. A characteristic of analog transmission is that a new copy is made from the old copy at intermediate points in an analog telecommunications network. Analog signals lose their strength, quality, and accuracy with distance as they travel over distribution (loop) transmission and interoffice transmission facilities. This requires the use of "repeaters" and "amplifiers" throughout the network.

Digital transmission systems convert speech into a coded series of numbers (zeroes and ones) or digits. Once the message is in digital form, it can be processed by special purpose digital computers (digital switches). Computer processing provides better quality and lower cost than analog systems. System maintenance is easier and calls are clearer because digital systems introduce little additional error (noise). The quality of a compact disk recording compared to a dusty phonograph record graphically illustrates the quality advantage of digital communications compared to analog communications.

The current telecommunications network infrastructure in Minnesota can be conceptually segmented into three distinct areas. These conceptual segments include:

1. Loop plant (distribution plant).

2. Switching.

3. Interoffice facilities.

The telecommunications industry in Minnesota has made progress in converting the switching segment of the infrastructure and the interoffice facilities segment of the infrastructure to digital. The conversion of switches and interoffice facilities to digital should occur by 1998. However, in so doing, the MTSG believes that local exchange carriers should not be permitted to prematurely retire otherwise functional analog-electronic switches in order to accomplish this conversion.

The loop plant segment of the infrastructure will be the last segment of the infrastructure converted to digital on a ubiquitous basis. There are multiple reasons for this, but they are basically centered around demand and cost. Today, virtually all switched telephone traffic (i.e. demand) continues to be for voice calls. Nearly all such calls are delivered to the subscriber in analog form, because human beings cannot process (hear and understand) voice messages (sound) in a digital format.

Nonetheless, digital switching is attractive for handling analog voice traffic because switching is accomplished electronically with no moving mechanical parts. Moving mechanical parts are subject to wear and corrosion which causes degradation. In addition, electronic analog and digital switch functionality is defined by computer software [Stored Program Controlled (SPC)] which is much easier to modify and enhance than are older hard wired electromechanical designs.

Digital Switching:

Digital stored program control switching equipment extends the concept of a computer controlled network. Digital switching is modular in design and uses a distributed architecture consisting of a highly specialized central processor and microprocessor controlled peripheral devices. Unlike analog switching, the physical path through the network is not dedicated to a single connection. The network path in digital switching is time shared to switch a number of encoded signals (each with their own time slot).

Digital switching expands on the advantages of analog electronic stored program controlled switching as is illustrated by the following points:

- Software defined switching allows for easier adaptation to meet customer service needs.

- Less building space is used.

- Sophisticated analysis, testing, and maintenance programs can be run by technicians via remote switching control center locations.

- Since features and services are stored in the software of the switch, the telephone company extends the capability of deploying advanced features and services to remote locations.

Digital switching has additional advantages which are distinguished from analog switching. These include:

- Digital switches are required in the development of an end to end digital network. They improve network efficiencies with the elimination of analog/digital conversions.

- Network quality is improved because digital signals are less subject to noise, attenuation, and distortion.

- The absence of mechanical relays in digital switching reduces wear and corrosion.

- Modularity of the digital switch allows for ubiquitous placement. Modularity is conducive to the addition of either software or hardware that will permit the introduction of new services such as ISDN or CLASS. (Existing digital switches are not broadband capable and in all probability will require replacement in order to accommodate broadband capabilities.)

- Digital switches enjoy advantages over analog switches in the form of lower maintenance costs.

- Vendor competition has driven digital switching costs below that of analog, thereby making digital an attractive economic alternative. The market for digital switching, formerly the domain of manufacturers like AT&T and Northern Telecom, now includes Siemens, Stromberg-Carlson and Ericcson.

Digital switching has emerged as the state-of-the-art technology. It is the preferred replacement vehicle for all new switch conversions. A brief description of the various types of digital switching systems follows:

Host/Stand-Alone for Larger Offices: The AXE10, 5ESS, DMS-100/200 combine large scale integrated semi-conductor devices and the latest software technologies into a local digital switching system. They are also designed to be applicable across the entire size range of offices. To cover this wide range of applications, a modular design is used that allows switching capacity, system features and processing power to be added in an incremental fashion.

Host/Stand-Alone for Smaller Offices: The DCO, 5ESS-CDX and DMS-10, as well as others, combine large scale integrated semi-conductor devices and the latest software technologies into a local digital switching system. They are designed to be applicable across the smaller size range of offices in a more economical fashion than the larger switches, even though the available features are usually similar. Economy is often achieved through smaller overall main processor capacity and delayed deployment of new features, capitalizing on the earlier large switch economies of scale. These switches typically have smaller line and trunk limitations than do the larger models.

Remote Switch Units for Smaller Offices: The remote switch unit (RSU) is basically a switch that is remotely located, connected by digital interoffice facilities to a digital host switch and provides switching capabilities in the network. An RSU can be used to offer customers any or all of the features of the host office in areas that cannot economically support the cost of a stand alone switch.

Tandem/Operator: Presently DMS-100/200, DMS-200, and 5ESS digital tandems provide intraLATA toll switching and serve as access tandems to the IXCs. The 5ESS may also provide intraLATA operator services with the Operator Service Position System

(OSPS) function through 5ESS host and remote switches. The OSPS function can also be part of the toll tandem, if capacity permits.

Digital switching has been used as a replacement technology in Minnesota for electromechanical and analog-electronic stored program control switches throughout the decade of the 1980s and to the current time. As a summary, the advantages of digital switching include cost, modularity, quality, maintenance, and the ability to have software updated to increase capacity and provide new services.

Future expectations are that digital switches will continue to replace analog electromechanical switches and analog-electronic switches until the MTSG's short term goal is reached. During the 1990s, several enhancements are planned for digital switches, not only to improve processor capacity and facilitate new service introduction, but also to enable the introduction of SS7 and ISDN.

The future of digital switching will be determined by the necessity of deploying fully capable broadband switches or the introduction of a new technology, i.e. optical switching. It is projected that optical switch technology may generally become available in the 2005-2010 time frame.

Recommendations:

1. All exchanges must be served by digital switches by January 1, 1998.[2]

   There are approximately 105 switches, serving 65,758 access lines, that will be replaced by January 1, 1998. If an average cost of between $350 to $500 per access line is used to estimate the cost of the upgrades, then replacing these 105 switches results in a total cost of between $23 million and $33 million.

   Current industry plans (with the exception of analog stored program control switches) call for the replacement of all switches to digital by January 1, 1998. Therefore, the current industry plans are consistent with the study group's goals. This recommendation by the MTSG will ensure that the industry adheres to the current plans without unnecessary deferrals.

   No costs beyond what is already planned would be incurred. For some LECs, current plans may include requests for local rate increases.

   By January 1, 1995, all providers of basic local service should submit a plan to the Commission for the provision of digital switching by the January 1, 1998 deadline or

[2]Analog stored program control switches are functionally equivalent and would, therefore, not be required to be replaced by January 1, 1998.

request an extension or waiver. An extension or waiver may be appropriate because the recommendation may disproportionately affect particular companies. Additionally, some companies may have to deploy significant resources in order to meet this standard.

2. All exchanges must be interconnected by digital interexchange facilities by January 1, 1998.

   Current industry plans are consistent with this recommendation. The industry anticipates spending approximately $16.1 million by January 1, 1998 for the provision of digital interexchange facilities. (The industry anticipated spending $28.5 million in 1991 and 1992 on digital interexchange facilities.)

   By January 1, 1996, all providers of basic local service should submit a plan to the Commission for providing digital interexchange facilities or request an extension or waiver.

B. Local Service Attributes:

1. Single Party Service:

Single party service is generally defined to include the following features:

- One subscriber per access line;
- Directory listing;
- Discrete telephone number;
- Access to directory assistance;
- Access to operator services;
- Access to emergency service (911/E911); and
- One-plus access to long distance.

Single party service is currently available to 99.2 percent of all Minnesota subscribers. A very small number of subscribers presently have access only to multi-party service. These subscribers will have their distribution/loop plant upgraded to enable single party service by 1994. Beyond 1994, single party service will be available to all Minnesota subscribers.

In addition to the features listed above, single party service may be preferable to multi-party service for the additional reasons of privacy and the availability of service at any time (i.e. not having to share service). A greater number of services and features can also be made available to single party subscribers.

Recommendation:

All providers of basic local service must offer single party lines to customers upon request by January 1, 1995.

Current industry plans are consistent with this goal. Since 99.2 percent of the access lines in Minnesota are already provided with one party service, the expense associated with meeting the January 1, 1995 date is approximately $28.3 million.

By July 1, 1994, all providers of basic local service should submit a plan to the Commission for implementing this recommendation or request an extension or waiver.

2. Touchtone Service:

Dual Tone Multi-Frequency (DTMF) is a term describing push button or touchtone dialing. (Touchtone is a registered trademark of AT&T.) With DTMF, when you touch a button on a push button pad it makes a tone, actually a combination of two tones, one high frequency and one low frequency. Thus, the name dual tone multi-frequency. These tones are sent over the telecommunications network, picked up and interpreted by telecommunication switches and devices. These tones may be sent over the network through the use of Customer Premise Equipment (CPE) even if the customer subscribes to rotary dial service.

Standard telephones have twelve buttons, thus twelve combinations of tones. The twelve possible tones that comprise the DTMF signalling system were specially selected to easily pass through the telephone network without attenuation and with minimum interaction with each other. Since these tones fall within the frequency range of the human voice, the dual tones were added to prevent the human voice from inadvertently initiating or "falsing" DTMF signalling digits.

With touchtone dialing, a wide variety of features and services are available to customers: accelerated dialing speed; dialing accuracy; information services such as sports, weather, legal, stocks, etc.; electronic banking; airline scheduling; voice mail; education; entertainment; TV marketing; voting and many more.

One hundred percent of Minnesota central offices are equipped with touchtone service and approximately 80 percent of Minnesota customers subscribe to touchtone.

There is a trend developing to include touchtone service as a part of basic service. As this trend continues, the penetration of touchtone service in Minnesota and the United States will increase. When touchtone is included in the definition of local service, regulators are confronted with decisions concerning revenue recovery through local rates for the former "premium" touchtone revenue stream.

Recommendation:

All providers of basic local service must equip all lines with touchtone and provide touchtone to all subscribers without separate charge by January 1, 1995.

By July 1, 1994, all providers of basic local service must file a plan with the Commission to eliminate the separate touchtone charge or request an extension or waiver. An extension or waiver may be appropriate if costs and lack of customer demand justify it.

3. Custom Calling Features:

Custom calling features are available with digital and stored program control switches. These optional services are provided to customers at a monthly fee, allowing them to select additional services by using the features available in their local telephone switch. Standard custom calling features include:

Call Forwarding: Call forwarding enables a customer to transfer calls to any local or long distance telephone number.

Call Waiting: When a customer is on a call, he will hear a soft tone signal when someone else is trying to reach him. Only the customer will hear the tone, the caller will hear normal ringing.

Call Waiting Control: This enhanced feature allows the customer to turn off call waiting at any time.

3-Way Calling: Allows customers 3-way conference calling availability from their telephones.

Speed Calling: Enables customers to dial frequently called telephone numbers by using only one or two digits.

Direct Number Transfer: Allows the customer to transfer all of their calls to a second predetermined telephone number. The local telephone company establishes this number at its office. The number is activated/deactivated by the customer.

Hotline: Enables customers to ring a predetermined number by simply dislodging the telephone receiver from its cradle position.

Warmline: Similar to the Hotline feature except that the customer has a set period of time in which to dial an outgoing call before their line rings to a predetermined number.

Call Transfer: Allows a customer to transfer a call from their line to another line.

Ring Again: If a customer receives a busy signal, their telephone will keep trying to call that number for 30 minutes. If the called line becomes available within this time period, they will be automatically connected.

Distinctive Ringing: Two separate telephone numbers are assigned to the same line. Each number has its own distinctive ring. (Also called Teen Service).

Recommendation:

All providers of basic local service must offer basic custom calling features to all subscribers by January 1, 1998.

Custom calling features are currently offered to 97 percent of the access lines in Minnesota. To reach 100 percent of the access lines in the State by January 1, 1998, there would be no additional costs beyond those identified for upgrading all switches to digital, as discussed above. As the current industry plans are consistent with the study group's goals, no additional costs would be incurred to achieve this goal.

By July 1, 1997, all providers of basic local service must file a tariff with the Commission for the provision of basic custom calling features or request an extension or waiver.

4. Equal Access:

Local Access and Transport Areas (LATAs) were defined at the time of the Regional Bell Operating Companies' (RBOCs') divestiture from AT&T. The RBOCs and GTE were prohibited by the divestiture agreement (the Modified Final Judgement or MFJ) and the Consent Decree, respectively, from providing interLATA services. LATAs are important because they define the geographic areas within which the RBOCs and GTE can provide local and short haul toll services. This is called intraLATA service. AT&T, and other interexchange carriers such as MCI, Sprint, etc., may provide service between LATAs or interLATA service. Local exchange carriers provide subscriber "access" to the IXCs so that subscribers may place long distance calls. There are five LATAs in Minnesota, as is illustrated in Figure 2-2.

"Access" may be defined as services which are provided to IXCs for interconnection to LEC networks and subscribers. Originating access is the capability for an IXC to receive a long distance communication which originates from an end user in a local exchange area. Terminating access is the capability for an IXC to deliver a long distance communication to the receiving end user. InterLATA access services are provided to interLATA IXCs for the provision of interLATA long distance communications. IntraLATA access services are provided to intraLATA IXCs for the provision of intraLATA long distance communications.

Minnesota LATA Boundaries

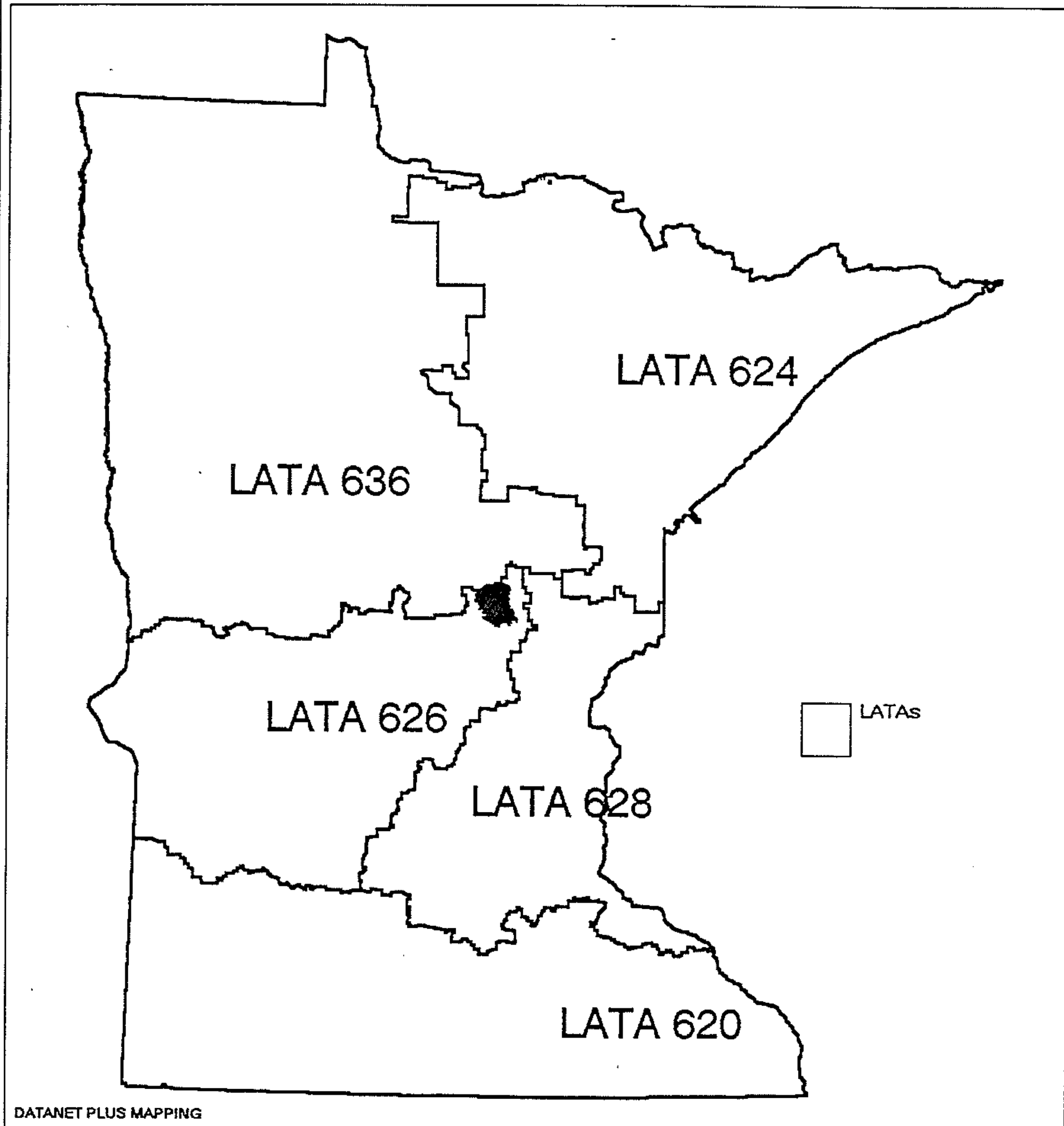

Figure 2-2

Equal access, either interLATA or intraLATA, is a specialized form of originating access service provided to IXCs. The interconnection is equal in type and quality for all IXCs. As a result of equal access services provided to IXCs, subscribers within the exchange areas of local telephone companies can route, by dialing "1" plus an area code and number, all their interexchange communications to the Primary Interexchange Carrier (PIC) of their choice. (Prior to the implementation of equal access, all interLATA long distance calls made by dialing "1" plus the number are routed to AT&T. All intraLATA long distance calls made by dialing "1" plus the number are routed to U S WEST. To have another IXC carry their toll call, a customer would have to dial several additional digits.)

Generally, when equal access is first implemented within a local exchange, the LEC has informed its customers of the options available and provided them with the opportunity to select a PIC. This process, called "presubscription", is usually accomplished with the use of customer information and a ballot sent to each customer. Customers not returning their first ballot with an IXC selection are sent a second ballot. Customers that have not responded to the second ballot are "allocated" or assigned to an IXC. These presubscription procedures are well documented in FCC guidelines.

In some cases, the equal access implemented allows for the customer choice of an IXC for interLATA 1+ calling and also for the choice of an IXC for intraLATA 1+ calling. This ability, or presubscription method, is called "2-PIC" or "full 2-PIC". Another presubscription method restricts the choice of intraLATA carrier to either the LEC providing intraLATA toll service or the same company as the customer's interLATA choice. This presubscription method is called "modified 2-PIC".

Equal access can technically be provided to IXCs in at least three different ways. First, a LEC can install appropriate software in its computer controlled local exchange central office switch. This method is referred to as end office equal access. End office equal access provides 1+ access at the local exchange central office without additional routing of the access traffic. Second, a local exchange company can place an adjunct unit between its local exchange office switch and the interexchange network. Third, multiple local exchange office switches can be connected to a central switch equipped with equal access capability. This third method is referred to as centralized equal access because it shifts the location of the equal access capability from the end office to a central switch which aggregates calls from many different end offices. The Minnesota Equal Access Network Systems, Inc. (MEANS) provides centralized equal access service in conjunction with approximately 61 independent telephone companies in the State of Minnesota.

Equal access service includes the forwarding of signalling information to the IXC, including Automatic Number Identification (ANI). This provides the IXC with important information regarding their customers and provides the IXC with the opportunity of recording and rating and billing and collecting for their customers' long distance calls under several different options.

Recommendations:

1. All subscribers should have access to multiple long distance providers on a presubscribed (1+) basis for interLATA calls by January 1, 1998.

   Unlike the other goals, achievement of this goal requires the participation of providers of local service <u>and</u> telecommunications carriers. Currently, Minn. Stat. §237.74, subd. 2, requires that "No telecommunications carrier shall unreasonably limit its service offerings to particular geographic areas unless facilities necessary for the service are not available and cannot be made available at reasonable costs." If providers of basic local service are required to provide interLATA equal access capability, Minn. Stat. § 237.74, subd. 2, provides a means for the Commission to ensure that carriers, in addition to AT&T (the current ubiquitous carrier), appear on the ballot to provide end users with a choice of interLATA long distance carrier.

   It has been estimated that the local exchange carrier costs of providing interLATA presubscription on an end office basis is approximately $48 per access line. To meet the above goal, 65,758 access lines have to be provided with interLATA equal access by January 1, 1998, for a total cost of approximately $3,150,000. These costs would be divided between the interstate and intrastate jurisdictions. The costs to provide equal access are generally recovered by the LECs from the IXCs through a per minute of use charge. End users may see these costs as a pass through from the IXC in the form of higher interstate and intrastate toll rates.

   By January 1, 1996, all providers of basic local service should submit a plan to the Commission for providing interLATA equal access or request an extension or waiver.

2. A recommendation on the time frame for providing intraLATA equal access and presubscription was deferred by the MTSG to Docket P-999/CI-87-697. In that docket, a study committee is looking at the specific costs of providing intraLATA equal access and presubscription, including switch manufacturers' ability to provide the service and the costs of provision. The study group provided current cost and availability information to the Commission on August 16, 1993. After that information was submitted, parties had 20 days to file comments. The Commission will likely take up the issue of implementing intraLATA equal access and presubscription during the Fall of 1993.

   Since this is an open and ongoing proceeding before the Commission, with many parties participating, the study group did not believe it was appropriate to make a recommendation in this report.

Section III: Intermediate Goals

The Minnesota Telefutures Study Group believes that consideration of Signalling System 7 (SS7), Integrated Services Digital Network (ISDN) and Custom Local Area Signalling Services (CLASS) is appropriate during the intermediate period (1994-2000) between achieving the short term goals identified earlier and the longer term broadband goals.

A description of SS7, ISDN and CLASS and the MTSG's recommendations regarding each are provided below. For comparison purposes, the current industry plans for the provision of the three services are shown in the following table.

CURRENT INDUSTRY PLANS
(Percent of Access Lines by 2001)

Features	% Capability
SS7	79%
ISDN Availability	59%
CLASS Availability	76%

Figure 3-1

A. Signalling System 7

In order to fully appreciate Signalling System 7 (SS7) capabilities, it is important to have a conceptual understanding of the required technology and how it fits into the existing telecommunications infrastructure.

Our current network infrastructure has limitations. It is a combined analog and digital network which will handle both voice and data demands with the appropriate conversion hardware and software. Its intelligence, however, is limited to common control functions and translations in the originating office to properly route calls to desired destinations, and to any terminating call features which may be invoked at the call destination.

Historically, the network infrastructure and switching hierarchy have required that the signalling for a call begin at the originating end and follow the same path as the call itself. Because there is not a separate signalling route or network, voice connections must be established by adding one circuit at a time, starting at the central office that serves the calling party and progressing toward the central office of the called party. Most of the signalling activity takes place before the called party answers. During this elapsed time, the transmission path is available for signalling. This signalling technique is referred to as per trunk or in-band signalling. The concern that per trunk signalling methods were not easily adaptable to evolving needs prompted the development of SS7.

The SS7 network and its use of out-of-band signalling will offer many important advantages over the network of today. These include: greater volume of signalling information, more efficient trunk utilization due to reduced call set up times, fraud reduction due to separation of the signalling and voice paths, and the opportunity for new service offerings.

A network infrastructure with more intelligence is essential to the provision of advanced services. The SS7 network will open the door to increasing the overall intelligence of the network by providing the capability to accurately and rapidly transmit signalling and control information between signalling nodes on the network.

The infrastructure of an intelligent network will consist of three basic elements including:

1. Stored Program Control Switching (SPCS) systems.

2. Centralized databases.

3. SS7 network.

It is important to remember that the SS7 network is a "dedicated" signalling network which is separate from the regular message or "plain old telephone service" (POTS) network. Figure 3-2 illustrates the basic network components which provide the SS7 capability. These basic SS7 network components include:

Signalling Transfer Point (STP): These are highly reliable packet switches that route SS7 signalling information between signalling points on the SS7 network. STPs are deployed in mated pairs for reliability reasons. The STPs provide translation and routing functions for SS7 signalling messages received from network signalling entities. They are the signalling "tandems" of the SS7 network.

Service Switching Point (SSP): The SSP is a switching office which is also equipped with SS7 capabilities to halt call progress, formulate and send a SS7 query to a database and route the call based on information contained in the response. SSPs are used in providing services such as 800 database and Alternate Billing Services and Line Information DataBase (ABS/LIDB).

Service Control Point (SCP): SCPs are databases in the SS7 network that provide SS7 network access to a variety of centralized database services such as 800 database and ABS/LIDB and calling name.

SS7 Network and Related Databases

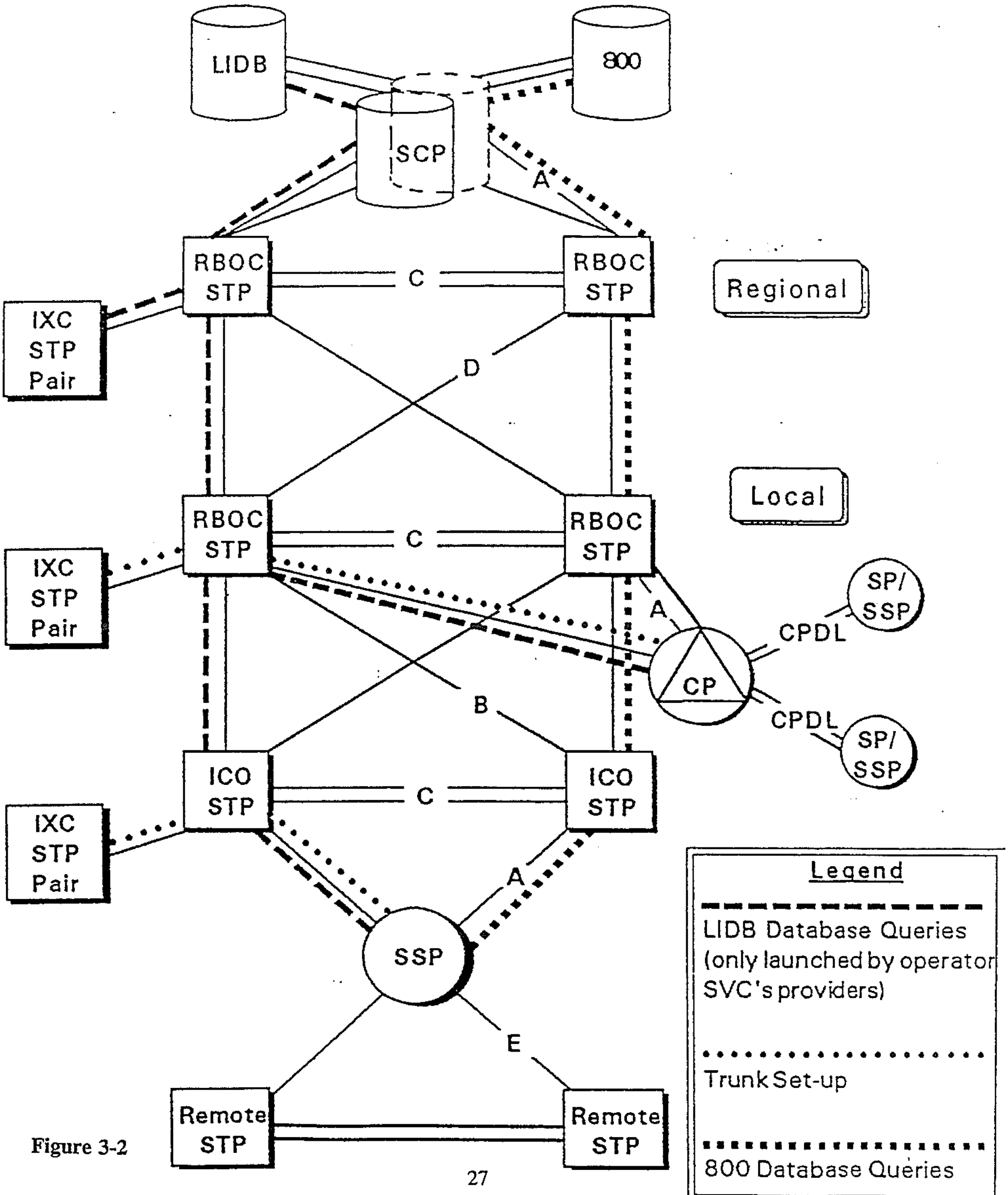

Figure 3-2

Signalling Links: These are the digital transmission paths operating at 56 Kb/s per second (Kb/s) that transport messages between elements of the SS7 network. Although signalling links may be routed directly between signalling points, they are normally routed to an STP for access to signalling links from other nodes on the network. For reliability, the link routes are encouraged to be physically diverse from each other.

Service Management System (SMS): This is an operational support system that provides service creation and customer control capabilities as well as support for the administration, coordination and control of the 800 database. The primary function of the SMS is to administer the customer call processing records in the SCP for 800 database service.

Signalling Engineering and Administration System (SEAS): SEAS is the operational support system for the SS7 network which provides surveillance, alarm reporting, recent change and verification, STP memory administration and traffic management.

Together, these components form a signalling network that can route and transmit messages in support of a wide range of network services and functions.

As implied above, SS7 is not a service. It is a technology that provides the capability for a wide variety of new products and services and significant improvements in existing services. Some of these new services and improvements include:

800 Database Service: This service will enable LECs to perform 800 number translation and to complete 800 calls independent of AT&T's database, from which LECs leased capacity prior to May 1, 1993.

The 800 service feature and the SSP work together to provide the capability to route 800 calls via the IXC chosen by the terminating 800 customer through the use of an 800 database provider (SCP). This is a technical way of describing 800 number portability (the ability of an 800 number subscriber to switch IXCs without having to switch their 800 number). The database creates and sends an SS7 response with the required call handling instructions (including the IXC network over which the call should be routed). The SSP/800 office then restarts call processing and routes the call based on these instructions.

As of May 1, 1993, all LECs in Minnesota were interconnected with an 800 database provider (SCP), enabling the 800 number portability feature. Prior to May 1, 1993, telephone companies had to enter and maintain an 800 database in their central office switches so that when a customer dialed an 800 number, the switch would know to which long distance company to route the call. With SS7, and the 800 database service, telephone companies will route calls over their networks to a regional database provider. The database provider will check the number dialed and send signalling instructions back to the LEC for routing the call to the appropriate IXC. Because 800 databases will be maintained by regional database providers, telephone company central office switches will no longer have to store the information. This will save local effort associated with in putting 800 codes and investigating trouble tickets associated with 800 codes.

It should be noted that 800 database represents an important SS7 related conversion activity for Minnesota, but it does not require the same level of capital modernization associated with investment in SS7 capabilities which facilitate other SS7 related services. As an example, additional modernization and capital expenditures are required to facilitate CLASS capability.

Alternate Billing Service/Line Information DataBase (ABS/LIDB): ABS/LIDB is the offering of calling card, collect and third number billing services using the SS7 architecture.

SS7 Trunk Signalling for Call Set-Up: The network use of SS7 for circuit switched call connection and release differs fundamentally from traditional in-band circuit signalling. Instead of sending signalling information on the facility used for subscriber to subscriber communication, the switching system sends signalling information via a separate signalling network. SS7 thereby allows switching systems to exchange information related to a circuit switched connection even when the circuit is in the conversation state. The benefit of this feature is the increase in the speed of call set up.

Custom Local Area Signalling Service (CLASS): CLASS is a set of call management features which generally provide the called party with control over incoming calls. The features are enabled by the ability to pass the calling party number to the terminating end office switch as part of normal SS7 call set up. This will generally require a generic software replacement in the local central office switch which results in the need to invest additional capital and expense dollars. CLASS services are explained more fully later in this section.

The LECs in Minnesota are generally deploying the SS7 infrastructure in an aggressive manner. Deployment is being driven in large measure by the Federal Communications Commission's (FCC's) 800 database order. This order provided specific post dial delay requirements. Under standards adopted by the FCC, each LEC may replace the 800 access system with the new 800 database access system when the LEC can reduce access times for 97 percent of its originating 800 database access traffic to five seconds or less, provided that, within two years thereafter, (a) none of its 800 database traffic experiences an access time of greater than five seconds, and (b) the mean access time for all of its 800 database traffic is 2.5 seconds or less.

Another driver of aggressive deployment in Minnesota is the fact that U S WEST is required to deploy a mated pair of STPs in each of the five Minnesota LATAs. Regional Bell

Holding Companies, including U S WEST, were not allowed to deploy STPs in a manner that would allow signalling information to be sent across LATA boundaries.

The final factor is the decision by MEANS to deploy the SS7 architecture. On a centralized basis, this will bring many of the benefits of SS7 to the participating LECs and their subscribers. MEANS has deployed an STP at its Plymouth, Minnesota access tandem location. MEANS is working cooperatively with Iowa Network Services (INS) in the deployment of this technology. The INS STP is located at its access tandem location in Des Moines, Iowa. Together, they are a mated pair. The MEANS STP is also interconnected with the U S WEST STPs in the Minneapolis LATA. For 800 database service, MEANS queries and U S WEST queries will be sent to the U S WEST regional databases.

SS7 is an appropriate intermediate goal for the MTSG to adopt for the industry because it is a technology which facilitates service improvement while also serving as a technology platform for services like CLASS.

Recommendation:

SS7 is the next generation of network infrastructure. The LECs in Minnesota have already expended significant resources to deploy SS7 capability in order to comply with the FCC's 800 database order. Since SS7 technology will pervade the network, its costs will be recovered from numerous services including local service, 800 database services, LIDB and CLASS.

The MTSG believes that the public interest will be served through continued deployment of SS7 capabilities throughout the State. This intermediate goal can be achieved through adoption of the following specific intermediate recommendation.

> SS7 trunk signalling for call set up should be deployed ubiquitously throughout the State by the year 2000. This will require considerable additional investment in central office generic software that will enable SS7 capabilities to be deployed at the end office level. The principle advantages include more efficient and faster call set up and the ability to deliver CLASS services on an interexchange or extended area service basis.

B. Integrated Service Digital Network (ISDN)

Integrated Services Digital Network (ISDN) is a digital architecture that provides an integrated voice/data capability over the end user loop facility. Using the public switched network, ISDN distributes voice, data, image and facsimile by two standard methods of end user access: a basic rate interface or a primary rate interface. These are serving arrangements which conform to internationally developed, published, and recognized standards generated by the International Telegraph and Telephone Consultative Committee (CCITT). This international standards committee derives its authority from the United Nations. The American National Standards Institute (ANSI) is the official group which determines United States standards and provides input and representation to CCITT.

The ISDN capability is provided through a digital switch, a two or four wire loop, and customer premise equipment (telephone set, computer terminal, etc.) which conform to the CCITT designated and published international ISDN standards. Standard messages allow any ISDN digital switch to converse with any ISDN CPE, regardless of the manufacturer of the equipment. The customer or property owner is responsible for the provision and maintenance of cable and wire facilities used to provide this service and located on the customer side of the demarcation point.

The basic rate interface moves information at 144 Kb/s throughput. This capacity consists of three distinct channels on one pair of wires: 2 B or bearer channels, and 1 D or data channel. This is also known as 2B+D ISDN access.

The ISDN line's B channels carry the customer circuit switched voice or data at 64 Kb/s from the Network Termination (NT) device over the loop facility. It terminates into a Line Termination (LT) device, which routes the traffic to the public switched network. The D channel carries signalling and packet data, moving the information at 16 Kb/s from the demarcation point, through the LT, to an attached D channel handler. The D channel handler routes the packet traffic to the packet switched network and routes the signalling messages to the signalling network.

The primary rate interface has a capacity of 1,544 Mb/s and it also has multiple channels: 23 B channels and 1 D channel. It is also known as 23B+D ISDN access. The B channels carry the circuit switched and packet data information, while the D channel handles signalling information. All of these channels operate at 64 Kb/s throughput.

Subscriber loop, interoffice facility and switching requirements are further detailed in Appendix V.

Basic standards for ISDN were agreed upon by the CCITT in the 1980s, but deployment of ISDN services has been slower than expected, especially in the United States. Early ISDN applications were limited to controlled pilot projects, used more by technical specialists in laboratories than by everyday workers in real world job situations. ISDN has often been referred to as a "technology looking for a market". Others comment that ISDN has been talked about for so long that people have gotten tired of hearing about it. However, as ISDN networks and applications are deployed, there is renewed interest and markets for the service.

Rapid advances in computers and communication technologies are resulting in the increasing merger of these two fields. The merging and evolving technologies, coupled with increasing demands for efficient and timely collection, processing and dissemination of information, are leading to the development of integrated systems that transmit and process all types of data. The evolution of existing public telephone communication networks to ISDN today is based on the development and integration of digital transmission and switching technologies.

The ISDN network is an international plan to install totally digital end to end telephone service. Once implemented, it should offer better reliability and throughput using digital channels that can handle much higher speeds than voice grade circuits. Users will be able to connect computers, facsimile machines, telephones and other communication devices to any other device that supports ISDN. Voice, data and video will be able to economically and simultaneously travel over the same digital ISDN lines.

A number of ISDN applications share a common theme, namely, using digital networking to accomplish tasks remotely that previously had to be done in person. The benefits are obvious: reduced travel time and expense allows workers to devote more time to productive activities.

ISDN will provide a variety of services to support existing voice and data applications, as well as provide for future applications now being developed.

The following is a sample of some of the ISDN services:

Simultaneous Data Calls: Two users can talk and exchange information over the D packet and/or the B circuit or packet switched channel.

Citywide Centrex: A myriad of services: Specialized numbering and dialing plans. Central management of all ISDN terminals, including PBXs, key systems, etc.

Call Waiting: A line is busy. A call comes in. The user knows who is calling. He can then accept, reject, ignore, or transfer the call.

Credit Card Calling: Automatic billing of certain or all calls into accounts independent of the calling line/s.

Calling Line Identification Presentation: Provides the calling party the ISDN "phone" number, possibly with additional address information of the called party.

Calling Line Identification Restriction: Restricts presentation of the calling party's ISDN "phone" number, possibly with additional address information to the called party.

Closed User Group: Restricts conversations to or among a select group of phone numbers, local, long distance or international.

E-Mail (Personal Mailbox): ISDN can carry information to and from unattended phones as long as they are equipped with proper hardware and software.

Multi-Location Ringing: An ISDN customer can specify several locations where an incoming call should ring simultaneously.

Selective Call Screening: Within a business, this application displays the phone number of the calling party before the phone is answered. If two people call simultaneously, the person answering can choose which call is the higher priority by seeing both calling numbers.

Shared Screen: Switched date services provided via ISDN enables two people in remote locations, both equipped with a computer terminal, to view the same information on their screens and discuss its contents while making changes - all over one telephone line.

Network Access: Most large companies have many computer networks and databases, but only those workers who regularly use those databases have easy access to them. ISDN allows a person at a personal computer to gain access to virtually any database.

Less Down Time/Cost Savings Moves: When a company moves an employee within an office, there can be hours or days of lost production while a computer terminal and telephone set are being installed. In some cases, the terminal is connected to a network via coaxial cable. ISDN virtually eliminates down time, as well as the need for coaxial cable.

ISDN features are valued highly by many customers for they represent a major advance in the evolution of the local exchange network. Further, telephone companies already have in place much of the investment needed to support this offering, such as digital switching, transmission and network signalling equipment. The success or failure of this offering is largely dependent upon its provision at a reasonable rate. It is in the wider deployment of this service that unit costs will be reduced and engineering efficiencies will be recognized.

Only one percent of access lines in Minnesota subscribe to narrowband ISDN where it is made available now. Telephone industry projections call for little improvement. Sophisticated business consumers are aware of the availability and cost of ISDN. When those considerations have been weighed against the benefits and costs of alternatives to ISDN, such as local area networks, the outcome appears to have favored the alternatives.

Recommendation:

While ISDN is an improved telecommunications technology, it is slow in developing and, at this time, has little market demand nationally or in Minnesota. The MTSG recommendation, therefore, is that information on ISDN features and availability should be provided but further ISDN deployment and penetration in the State should be left to customer demand and individual company offering.

C. Custom Local Area Signalling Services (CLASS)

Custom Local Area Signalling Service (CLASS) is an enhanced family of nine central office based services now available to any subscriber served by a central office equipped to provide these services.[3] The services will also function to and from distant locations if both end offices and the interconnecting network is equipped with SS7. Typically this requires the addition of two SS7 links (a primary and a backup) to each end office, tandem and the interconnecting transmission network. These links are each a 56 Kb/s data channel on the transmission network, which may be in the form of one channel out of a trunk group, plus the accompanying port equipment in each switch. Additional software is also necessary to operate the system. Most modern digital switches may be equipped to operate in an SS7 mode and some analog switches may be so equipped via external processors. Services which may have been available only to large business users with sophisticated internal telecommunications systems can now be made available to any residential or business subscriber equipped with a touchtone telephone.[4]

Two of the features, automatic call back and calling number delivery blocking, are call management features which allow a customer to more efficiently utilize the network to their advantage while making outgoing calls.

The remaining seven features are automatic recall, calling number delivery (caller identification), customer originated trace, distinctive ringing/call waiting, selective call acceptance, selective call forwarding and selective call rejection. These features allow enhanced management of incoming calls to provide the customer with more information about a call, the ability to screen and selectively answer or otherwise process that call, or to enable returning missed calls.

An additional feature known as CLASSPLUS will furnish the calling party number, name, address and/or other information via a separate database. This service is typically intended for commercial or government/emergency services applications.

Deployment of CLASS services depends upon availability of the appropriate SS7 and CLASS hardware and software in both local offices and the entire network. Regulatory approval, and of course user demand, will be major contributing factors.

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[3]An additional incoming call management service, anonymous call rejection, is under development with availability scheduled for 4Q93 through 1Q95 depending upon the switch vendor in use.

[4]Calling number delivery requires either a CLASS compatible display telephone or a CLASS display unit which may be plugged into any standard modular jack.

The following technical considerations have or will affect the availability of CLASS features:

1. Tandem office connection of SS7 is scheduled for the May 1993 time frame and continuing until approximately June of 1994 in Minnesota, which will provide the CLASS services database access and provide for 800 number portability, the driving factor nationwide. This will ensure compliance with the FCC 800 number portability deadline.

2. IXC connection of SS7 has already started in Minnesota as of early 1993 and will provide for end to end CLASS message transmission as well as faster call set up and trunk usage efficiency.

3. Local end office deployment of SS7 and CLASS software/hardware started in March 1993 in Greater Minnesota (the Mankato trial). Deployment will continue throughout 1993 for exchanges served by the MEANS tandem. Minneapolis/St. Paul metro area exchanges are scheduled for deployment starting in 1993 and continuing until 2001. This deployment schedule will provide for local or "regionalized" CLASS availability and covers approximately 2,338,000 of the approximately 2,500,000 access lines in the State.

4. At the time that items 1-3 above are ubiquitous nationwide, the CLASS family of services will work as designed because universal availability depends upon universal SS7 deployment on an end to end basis throughout Minnesota and elsewhere. Therefore, service in one area has less value if not deployed in other areas.

In addition to technical considerations, regulatory factors will also affect when CLASS features are made available:

1. As noted above, certain SS7/CLASS requirements are already being met to comply with unrelated FCC docket decisions regarding 800 number portability.

2. One Minnesota telephone company, Mankato Citizens Telephone Company, is already conducting a CLASS services trial under Commission guidelines (the Mankato trial) which is concurrent with a generic Commission docket (P-999/CI-92-992) regarding CLASS. In the generic docket, hearings were held before the Commission in May 1993 to ascertain the climate under which CLASS may be furnished. Several parties testified as to privacy issues (of both the calling and called party) and the pros and cons of the services, both to the general public as well as businesses and specific classes of individuals such as handicapped, those subject to harassing calls, law enforcement/governmental jurisdictions and those subject to physical abuse and wishing anonymity. The Mankato trial may prove beneficial from a regulatory standpoint to gain valuable public reaction to the services.

CLASS services in general were found by the Commission to be in the public interest subject to several requirements for blocking option deployment before, concurrent with, and subsequent to, commencement of the service. (Specific language is contained in the Order in Docket No. P-999/CI-92-992, included in this report as Appendix VI.)

Legislation was also passed during the 1993 session to require the provision of CLASS capability in the Minneapolis/St. Paul seven county metropolitan area by 1995 (Minnesota Laws, Chapter 268, Minn. Stat. § 237.75) unless scheduling is waived by the Commission.

Consumer demand will also play a role in the deployment of CLASS:

1. Since CLASS services are similar to current custom calling features in many ways, and given previous public exposure through the media as well as first hand experience in other states by today's mobile society, the public in many cases is aware of CLASS features, particularly calling number delivery (caller ID). While some users are knowledgeable enough to react favorably to a feature that they have only heard of or used once if they see a perceived benefit, others will need more extensive education before they will subscribe to this service on anything other than an incidental basis.

2. One significant difference between CLASS and traditional custom calling features is that telephone companies offering these services will have to do at least as good a job of educating all subscribers, not just those taking service, as they did for custom calling features. This will be especially true for those potential subscribers who do not immediately recognize these services by name. CLASS is a sophisticated offering in comparison and carries the additional complication of network wide availability (or initially lack thereof).

Demand, as a result, will probably mirror that of cellular telephones or other previously offered services: some will want it immediately, some will want it after analyzing the benefits, some will never want it. Previous experience in other states indicates that penetration rates will be as shown in Figure 3-3.

The following is a short description of the CLASS services that can currently be made available to customers. (More detailed descriptions, including activation and deactivation codes, are available in Appendix VII.)

Automatic Call Back: An outgoing call management feature which will enable the customer to have the system redial the last number called from his station.

Automatic Recall: An incoming call management feature which will enable a customer to have call set up performed automatically to the calling party of the last incoming call.

Calling Number Delivery (Caller Identification): Will enable the customer to receive the calling number on incoming calls. The number will be delivered to the called party's CPE in the interval between the first and second ring.

Calling Number Delivery Blocking: Will allow the calling party to suppress his directory number so that the called party with calling number delivery does not receive the information.

Customer Originated Trace: Will allow the customer to initiate a trace on the last incoming call by dialing an activation code. The call will be traced automatically with the print out of the originating directory number and the time the call was made forwarded to a predetermined location, not to the customer. The customer then contacts the telephone company or law enforcement agency to determine further action.

Distinctive Ringing/Call Waiting: An incoming call management feature which will allow the customer to define a list of calling directory numbers that will provide the customer with special incoming call treatment. Any incoming calls on this list will be indicated by a distinctive ringing pattern or a distinctive call waiting tone.

Selective Call Acceptance: Will allow customers to define a list of calling directory numbers that will be accepted. Any calling numbers not on that list will be routed to announcements and rejected.

Selective Call Forwarding: Will allow the customer to define a list of calling directory numbers to be forwarded to a designated remote location.

Selective Call Rejection: Will allow the customer to define a list of calling directory numbers to be screened. Any calling numbers on this list will be routed to announcements and rejected.

Recommendations:

In extended area service (EAS) markets, the MTSG recommends that where one of the exchanges obtains CLASS service, the exchanges with EAS to that exchange should also obtain CLASS services within three years. If the local service providers are not able to deploy CLASS within the three year period, the MTSG recommends that these carriers should submit their plans for CLASS deployment in the affected exchanges to the Commission. This recommendation generally follows precedent set by the Minnesota Legislature in legislation which requires the ubiquitous capability of CLASS in the seven county Twin Cities metropolitan area. While this legislation provided a one year window, the MTSG recognizes that market and economic conditions require additional flexibility for markets in greater Minnesota.

No further recommendations are provided in this report considering that the Minnesota Public Utilities Commission Order in Docket No. P-999/CI-92-992 may be subject to appeal and is, therefore, still an open docket.

CLASS Feature Penetration Rates

	EXCHANGE SIZE (Access Lines)		
FEATURE	< 10,000 %	10,000-50,000 %	> 50,000 %
Automatic Call Back	0.69	0.30	*
Automatic Recall	1.12	2.66	*
Calling Number Delivery	2.49	N/A	*
Calling Number Delivery Blocking	N/A	N/A	*
Customer Originated Trace	N/A	N/A	*
Distinctive Ringing/Call Waiting	0.30	0.14	*
Selective Call Acceptance	0.22	0.11	*
Selective Call Forwarding	0.23	0.11	*
Selective Call Rejection	0.23	0.40	*

* Total of all 9 features equals 5.00%

(Source: Jo Shotwell, Rural Telecommunications, January 1993; US WEST Communications.)

Figure 3-3

Section IV: Long Term Goals

An appropriate long term objective for the citizens of Minnesota is the introduction of advanced services throughout the State. The advanced services recommended by the MTSG are currently provided by existing broadband technology.

A. Description of a Broadband Infrastructure

1. What is Broadband?

Broadband transmission is required for services and systems that need transmission channels capable of supporting speeds greater than 45 megabits per second (Mb/s). This definition originated from the Consultative Committee on International Standards for Telegraph and Telephone (CCITT).

In non-technical terms, there are generally three categories of digital transmission rates. These are narrowband, wideband, and broadband. As a reference, consider the following diagram:

DIGITAL TRANSMISSION RATE	ENGINEERING TERM	NON-TECHNICAL TERM
16 Kbps ▼ 64 Kbps ▼ ▼ ▼ 1.5 Mbps	DS-0 DS-1	Narrowband
▼ ▼ 45 Mbps	DS-3 / OC-1	Wideband
▼ ▼ ▼ 150 Mbps ▼ ▼ ▼ 600 Mbps	OC-3 OC-12	Broadband

DS-0 represents the standard bandwidth for one voice grade phone line.

Figure 4-1

To put the definitions of narrowband, wideband, and broadband in perspective, it is useful to consider them in terms of today's telecommunications services.

Narrowband represents the category of transmission rates that supports Plain Old Telephone Service (POTS) including voice, touchtone signalling, custom calling services, voice messaging, SS7/CLASS, fax, PC modems, basic rate ISDN, low speed private line data services, and transmission rates between low density central office switches. Narrowband transmission rates can also support transmission of interactive video services currently at less than broadcast quality.

Wideband represents the category of transmission rates that supports broadcast quality interactive video services, high speed private line data services, primary rate ISDN, and transmission rates between high density central office switches. Wideband transmission rates also support the emerging services that are designed to connect terminals and personal computers to host computers and facilitate interconnection to and between Local Area Networks (LANs). Examples of these services include frame relay service, transparent LAN service, and Switched Multi-Megabit Data Service (SMDS).

Broadband represents the category of transmission rates that is envisioned to support high definition digital television and high definition interactive video, enhanced imaging, multimedia services, supercomputer interconnection and Computer Aided Design/Manufacturing applications (CAD/CAM).

The following chart may also be helpful in understanding the speed of the various transmission rates. It shows how long it would take to transmit the book War and Peace by Leo Tolstoy at the various narrowband, wideband and broadband transmission rates:

	Transmission Rate	Transmission Time
Narrowband	1.2 Kb/s	7 Hours
	9.6 Kb/s	52 Minutes
	64 Kb/s	7.8 Minutes
	1.5 Mb/s	20 Seconds
Wideband	45 Mb/s	0.7 Seconds
Broadband	150 Mb/s	0.2 Seconds
	1.0 Gb/s	0.03 Seconds

Before concluding this definition section, it would also be appropriate to mention SONET. SONET stands for Synchronous Optical NETwork. It is a family of optical transmission channels for transmission speeds that range from DS3 (45 Mb/s) to 2.4 Gb/s (i.e. 2400 Mb/s). As an analogy, SONET is to broadband what T1 (or DS1) is to digital. At transmission rates greater than DS3 (i.e. 45 Mb/s), you should not expect to hear engineers using a "DS4 or DS5" terminology. Instead, you would hear the terms "OC-1, OC-3, OC-12, OC-24 or OC-48". OC stands for Optical Carrier rate. These are the SONET transmission channel rates. In the SONET family, the common channel rate multiplier is 51.84 Mb/s. Therefore, OC-1 is 1*51.84 Mb/s = 51.84 Mb/s. This would be slightly greater than DS3 (45 Mb/s). OC-3 would be calculated as follows, OC-3 = 3*51.84 Mb/s = 155.52 Mb/s. The figures in Appendix VIII will provide the reader with an appreciation for the narrowband, wideband, and broadband/SONET transmission speeds.

2. Components of a Broadband Infrastructure

Notwithstanding the preceding discussion, it is important to remember that broadband is **not** defined in terms of technology, but rather it is defined in terms of transmission speed. This is an important distinction to recognize. It is important from a policy perspective because there are different technologies which are capable of delivering broadband services like distance learning, video on demand and video teleconferencing. Broadband services do not necessarily require fiber optic distribution to the customer's premise. The technology used is independent of the transmission speed. Copper, coaxial cable, and fiber represent examples of technologies which are technically capable of delivering transmission at rates included in the broadband definition.

A broadband infrastructure will consist of distribution/loop plant, switching, interoffice facilities, signalling systems, and customer premises equipment. A technical description of these infrastructure components is voluminous and is outside the scope of this document. The intent of this paper is only to provide a non-technical appreciation for the components of a broadband infrastructure.

a. Distribution Alternatives:

There are several distribution alternatives which are being developed for delivering broadband transmission services to the premise. One category of alternatives is copper based and is labeled High Speed Bit Rate Digital Subscriber Line (HDSL) and the other is labeled Asymmetric Digital Subscriber Line (ADSL). A second category of alternatives is labeled Fiber In The Loop (FITL). A third category is a hybrid which utilizes fiber, coaxial cable, and copper.

Copper Alternatives:

While experts concur that fiber is the ultimate and long term solution for delivery of broadband services on a ubiquitous basis to the premise, it is also agreed that this cannot be achieved in less than a 15 to 20 year period. It is also agreed that market demand and cost recovery may not justify displacement of the embedded base of copper distribution assets. Vendors are also helping telephone companies delay the often predicted demise of the copper plant.

At the forefront of current solutions for providing broadband over the local loop is the HDSL. HDSL grew out of ISDN development. There were many local loop impairments in the early ISDN development/deployment stages including crosstalk, impulse noise, attenuation, delay and echo. Resolving these problems required extensive loop reconstruction and slowed ISDN deployment. These problems were eventually solved using a transmission line code solution called 2B1Q, and this line code was adopted as the North American standard for basic rate ISDN lines. This line code technology was able to adapt to the cable impairments found in the ubiquitous subscriber loop plant. This success made it a logical choice for higher frequency demands over copper.

HDSL transmits 784 Kb/s over a 12,000 foot copper pair within a carrier serving area. This allows two HDSL transceivers the capability of sending a 1.5 Mb/s transmission rate over two copper pairs. It is important to note that the current distribution engineering standard is to deploy a minimum of two copper pairs to each premise. Essentially, this would enable the provisioning of DS1 to the premise over embedded copper plant which clearly facilitates economic savings and early service turn up. HDSL, therefore, would reduce equipment costs, design and installation costs, and maintenance.

HDSL allows DS1 service to be provided as quickly as POTS. Once the copper pairs conforming to the HDSL carrier serving area are cataloged, DS1 service can be provided on demand. HDSL can be installed faster than conventional DS1 because there is no need for cable conditioning or many repeaters. Conditioning involves the removal of bridge taps, which have been placed on copper pairs between the central office and the residence drops, to accommodate future services. In typical DS1 installations to the premise, these taps have to be removed because they cause echoes.

HDSL will also aid in the ultimate deployment of fiber further into the loop plant architecture and closer to the premise. Experts believe that since HDSL will cut the cost of delivering high bandwidth services to the customer premise, demand growth will justify the economic rationale for more fiber hub distribution centers.

HDSL's biggest negative is that it is not generally available yet. Prototypes and product trials are currently underway.

The newest high speed member of the copper based digital subscriber line transmission family is ADSL. ADSL is a technology extension of HDSL. ADSL is meant to link fiber and copper facilities and provide enough capacity for customers to receive VCR quality video along with regular telephone company services. Although not as far in development as HDSL, ADSL has drawn attention because of the FCC's order on video dial tone. Advances in compressed video below 1.5 Mb/s could help establish ADSL as an early network technology for providing video dial tone type services. Bell Atlantic and AT&T agreed in October 1991 to collaborate on a project using ADSL to provide interactive voice and data and full motion video services to educators and students over the copper network. Additionally, AT&T and Bell Atlantic have initiated trials for teachers, students and parents to access information and videos stored in multimedia libraries and large scale computer databases from their classrooms and homes.

ADSL will operate at 1.5 Mb/s between the network and the customer and at 64 Kb/s between the customer's premise and the network. The lower speed channel will enable the user to talk back to the network. The kinds of applications envisioned include customers using a terminal at home and accessing high resolution graphics. The one directional nature of ADSL is not generally seen as an obstacle because residential customers do not generally need to send massive amounts of data.

The reason for including a section on copper distribution alternatives in this paper is to provide the reader with the confidence that wideband alternatives can be made available to subscribers served via copper distribution plant during the time period between now and the ultimate ubiquitous deployment of an advanced broadband distribution system to all premises. This should help policymakers with issues associated with fairness and information "haves" and "have-nots". Additionally, copper distribution provides immense economic advantages. As a supplement to this section, we have included the attached ADSL diagram (Figure 4-2) to provide the reader with a visual appreciation for this technology.

ASYMMETRIC DIGITAL SUBSCRIBER LINE

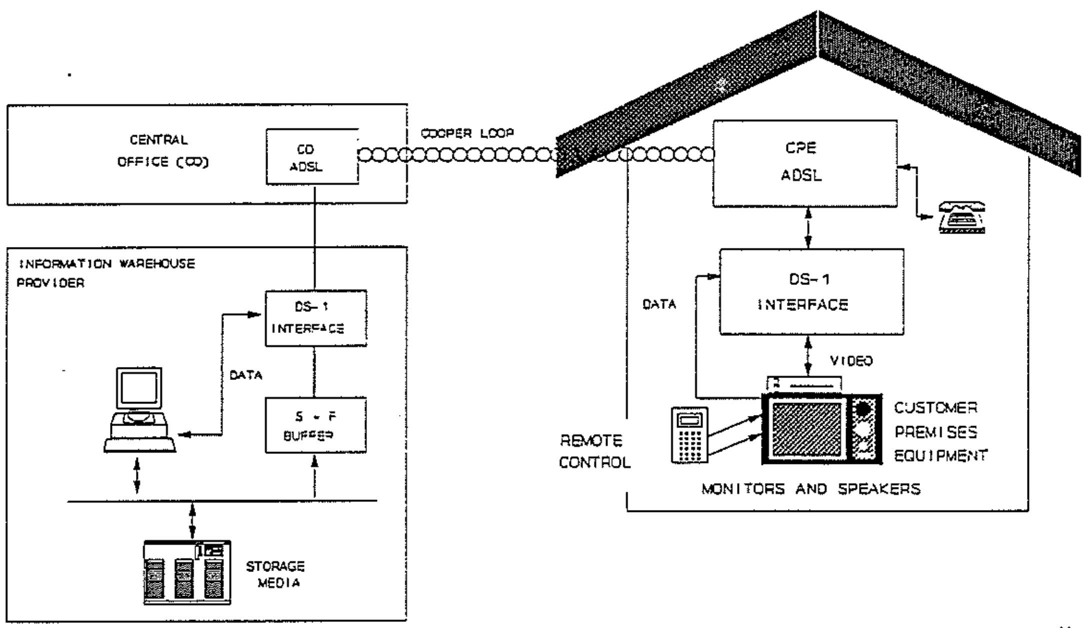


Figure 4-2

Fiber In The Loop Alternatives:

Fiber In The Loop (FITL) encompasses the "variety" of methods for integrating fiber optic technology into the distribution architecture. It encompasses methods for delivering Fiber To The Home (FTTH), Fiber To The Curb (FTTC), and hybrid approaches which integrate the use of fiber, coaxial cable, and copper to provide broadband transmission to the premise.

Looking into the future, it is easy to project that telecommunications networks will move a greater variety of information faster and faster with fiber optics becoming increasingly important. That is why it makes sense for service providers to install FITL systems. It is the specific nature of change, however, that is so unpredictable. Early FITL architectures may have shown ingenuity in extending fiber plant into the local loop, but they were hardly prepared for the FCC's decision in July 1992 which allowed LECs to offer video dial tone. That ruling, combined with the realization of increasing competition, has forced LECs to reconsider the way FITL systems will be deployed in the new environment.

What is important is to deploy a FITL "migration" strategy that is flexible enough to adapt to emerging technical standards, emerging market demand, the reality of limited capital, and the embedded base of copper based distribution assets. And, while the technical standards are emerging and future demand is evolving, current FITL products are quite varied. Different systems feature different architectures, meet different protocols and support different applications and services.

Currently, there are three general FITL architectures. These are known as the digital active star, the next generation digital loop carrier, and the passive optical network. Each has specific strengths and weaknesses. When analyzing the alternatives, decisionmakers must ask a few essential questions about system flexibility: Does the system have a modular design? Does it handcuff planners in the placement of network elements? Will it allow a full mix of narrowband and broadband services to be delivered? Can the services be delivered economically? Which industry standards does the system meet?

In the end, LECs and their subscribers will benefit most from a system that can adapt to both technological and regulatory changes and that supports the widest variety of services. This sort of flexibility will be the fundamental key to ubiquitous deployment.

FITL systems must be flexible enough to support a full range of applications. LECs today provide complete narrowband services, including standard POTS, ISDN, and private line data services. Some FITL systems now are achieving cost parity with copper in supporting these services. LECs must also consider whether these FITL systems are optimized for broadband services such as video.

In summary, there are many different vendors and many different ways to deploy FITL. Each approach has strengths and weaknesses and standards are still evolving. A public policy mandate to deploy broadband to the premise during a period of evolving standards, uncertainty regarding demand, and significant changes in the regulatory and competitive environments would not be advisable.

Figures 4-3 and 4-4 depict the manner in which FITL can be provided. Figure 4-4 represents the architecture chosen by U S WEST in its recent broadband announcement. The U S WEST architecture utilizes fiber, coaxial cable, and copper.

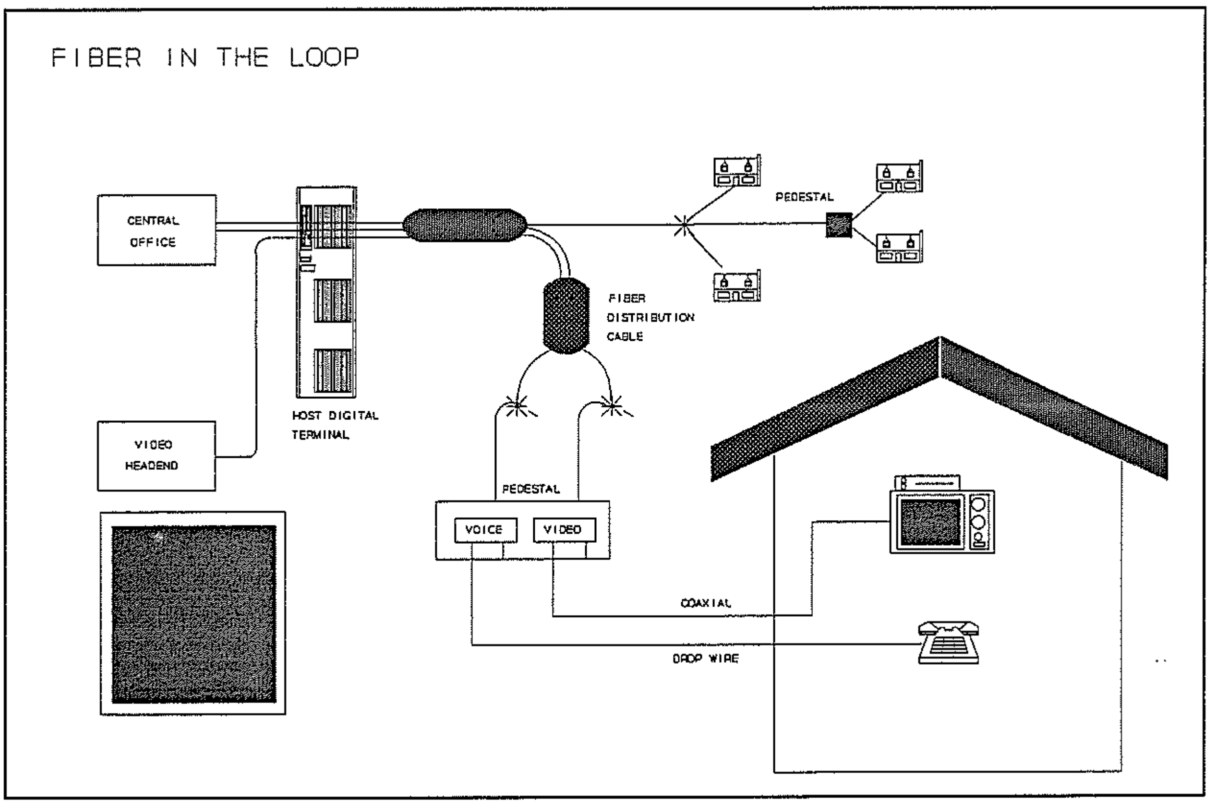
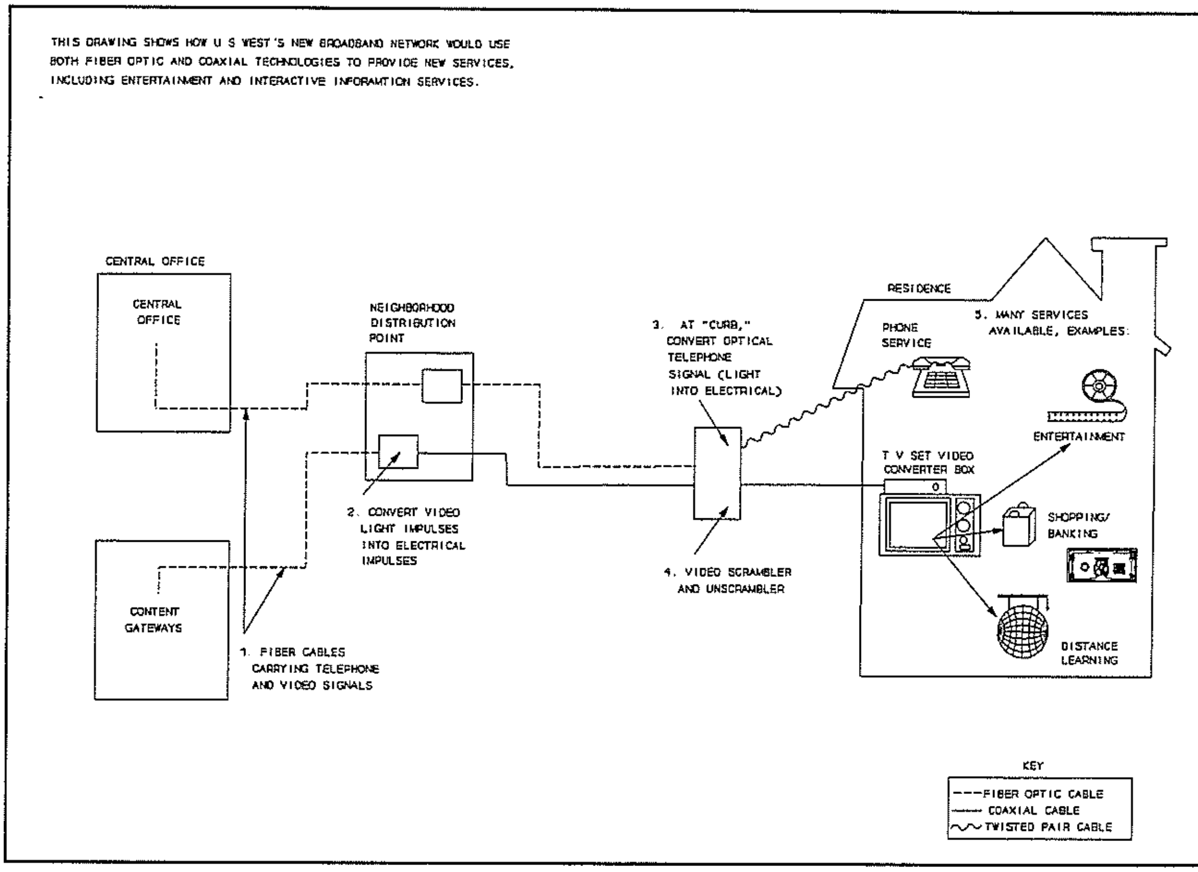


Figure 4-3

Network Structure



As shown in the above diagram, the network architecture uses fiber to transport signals into neighborhoods. From there, the video signals will be converted to electrical impulses and travel over coaxial cable to individual homes. The telephone signals travel over fiber to a telephony optical to electrical conversion unit. The loop into the home will be twisted pair copper.

The system will have its own powering system for basic telephone services so that they will continue to operate during commercial power outages. This powering arrangement is key to the cost effectiveness of this system.

The central office houses the digital switch used for telephone applications and a video dial tone platform for the broadband features.

A technical trial of this broadband network will begin late this year. U S WEST expects that 100,000 customers will be using it by the end of next year. By 1995, U S WEST expects that construction will be at a pace that will add up to 500,000 customers a year to the new network.

Figure 4-4

b. Switching:

The challenge of switching is to move from the current environment with an embedded base of Central Office (CO) digital switches capable of switching voice communication and 64 Kb/s data circuits, to an environment of switching high speed data and video, as well as traditional voice applications, in a broadband environment. It is generally accepted that standard voice communications are not the growth market of the future for LECs. Data and image communications, requiring much greater bandwidth and a fundamentally different type of switching, will be the growth services.

Traditional LEC switch vendors have developed a product strategy that allows high speed data networks to be rapidly deployed as an overlay to the existing voice network. This approach allows LECs to install expensive new technology where there is market demand and then build the network as demand grows.

There is a big question over the role of today's switches in the provision of broadband capabilities. At this time there is no switch on the mass market that is capable of broadband switching. Thus, even those switching vehicles that are being used to upgrade Minnesota exchanges today would have to be replaced in order to accommodate a broadband environment. Consequently, the requirement of a ubiquitous broadband network would necessitate the replacement of virtually every central office switch in the State of Minnesota, notwithstanding its age. The Asynchronous Transfer Mode (ATM) described later in this document is still in its developmental states.

In the short run, generic upgrades to existing LEC switches will provide the capability to offer multiples of 64 Kb/s channels on a dial up basis. This is based largely on the growth in demand for video conferencing. One of the fastest growing services is at the 384 Kb/s rate at which a substantial amount of video conferencing is taking place. By providing 384 Kb/s on a switched basis, rather than having a user order multiple 64 Kb/s or 56 Kb/s lines that are then concatenated at user premises by an inverse multiplexer, the LEC provides the user with faster set up time.

The next step in the upgrading of LEC switching is switched DS1. Currently, AT&T and U S WEST are testing this as part of U S WEST's COMPASS trial in Minneapolis. The medical imaging and video conferencing services being tested use an AT&T 5ESS switch and an attached processor product.

To meet higher bandwidth user requirements, LECs are currently unable to utilize the embedded base of CO switches. These needs are typically associated with high speed data, interconnection in and between Local Area Networks (LANS) and Metropolitan Area Networks (MANS). In order to meet these specific demands, LECs are deploying service specific packet switches for frame relay, LAN interconnect, and SMDS, where demand justifies their deployment. Packet switching is also utilized extensively in the SS7 out-of-band signalling network.

What is a broadband packet switch? Broadband packet switching is a specialized form of packet switching and multiplexing. The use of the word "broadband" implies that the technologies are appropriate to be used at "broadband speeds", that is, at DS1 (1.5 Mb/s) and higher. Broadband packets are fundamentally the same as any other type of packets, consisting of a header, a payload (data/information) and, in specific instances, some trailing information. There are three kinds of broadband packet switching technologies, frame relay, SMDS, and ATM, and they share two common assumptions:

1. Broadband packet networks are optimized for transporting protocol oriented traffic (data). None of the technologies offers guaranteed delivery of data, including retransmission on error. The inherent protocol in the traffic will guarantee delivery, so the network need not perform that task. This assumption allows the network to bypass processing tasks that guarantee delivery, thus accelerating the throughput possible with a given amount of computer processing power.

2. Broadband packet networks assume "clean" (very low error rate) transmission facilities. Clean transmission facilities greatly reduce the chances of encountering a transmission error.

The result of these assumptions is that all three broadband packet switching technologies are much more similar than they are different.

While this discussion is very technical, the important points to remember are that:

- Current LEC CO switches have limited capabilities to switch broadband services.

- Current broadband services are switched via packet switching technologies and traditional packet switches do not switch traditional voice applications.

- Switching is evolving to Asynchronous Transfer Mode (i.e. ATM).

All of the literature researched by the MTSG assumes a switching evolution to ATM. Unfortunately, ATM is not fully developed. Vendors are beginning to announce ATM product availability. The best way for the lay person to consider ATM is that it will have the capability to switch voice, low speed data, fractional DS1, DS1, and broadband packet applications for data and full motion video, all in the same switch.

The series of graphic illustrations in Appendix IX should provide the reader with an appreciation for ATM switching.

c. Interoffice Facilities:

The telecommunications industry in Minnesota has made great progress in modernizing the interoffice facilities portion of the network. It will be 100 percent digital and almost totally fiber based by 1998, as part of the short term MTSG goal. In order to upgrade the interoffice network to accommodate broadband applications, two categories of modifications will need to be made.

First, the channelizing equipment will need to be modified/replaced in order to equip the interoffice facilities to carry information in the SONET format. This will require terminal equipment changes/replacements at host/remotes, stand alone central offices and tandem locations throughout the network.

Second, interoffice facility diversity should be implemented where economically feasible. The diversity should include self healing features so that information will not be lost and service disruptions are invisible to subscribers.

d. Signalling:

At this time, the industry is implementing SS7. SS7 is seen as appropriate for the foreseeable future.

e. Customer Premise Equipment:

Large scale demand and utilization of a broadband infrastructure are dependent on the manufacturers of Customer Premise Equipment (CPE). If the CPE is not adaptable, modular, user friendly, and affordable, many of the envisioned broadband applications and benefits will not materialize for the mass markets of residence and small business customers.

Broadband CPE will include High Definition Televisions (HDTV), picture phones, and computers. Many futurists feel that there will be a combining of functionality such that the television will contain a camera that will allow it to operate as a picture phone. Or, a camera will be put into the monitor of a personal computer that would allow the computer to operate as a picture phone. Or, the personal computer and the television may be combined functionally. The cost of the CPE will be prohibitive for many residential subscribers for several years. As an example, today picture phones cost approximately $1000 to $1500. The first HDTVs are likely to retail in the $2000 - $3000 range. Computers for residential applications range from $1000 to $3000 and beyond.

3. Summary

In summary, this description of broadband infrastructure was intended to provide a non-technical appreciation for the complexities and issues associated with deployment of a ubiquitous broadband infrastructure. Full evolution to this infrastructure may take two decades. Standards are evolving and technology is moving forward to offer solutions that may justify interim solutions on the basis of economics. The costs of implementing a broadband infrastructure will be massive. The MTSG estimates the range of potential costs of from a minimum of $11.52 billion to $69.3 billion.

The cost of deployment of a broadband network is difficult to quantify. For example, the identified direct cost range includes fiber loop, central office and customer premise equipment but does not include the cost of loop electronics, which are required for operation and could rival the costs included in Figure 4-5. In addition to these costs, however, it is necessary to consider all of the costs that a decision such as this will engender. These include costs associated with the retirement of central office, distribution and transmission plant that is removed from service prematurely. Investment figures must also be adjusted upward to account for spare and breakage. It must also include depreciation costs considered by telephone companies to reflect "realistic" lives, since it is these rates that regulators will ultimately be asked to approve. Any estimates also have to be adjusted to reflect current costs of money and operating expenses. These are just some of the costs that must be considered and given serious consideration before any modernization plans are implemented.

BROADBAND DEPLOYMENT COSTS*

Per Access Line:	**Minimum**	**Maximum**
Fiber Loop:	$ 1,500**	$ 1,500**
Central Office:	$ 300	$ 1,600
Customer Premise:	$ 3,000	$20,000
	$ 4,800	$23,100
Statewide:	**$11.52 billion*****	**$69.3 billion*****

* Includes only direct investment costs.
** U S WEST estimate; does not include loop electronics.
*** Based on 2.4 million access lines in Minnesota.

Figure 4-5

B. Broadband Services/Applications

It is difficult to list and describe all of the potential applications and services which will ultimately be delivered via a broadband infrastructure. The list below is limited only by our collective imagination.

1. Current and Potential Services

First of all, the broadband infrastructure will be able to deliver all of the traditional telephone services. A partial listing of these services includes:

- POTS
- Long distance toll services
- WATS
- 800 service
- Interconnection services for other telecommunications providers (i.e. IXCs, CAPs, ESPs, cellular, PCS, CATV, RCCs, resellers, etc.)
- Directory assistance
- Electronic white pages
- Operator services
- Touchtone
- CENTRON
- PBX interconnection
- Voice messaging
- Custom calling features
- CLASS
- SS7 signalling
- 800 database
- LIDB
- Private line transport services
- Switched data services
- Frame relay
- Transparent LAN service
- SMDS
- Public telephones
- Credit card calling
- Services for the disabled
- Equal access
- ISDN

It is important to note here that large business, government and education subscribers in Minnesota are currently being offered broadband services. These include frame relay, transparent LAN service, SMDS, and interactive video. To assume that subscribers in Minnesota are not currently receiving advanced broadband services would be an error. In addition, the Minnesota Commission has created an environment conducive to technical and market trials of broadband technologies and applications. Fiber in the loop trials have been approved and the COMPASS trial being conducted by U S WEST is testing applications associated with medical imaging. Large business, government, and education subscribers in Minnesota are receiving broadband services based on their demand and willingness to pay.

2. Current and Potential Applications

In addition to the traditional telephone services, a broadband infrastructure will support the applications enumerated below. It should be noted that the existing telecommunications network is already capable of providing many of these applications and, as technology continues to advance, the broadband transmission capacity needed to support other services may erode.

Videophone Service
- Personal Conversations
- Medical Consulting
- Shopping
- Video Newspaper Delivery
- Book Reading (library browsing)
- Video Mail Service (analogous to voice mail)

Video Conferencing
- Two/Four Party (split screen capability)
- White Board Camera

Multi-media/Computer Terminal
- Telecommuting
- Disabled (specialized terminals)
- Electronic Mail

Education
- Distance Learning
- Video Course/Lecture Libraries
- Computer Aided Education
- Video Databases
- Research Access to Libraries

Computer Aided Design (CAD)

Computer Aided Manufacturing (CAM)

Electronic Photograph Storage (35mm slides)

Medical
- Picture Archiving & Communications System
- Remote CAT Scan
- Remote Diagnosis
- Computer Aided Tomography
- Counseling
- Birthing Classes

Video Dial Tone
- Selected Sporting Events
- Selected Entertainment Events
- Selected Movies/Programs

Video Storage/Retrieval

International Video Gateways/International Databases

Computer Art

This listing represents a small sample of the applications that would be enabled by a broadband infrastructure. It is important to keep in mind that the realization of these applications and services would be greatly dependent on the development of service providers and the development, ease of use and price of CPE.

C. Broadband Benefits

1. Customer Benefits of Broadband

Following are examples of customer applications using broadband. It should be noted that many of these applications can be achieved without the use of broadband and some are in use today using other methods, with slower speeds and compression being key to those implementations. Lower quality is inherent in these non-broadband applications.

Video conferencing: Typical uses of video conferencing are: educational programming, travel reduction, product announcements and demos, problem solving and support, special events, intercompany meetings, business TV and distributed video (intra-building video). Benefits include travel and time savings, responsiveness, and immediate communication, all things that help companies achieve their overall profit goals and further the nation's economy.

Health Care: Medical images are captured for transmission in two ways: a direct connect with a digital imaging device or an indirect connection (graphics stand and high resolution camera whereby films from any of the digital modalities or rays are photographed, stored on disk as a file and sent to compatible equipment at the distant end).

Bethesda Lutheran Home in Watertown, Wisconsin, is a multi-facility health care organization, providing health care for the mentally retarded, with 32 sites in ten states. Bethesda has an extensive video conferencing network with three primary uses:

- Training health care providers (residential aides);

- Consultation regarding movement or transfer of patients from one facility to another; and

- Medical consultations (2-3 percent of total use).

An example of a medical consultation is medical assessment for a hip replacement. Fifteen to twenty percent of the assessment involves observation of the resident's ability to walk. This would require very high resolution and there could be no jerkiness in the picture. Close-ups of the hip displacement, general observation and certain x-ray or other image transmission would be acceptable with a lower quality image. Broadband would be required for almost all medical consultations, because of the high detail required.

Mayo Clinic in Rochester, Minnesota, has a broadband (satellite based) link between its three primary clinic sites. Clinics in Rochester, Minnesota; Scottsdale, Arizona; and Jacksonville, Florida, are linked on the broadband system. It is the first system used to support a clinical practice. It is live color transmission via satellite, with real time, full motion video. (Speeds less than broadband would not be full motion, but compressed video.)

The system is used for two-way consultations and combines voice, data and video, including imaging. It is used for patient care, administrative activities, and continuing education activities between Rochester and the distant sites. Consultations and video diagnostic applications include: real time echocardiography, ultrasound exams of abdomen and endocrine organs, fluoroscopy, x-ray exams and telepathology.

Other applications for health care include remote patient monitoring (possibly even from a patient's home, if broadband facilities were available), a physicians' network between rural and metropolitan areas (especially useful for consultations with specialists), and viewing of records and billing.

<u>Financial</u>: Alex, Brown & Sons of Baltimore, whose traders make markets in stocks and bond issues by dealing with large institutional investors and who collectively manage

assets estimated at $1 trillion, use video conferencing on a daily basis. Each morning - before Wall Street opens for business at 9:00 - personnel in Baltimore, New York and San Francisco sit down in interactive digital video conference rooms to plan their attack. Gallery seating accommodates 50 people. Images and charts are shown on two large screen displays and the audio system bridges three video sites and 20 other offices nationwide. All conferences are digitally encrypted for security purposes. The sales force, management, clients and potential clients get first hand information from analysis experts.

Public Transportation: Public transportation costs for new mass transit, airport expansion, road construction and air pollution control can be offset with the broadband applications of telecommuting, remote database access and video conferencing.

During the first six months of a telecommuting pilot project in Phoenix, 134 telecommuters drove 97,078 miles less than usual, eliminating about 1.9 tons of vehicle related pollutants. The estimated cost savings were $10,372. Best of all, working at home increases employee productivity and morale while reducing stress and turnover.

Education: Distance learning represents an area where video technology can benefit society. Through distance learning many school districts can share scarce professional teaching resources to better utilize their talents. Two-way interactive television is currently being used by K-12 schools and has vast potential for the future. Interactive television enhances the educational delivery system by providing specialized classes from area schools or school districts.

As of July 1993, 200 of 400 school districts in Minnesota were using interactive television to expand educational support. Most of these have complete two-way interaction among all participating sites. Every television classroom has the identical capability to send and receive continuous, full motion video and audio signals. Various transmission media are being used, but fiber optics is increasingly being chosen because of future capability. Most fiber is leased from local telephone companies, but some K-12 systems have installed their own fiber.

Interactive television responds to a local desire to expand state curriculum requirements and to fulfill increased college entrance requirements, while making it financially feasible to offer specialized classes to a small number of students. Beyond the school day, interactive systems are used for adult classes and seminars. The Higher Education Interactive Television Network operates a digital backbone service that links the regional networks.

Technical Colleges - there are approximately 30 technical colleges that are linked with each other, at least four correctional facilities, two university systems, 12 community colleges and many K-12 schools. The broadband system is used for two-way interactive teaching, audio/video, and data connectivity.

Community Colleges - there are 18 campuses, nine of which offer interactive video classes, that are linked with two campus centers. Classes are taught via two-way interactive TV and national seminars are received via satellite.

State Universities - support instruction with a computerized library system.

University of Minnesota - televised instruction on campus and via local TV stations, and business instruction in the Twin Cities, Rochester and western Wisconsin.

Broadband benefits to education include on-line library services, computer access and distance learning via the switched network. Teachers can continue their training without traveling and non-traditional students can be served with distance learning.

The Minnesota Department of Trade and Economic Development's Task Force on the Future of the Minnesota Computer Industry made a central recommendation for the governor to adopt and implement a state telecommunications policy to install a fiber optic network linking **all** educational institutions, state agencies, private businesses and households by 1997. This action would allow Minnesota firms to be on the leading edge in equipment and application development for this broadband network.

In the 1993 legislative session, the higher education bill appropriated $4.8 million to the Minnesota Higher Education Coordinating Board. The money will provide grants to regional organizations to complete, coordinate and manage regional networks so that ultimately any post secondary institution will communicate with any other post secondary institution. A statewide telecommunications council has been established to provide planning, leadership and policy for this effort.

The figures in Appendix X illustrate the use of video technology for educational purposes.

Business Applications: In today's competitive environment, lower inventories, faster product delivery, and quicker time to market are required of successful businesses. These needs can be met with the following broadband applications: work group LANs, global connectivity, standardization, a high speed backbone, real time bandwidth on demand, network management functions (diverse routing and disaster recovery), and integrated telephone and computer applications for customer service needs.

Interconnecting LANs into WANs to create corporate or intercorporate connections allow companies to share information with key suppliers and customers. Transmission of large amounts of data or bulk data transfer, known as electronic data interchange, is used for corporate data base reconciliation or the transmission of regional reports. Bulk data transfers require economical intermittent or regular high bandwidth connections for extended periods of time.

For example, a local warehouse transmits inventory and transaction information back to the corporate office, which reconciles all the local data bases and transmits back the updated status of each location. Each regional office notifies its local customer of stock availability throughout the country without being dependent upon a single, corporate data base for local transactions. Additionally, the central corporate computer transmits reports on such things as market intelligence and network service. The regional site then forwards information such as product documentation on to the customer and eliminates the delays associated with shipping and handling. The end result is a competitive advantage: closer coordination from headquarters to regional offices means more effective service to customers.

Other examples include an aeronautical engineering firm with an infrared scan of a prototype engine, or a university with a computer generated model of a supernova. The institution can send data to a central image processing site with expertise and equipment to analyze and create an image of the object, and this center can transmit the completed image back to the client. Newspaper and magazine publishers can transmit regional versions of the publications to local printers, thus saving on delivery fees. Readers who want electronic versions of the periodicals can subscribe.

Corporate data networks have periods of peak usage when the network is subjected to substantially more traffic. The two most common solutions, attempting to even the network traffic load by staggering working hours and tasks or configuring the network for the peak load, are unsatisfactory. Spreading the network load to off hours can be a problem when individuals need to communicate and share large amounts of information. Provisioning the network for maximum usage means that a costly resource is being under utilized, without accompanying savings on the off peak usage. The best solution is to subscribe to additional bandwidth only during peak periods on an as needed basis, commonly referred to as bandwidth on demand. This is a solution which can only be provided by a broadband network. Businesses would be able to handle traffic overflow and private line disaster recovery, and cost effectively extend wideband services such as video transmission and conferencing, data storage/retrieval, and LAN interconnectivity to locations outside the private network.

<u>Residential Applications</u>:

Cerritos, California, a GTE test site for cable TV (coax) and fiber to 802 homes. Benefits the residents received were: near video on demand ("Center Screen"), interactive video ("GTE Main Street"), and video on demand services. Residents who desired pay per view services were required to install a Telephone Interface Module (TIM) for billing information and a decoder. Movies were $4.95 per view and special events were $24.95 (advance sign up) or $34.95 (same day sign up).

GTE Main Street services included: interactive encyclopedia, financial services (stock quotation and brokerage), travel services, municipal services and information, SAT study course, UPI news, video games, interactive full motion video (new auto model demos), and viewer interaction with live broadcasts (football, etc.).

According to a recent article in the Washington Post[5], the project now is four years old and the number of subscribers has been disappointing. Most do not purchase cable television, and many who do have indicated that they have no interest in ordering flowers on-line or scanning an encyclopedia. Subscribers say that they would rather rent movies from a video store because it is cheaper, or pay bills through the mail rather than entrust that task to their televisions. A GTE spokesperson was quoted as saying, "A lot of what we're doing here is speculation. I don't know if we can prove demand exists for all these services."

The Cerritos trial illustrates that consumer acceptance of broadband technology will depend greatly on the extent to which the services provided on broadband are priced in a competitive manner. Few consumers will continually pay a premium simply because the technology is new, exciting or convenient.

Heathrow, Florida, a residential community 40 miles northeast of Orlando and a joint project with Southern Bell, Northern Telecom and Bell Northern Research. (Jeno Paulucci was the developer for the area.) Fiber was brought to each subscriber (residence) and provided the following services: POTS, ISDN, CATV, interactive TV programs, and high definition TV.

Installed in 1987, this was the first application of ISDN to the home using fiber and providing multiple services. The services provided included home banking, home shopping, climate control, intercom, energy management, and security (alarm monitoring, card access medical alert systems). Cable TV was installed and pay per view services were available. Residents were able to work at home without special installations or charges. Video text services were also available (reserving tennis courts, checking lunch menus, school bus schedules, information database access). School children used it for working together on homework without leaving home by use of a personal computer and a telephone.

The study ended in 1992 and the residents wanted to keep the system, even though the hardware needed repair or failed fairly often. The quality of services were highly regarded and the repair seemed to be a minor inconvenience. (Hardware was prototype for this project.)

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[5]John Lippman, "'TV of Tomorrow' Is a Flop Today," The Washington Post (September 1, 1993): F1.

2. Social Benefits of Broadband

The benefits which would likely flow to society from broadband communications depend on numerous factors whose own characteristics are evolving, so our understanding of social benefits remains indistinct and somewhat intangible.

Uncertain Projections: In the first place, the technical features supporting delivery of broadband are evolving, though a steady trend exists toward larger capacity at lower cost. Therefore, projections about costs of a broadband network are extremely varied, time sensitive, and likely to reflect the motives of those providing them. This situation calls for timely and extensive comparison of projections and for a special search for projections from somewhat disinterested sources before conclusions on this point are reached.

Broadband in the Public Switched Network: In the second place, the relationship between deployment of broadband capacity and the public switched network is largely undefined. Some visualize that a publicly switched broadband telecommunications platform connecting all users for broadband applications is the natural evolution of universal service. They foresee significant general social benefits from a goal of near term, wide deployment of broadband.

Others see this as an excessively costly and unnecessarily luxurious provision of capacity to residential and small business users. They foresee a more gradual migration toward broadband capacity with a longer time frame during which differences in access to broadband services will prevail.

Mass Consumerization of Broadband: In the recent past, the use of telecommunications has begun to divide between the higher volume users whose owned or leased private networks contain many sophisticated network features and the lower volume users whose options are set by the capabilities of the public network. Therefore, the steps toward deployment of broadband are taking place in an environment which is already characterized by some plurality of networks among users.

The creation of broadband capabilities and information services is expected to increase the use of telecommunications by all users, but especially the lower volume user, leading to a mass consumerization of information services in a myriad of ways. However, there is great debate about this expectation, not only over the pace and extent of growth, but also over the question of access. The fear is that evolution away from universal service and migration toward pluralism in networks will make it more difficult to avoid significant differences between information rich and information poor users.

Benefits from Mass Consumerization: There are numerous scenarios depicting the possible benefits from a widely deployed broadband network. Among the benefits commonly named are:

- Reduced cost of delivering health, education, and other government services;
- Improved quality of public and private services through flexible access and lowered distance costs;
- Greater access to jobs and job training;
- Lowered costs of provision of training;
- Improved access to economic and social activities for those with disabilities;
- Improved access to all services and information by the frail elderly;
- Reduced pollution through substitution of network for physical transport; and
- Increased innovations in network services spurred by the existence of the network.

3. Characteristics of Current and Future Demand

The evolving integrated broadband infrastructure of the future will serve business and residential customers with equal effectiveness.

Demand for broadband services at the present time is dominated by large business, government, medical and education users. Large businesses are demanding high speed data, LAN interconnection products and video conferencing. Government demand is characterized by the need to share data and establish interconnection of computer networks among distributed offices/agencies and departments through frame relay and other LAN interconnection and data products. Hospitals and medical clinics are beginning to experiment with video services. In terms of education, Minnesota is a leader among states in the utilization of interactive video for distance learning.

At the current time, there is no specific identification of demand from either residential or business customers for broadband services. Near term enhancements to the existing network, including copper distribution facilities, may enable widespread deployment of ISDN and the capability to deliver the equivalent of narrowband (1.5 Mb/s) service to the premise using ADSL technology.

The demand for residential broadband services is largely thought of in terms of entertainment. The market for video technology has been expanding, but it is not clear how video applications of telecommunications technology will affect that growth. If it is assumed that consumer budgets for discretionary purchases are fixed, any expenditures for telecommunications video entertainment would have to displace expenditures presently associated with other forms of entertainment. Thus, this medium will have to shift customer demand away from other media. Further, the cost of these services will play a large role in the percentage of the market they are ultimately able to capture.

The other event that will stimulate demand is the evolution of services. Remember that infrastructure providers are not generally in the "content" business. Service providers will need to create video libraries, course catalogues, shopping services, etc. It will take time for these service providers to create and deliver their services.

In researching the issue of demand for broadband services, one of the key findings is that it is exceedingly difficult to "quantify" demand, either current or future. There is no standard unit of network facility or usage element that can be counted to quantify demand. Correspondingly, there does not seem to be any organized method for capturing the number of applications from customers. Customers purchase pipes, packets, routers, etc., and are not necessarily obligated to tell us their application or utilization.

The final observation on demand is that demand forecasts tend to appear optimistic beyond the year 2000. An NTT (Nippon Telephone & Telegraph) forecast from 1990 suggests that most business subscribers will demand some form of broadband service by the year 2000. This same forecast projects that 30 percent of NTT's subscriber base will be utilizing broadband services by the year 2005 and that this will increase to 100 percent of NTT's subscriber base beyond the year 2015. By way of contrast, a Siemens forecast for Germany projects a grand total of 76,000 business subscribers for broadband services by the year 2000, growing to 1.2 million in the year 2005, and 2.5 million beyond the year 2015. The 2.5 million business subscriber estimate for the year 2015 would represent approximately 80 percent of business subscribers. The Siemens forecast does not attempt to quantify residential demand, but does assume that it will be widespread.

In summary, current demand seems to be limited to high speed data, interconnection to and among computing networks, and forms of video conferencing (to facilitate business meetings and distance learning). Current demand is limited to large business, government, medical and education. Demand is exceedingly difficult to quantify and demand projections are optimistic, but only beyond the year 2000.

4. Broadband Costs and Risks

The provision of an infrastructure that will facilitate the provision of services that require broadband transmission capacity is a controversial issue. Some of the applications and services have been discussed in this document while others await entrepreneurial action. At the present time, the majority of the applications involve video services and it is highly questionable whether demand at the required price level will be sufficient to support the required investment. Indeed, there has been no substantiation that there is a market for these services. Further, in jurisdictions throughout the country in which the network infrastructure issue has been debated, projected revenues from new services have fallen far short of the revenues required to support the proposed modernization effort. Rather, the financial responsibility has fallen, for the most part, upon the basic local exchange customer.

There are still other issues relative to any proposed infrastructure that must be addressed. One involves the fact that many of the services that have been identified as requiring the transmission capacity associated with broadband services will be optional and will ultimately be offered outside of the company's regulated business. This may occur through the formation of a separate subsidiary, but will most likely occur as the result of an accounting transaction. Absent its position as a local exchange carrier, the LEC would not have had the ability to leverage its entrance into the market via its infrastructure modernization. Moreover, simple removal of certain costs associated with the provision of the services provided outside of the regulatory sphere does not necessarily adequately compensate customers for the risks they have had to assume on behalf of the company. The solution to this dilemma requires a thorough evaluation and decision by the appropriate regulatory agencies to ensure that both the utility and its monopoly customers are afforded equitable treatment.

Another important aspect of this issue is the recognition of all of the different stakeholders in the infrastructure debate. These include, but are not limited to, local exchange carriers, interexchange carriers, cable television providers, resellers, cellular providers, competitive access providers, information providers, enhanced service providers, customer premise equipment providers, business, educational institutions, and government. These entities may act as partners or competitors. It must be recognized that any advanced infrastructure is not, and indeed should not be viewed, as the responsibility of the local exchange carrier and its ratepayers. Rather, regulators may find that the local exchange carrier's participation in any modernization undertaking should be limited to those services whose usefulness is directly related to their degree of connectivity. Such a limitation could ensure that the benefits go to the large customer base, and not those dedicated to the direct use of a single buyer.

D. Participants (Competitors/Co-Providers) In the Building Of A Broadband Infrastructure (Examples)

The advent of Asynchronous Transfer Mode (ATM) digital switching technology has the opportunity to greatly change the means by which telecommunications users receive their voice, data and video communications. The technology holds the potential for cable television companies to offer voice services and for telephone companies to offer video services in addition to the services they currently provide. Both industries will use these switches.

Other companies are trialing Asymmetric Digital Subscriber Line (ADSL) technology to deliver video services over twisted pair copper lines.

All types of telecommunications service companies -- local exchange carriers, interexchange carriers, cellular companies, competitive access providers, cable television companies -- are positioning themselves to be participants in the building of a broadband infrastructure. They are deploying advanced technology, installing fiber optic cables, making strategic acquisitions, forming cross over business alliances, and seeking regulatory approval for plans which would result in a more competitive business environment. The following are examples of actions being taken to build and utilize broadband networks.

1. Telephone Companies

Pacific Bell and a consortium of three North Carolina telephone companies have announced the most ambitious plans for developing sophisticated broadband networks. Pacific Bell will deploy ATM digital switching technology, ISDN offerings, frame relay and SMDS during late 1993 and early 1994 for two applications. The first network will link participating universities, schools, hospitals and high technology businesses. The second project will bring commercial ATM service to users.

Three North Carolina telephone companies, Bell South, Carolina Telephone & Telegraph and GTE South, will operate a statewide, multi-media, broadband network based on the SONET standard and ATM digital switching technology. Initially, nine ATM switches will be deployed to serve 104 locations. Initial applications for the system will be video based distance learning in the state's schools, remote medical imaging and diagnostics, and management of state government systems.

Chesapeake and Potomac Telephone Company of Virginia was given authority by the FCC to conduct a video dial tone trial using Asymmetric Digital Subscriber Line (ADSL) technology to deliver video programming over existing twisted pair copper lines in northern Virginia. C&P plans to use the video dial tone platform to test the delivery of video on demand services.

Southwestern Bell has purchased cable television franchises for some 225,000 households in the Washington, D.C. area.

U S WEST recently agreed to pay $2.5 billion to become a 25.51 percent owner of Time Warner Entertainment. U S WEST will be a partner with Time Warner Cable to develop an interactive television network. The system will be deployed first to 4,000 customers in Orlando, Florida. The full service network will utilize ATM digital switching technology. Initially offered services will include movies on demand and interactive video games. Future services include home distance service interconnection and video conferencing. If successful, the service will be deployed in 24 United States metropolitan areas by 1998.

As part of its ongoing COMPASS broadband services trial in Minnesota, U S WEST will also use a prototype ATM switch from AT&T Network Systems to conduct a multi-media distance learning trial with the University of Minnesota. The system will link the university hospital's Department of Radiology in Minneapolis to two other Twin Cities medical facilities, the Hennepin County Medical Center and the Veteran's Administration Hospital. Students will use the links to participate in "virtual classroom" lectures. U S WEST, now in the ATM portion of its COMPASS trial, is testing switches from AT&T, Fujitsu and Siemens Stromberg-Carlson. Eventually those switches will be networked. The AT&T prototype ATM switch supports basic rate ISDN, DS1, DS3, DS3/802.6 and SONET STS-3c interfaces. As U S WEST winds down its testing of large, core ATM switches, it is now in the final stages of evaluating responses to a request for proposal for smaller, edge ATM vehicles for trials set to begin by the end of 1993.

Rochester Telephone Corporation, in early 1993, sought regulatory approval to separate its local exchange operations in Rochester, NY, into retail and wholesale functions and to open the six county local exchange market it serves to competition. Under its "open market plan", the local telephone company would be restructured into two separate and distinct corporations. The two new corporations are named R-Net and R-Com:

> R-Net would have the assets and personnel that now support the basic transmission and switching network in the Rochester offices, and outside plant engineering operations currently used by Rochester Telephone Company. It would offer telephone services directly to end users on a retail basis, except for "911" emergency services to government entities. It also would continue to provide "white pages" service, local directory assistance, and local operator assistance.
>
> R-Com would take over all assets relating to the telephone company's currently unregulated lines of business such as voice mail, inside wire maintenance, "yellow pages" service, equipment leases, and sales. It would seek authorization to provide any telecommunications service on the same basis as any other common carrier or reseller. R-Com would offer services comparable to Rochester Telephone Company's existing residential and business exchange, private line and coin services. It also would purchase intraLATA toll service wholesale from R-Net and resell it to customers.

2. Cable Television Companies

The most stunning example to date of convergence in the telecommunications industry was the October 13, 1993 announcement that Bell Atlantic Corporation has agreed to acquire both Tele-Communications, Inc., the nation's largest cable operator, and its cable programming company, Liberty Media Corporation. The transaction is valued at more than $33 billion, and will give Bell Atlantic access to approximately 40 percent of all homes in the nation.

Time Warner and Cablevision Systems Corporation have announced plans to deploy ATM digital switching technology. The technology will be used to deliver video on demand services.

Tele-Communications Inc. will install over 7,000 miles of fiber optic cable during the next four years to serve 300 communities where it provides cable television services.

Fiber deployment in 1992 and 1993 will put the cable television industry's installed fiber optic cable base at 45,453 fiber route miles compared to 750 miles in 1988.

3. Interexchange Carriers

AT&T is planning to purchase McCaw Cellular for $12.6 billion. Once the purchase is completed, the brand name, Cellular One, will be changed to AT&T Cellular. Customers will be connected to the AT&T long distance network and its electronic mail system. The purchase of McCaw Cellular will also give AT&T the opportunity to provide local telephone service.

4. Competitive Access Providers

The sale of competitive access provider Penn Access Corporation to Digital Direct, a competitive access provider owned by Tele-Communications, Inc. (TCI) was recently approved by the Pennsylvania Public Utility Commission. In 1992, TCI purchased a 49.9 percent stake in Teleport Communications Group. Another cable television company operator, Cox Enterprises, owns 12.5 percent of Teleport.

Southwest Fibernet plans to install a 140 mile fiber optic loop in Phoenix to provide competitive local and interexchange access to businesses and other high volume users.

5. Computing Networks

AT&T and Lawrence Livermore National Laboratory have signed a three year agreement to develop a high speed computer communications network. They each will contribute two million dollars to conduct joint research and development of the computer network. It will make use of ATM digital switching technology. This will lead to improved remote access to supercomputers at different facilities. AT&T will contribute its ATM switching and transmission designs for the public network. Livermore will contribute its technology for a LAN called Fiber Channel, which can transmit data at rates better than one billion units of information per second.

Another project is the California Research and Education Network (CalREN). Applications expected to run over the network include "teleseminars", which would include face to face video conferencing, electronic white boards and interactive document sharing; virtual consortia, where companies would work together on-line; and medical applications, including electronic monitoring and consultations.

The Minnesota Supercomputer Center has joined a three year research project sponsored by the U.S. Department of Defense to integrate high performance computing technology to transmit various types of multi-media, data, video and voice communications across long distances at high speeds.

E. Broadband Infrastructure Deployment Scenarios

Overview:

The MTSG anticipates that the deployment of a broadband infrastructure in Minnesota could take place over a number of years in a variety of ways. For purposes of providing the Commission with policy guidance, the MTSG has conceptually identified three scenarios for evaluation. These include the:

a. Build It and They Will Come Scenario

b. Market Demand/Deployment Scenario

c. Industry/Public Joint Action Scenario

Each of these scenarios is explained more fully below. After the scenarios are described, the MTSG provides a listing and discussion of the pros and cons, from a policy perspective. This discussion is followed by policy recommendations.

Before discussing each scenario, it would be helpful to recall the definition of broadband used in this report. A broadband infrastructure would include switched transmission at 45 Mb/s and greater. This would enable the delivery of communications, information, and full motion video. It would require the replacement/enhancement of the overwhelming majority of distribution plant, interoffice facilities, and switching capabilities in the State.

Finally, it should be repeated that broadband infrastructure and services are already being deployed in Minnesota where customer demand and willingness to pay have materialized. This has occurred largely in the government, education, medical and large business sectors of the economy. Local exchange carriers and other providers have deployed the infrastructure, on demand, to provide interactive video services (distance learning, video conference), LAN interconnection services (transport LAN service, frame relay) and high speed private line data services. Additionally, telephone companies are trialing broadband infrastructure technologies and services (i.e. U S WEST COMPASS trial), and U S WEST has publicly announced its intention to deploy a broadband infrastructure beginning in 1994. These efforts are over and above the modernization efforts that will result in attainment of the MTSG's short term and intermediate goals associated with digitally supported switching, single party, touchtone, digital interoffice facilities and SS7.

1. Scenarios for Broadband Deployment

a. Build It and They Will Come Scenario

This scenario envisions the construction of a broadband network without regard to present demand and without a cost/benefit analysis. It presumes that with a network in place, the demand for services will materialize in the future. An example of this type of scenario would be the enactment of a legislative mandate to deploy fiber to every premise in Minnesota and to support this ubiquitous fiber distribution network with the ubiquitous deployment of ATM broadband switching. A legislative mandate of this type could specify a date certain for completion (e.g. 1998). The pros and cons, from a policy perspective, are as follows:

<u>Pros</u>:

1. **Accelerated Deployment** - The Build It and They Will Come Scenario would accomplish the deployment of the broadband infrastructure to every premise in Minnesota faster than any other scenario. Consequently, if advanced services are available, their benefits will be brought to every Minnesotan at the earliest possible date.

2. **Ubiquity** - This scenario would mandate that all residential and business premises in the State be connected to the broadband network. Such a mandate would eliminate the possibility of information "haves" and "have nots" by requiring that all segments of the population and all geographical locations in the State be connected to the network at the same time.

3. **Accelerated Introduction of New Services** - With a ubiquitous broadband network in place, information service providers would have a stronger incentive to develop broadband services (i.e. information services, remote medical services, remote government services, home shopping, etc.).

4. **Accelerated External Benefits** - External economic and environmental benefits that result from an advanced telecommunications network would be accelerated. Such benefits may include economic growth, decreased information costs, and a reduction in environmental externalities through telecommuting, among others.

<u>Cons</u>:

1. **Cost Uncertainty** - The costs of deploying a useful ubiquitous broadband infrastructure in Minnesota (e.g., fiber in the loop, broadband switching, and CPE) are highly speculative, ranging from $11 billion to $69 billion.

2. **Public Funding** - Costs of constructing the network may exceed provider ability to recover investment because of inadequate subscriber demand and willingness

to pay or an unavailability of services to generate revenue. If customer demand or advanced services do not materialize, revenue shortfalls may require price supports in the form of increased taxes or other public funding.

3. **Obsolete Technology** - Broadband technologies and standards are still evolving. Premature ubiquitous deployment of a particular technology may leave the State's infrastructure obsolete and vulnerable to "leapfrog" technology advancements (e.g. optical switching) and result in unrecovered and stranded investment.

4. **Barriers to Entry** - Exclusive franchises, the paradigm of traditional regulation, would probably be continued to allow broadband providers to recover their investments. Exclusive franchises and public funding may raise barriers to entry for alternative providers, such as cable companies, who may be able to offer new and existing services at a lower cost.

5. **Increased Regulation** - Mandated deployment of a ubiquitous broadband network would require increased regulation (regulatory oversight, schedules, compliance filings, rate treatment).

6. **Significant End User Investments Required** - CPE is not currently available to mass market subscribers on an economic basis (high definition television, video equipment). This drawback is extremely significant. It means that even if the most advanced broadband infrastructure is deployed, it will not be utilized if compatible, economic and user friendly CPE is not purchased by subscribers. It is impossible to know how rapidly manufacturers will produce this CPE and whether market demand will be significant enough to lower production costs and retail prices.

7. **Lack of Customer Demand** - Broadband services/software for mass market applications are in their infancy. Experience with videotext information services and ISDN has not provided proof of mass market appeal. To this point, mass market demand for these services, though they are not even broadband (they can be delivered over copper using narrowband and wideband technologies), has not materialized.

8. **Regulatory Environment** - The telecommunications regulatory environment is dynamic. The FCC is moving to accelerate local competition with varying degrees of success, and many state regulatory policy issues involving a competitive environment are unresolved (provider of last resort, average versus deaveraged pricing, etc.). This dynamic environment adds to the uncertainty of the ability to recover the infrastructure investments.

b. Market Demand/Deployment Scenario

Under this scenario, the basic assumption is that the network can be deployed most efficiently if the decisions to build respond to market demand rather than mandating ubiquitous deployment by a date certain. The pros and cons of this scenario, from a policy perspective, are as follows:

<u>Pros</u>:

1. **Market Demand** - Investments will be made where providers anticipate and/or observe market demand and willingness to pay. This willingness to pay will ensure that the network is not over built and under utilized. It will also help to ensure that providers will be able to recover their investment. As a result, the timing of the development of mass market broadband services/software is more likely to be synchronized with mass market deployment of infrastructure.

2. **Cost Recovery** - Costs will be recovered by revenues from the new advanced services, insuring that captive monopoly telephone customers will not bear the risks associated with the deployment of a broadband infrastructure.

3. **Public Funding** - Because the network would not be deployed unless demand were present, public funding would not be necessary under this scenario.

4. **Efficient Technology Deployment** - Since this scenario assumes a more gradual implementation on a statewide basis based on market demand, there would be less risk of subscribers and providers (and the State) being vulnerable to technology "leap frog". For example, if the market anticipated a change in technology, the demand for the old technology would evaporate and the broadband network would not be deployed using that technology.

5. **Cost Effective Technology** - As has been observed in many diverse areas, the cost of technology diminishes over time as production costs decline and demand increases. Under this scenario, providers would be purchasing broadband infrastructure components from vendors at economic points on the technology cost curve.

6. **End User CPE Investments** - This scenario minimizes the risk of user friendly CPE not being available to customers at a reasonable price because providers will include the cost of CPE and the price of service in developing demand forecasts before the network is deployed.

7. **Regulatory Environment** - This scenario provides State regulators with time to resolve the policy issues associated with the possible emergence of a competitive

environment for basic telecommunications services. This scenario would also preserve the dynamic regulatory environment.

8. **Market Entry** - This scenario will allow ease of entry by competitive providers for the future deployment of competition. Alternate providers of basic telephone and telecommunications services will emerge to compete with incumbent telephone companies. These new entrants will include cable television companies, personal communications services (PCS) companies, competitive access providers (CAPs), and other LECs.

Cons:

1. **Deployment May Be Delayed** - This deployment scenario is likely to be more gradual than the Build It and They Will Come Scenario. The MTSG estimate is that ubiquitous deployment would not be completed until 2015.

2. **Non-Ubiquity** - This scenario may lead to a condition of information "haves" and "have nots" as the broadband network is deployed in selective markets where demand and customer base are perceived to be significant enough to support the cost of the network. As a result, individual residential and small business subscribers with demands for broadband services and applications may be frustrated if they reside in an area where mass market demand and competition have not materialized. Large business or governmental subscribers will probably enjoy access through dedicated facilities.

c. Industry/Public Joint Action Scenario

A third deployment scenario would be an agreement on the part of the industry and policymakers to deploy, by a date certain, a broadband infrastructure ubiquitously to public and social institutions (schools, libraries, hospitals, government offices, and universities) with residual deployment to residence and business subscribers based on the Market Demand/Deployment Scenario. The Industry/Public Joint Action Scenario assumes that the market would fail to adequately provide broadband services to some segments of society and that public policy is necessary to insure that the public welfare is maximized.

Pros:

1. **Targeted Accelerated Deployment** - This scenario has almost all of the pros associated with the second scenario, because broadband deployment to non-public/social institutions is based on current demand. Mandated deployment by a specific date would be limited to the public/social institution sector of the State.

2. **Demand Stimulus** - This deployment scenario would provide exposure of broadband services to a great number of citizens who may not gain access to broadband services under the market demand scenario as quickly as they would under this scenario. Targeted deployment and the construction of a backbone network to public/social institutions may help stimulate demand by residence and small business subscribers, and provide a springboard for competitive deployment.

3. **Market Entry** - Targeted deployment would allow open competitive entry to the residual market by competitive providers.

4. **Social Benefits** - This scenario would increase social welfare by providing advanced facilities and services in the areas of medicine, education and government services throughout the State.

Cons:

1. **Usefulness** - Policymakers may misjudge the usefulness of this deployment to the public and social institutions, which would result in an inappropriate allocation of resources.

2. **Funding** - Funding, pricing and recovery issues would need to be resolved by providers, regulators and legislators.

Recommendations:

Based on the above analysis, the MTSG does not recommend the Build It and They Will Come Scenario. The costs of this type of scenario, as outlined above, would far outweigh the societal benefits or the ability of providers to recover their investment.

If economic efficiency and governmental and budgetary constraints are given the greatest weight, then the second scenario, the Market Demand/Deployment Scenario, is recommended. Furthermore, this scenario recognizes the fact that broadband infrastructure and services are already being deployed and provided in Minnesota where market demand has materialized. Although ubiquitous availability of advanced services would not be accomplished until approximately 2015, this is not out of line with the goals of other countries, such as Japan and Germany, which are considered proactive.

If policymakers feel that societal and economic benefits justify the advancement of broadband deployment sooner than would be accomplished by the second scenario, then the MTSG recommends that a version of the Industry/Public Joint Action Scenario be considered. This would require that a detailed and comprehensive study be undertaken to fully evaluate how the broadband network infrastructure components of distribution, interoffice, and ATM/packet switching could be deployed in a manner that would ensure ubiquitous deployment of interactive voice, data, imaging, video, multimedia and information services to these public/social institutions throughout the State. The study would need to incorporate an extensive inventory of current services/infrastructure (since many of these entities may already have some form of broadband service). Additionally, the study would need to complete an extensive needs analysis for these institutions to determine what information needs exist. Furthermore, the study would need to incorporate a vision of how the infrastructure would be utilized to benefit Minnesota. The study should be completed by a group composed of representatives from industry providers and representatives of the affected institutions.

Finally, the MTSG recommends that a broadband/broadband-like services tracking mechanism be instituted so that policymakers can track the advancement of the infrastructure over time. This would help in assessing the deployment of infrastructure, market demand, and geographic coverage, for example. Because advanced network services may be offered by many different entities, the tracking mechanism must be flexible enough to track such services regardless of the provider.

F. Wireless Infrastructure Deployment

Wireless service can be broadly characterized as a system to provide a subscriber with mobile/portable two-way telecommunications services. This service may or may not be geographically ubiquitous and may or may not be functionally equivalent to the land line service that is the current industry standard.

In the relatively immediate past, wireless usage was limited to short range portable (cordless telephones) and mobile (Improved Mobile Telephone Service or IMTS.) Users were either tethered to the home base unit with cordless portables or were constrained to limited service availability, large hardware and power requirements in a vehicle mounted mobile unit and cumbersome dialing patterns with the IMTS system. As a result, the use of cordless telephones was viewed as an extension of the main wireline service and mobile service had a much lower penetration level than is currently exhibited with cellular systems. The improvement in both hardware and service provision has alleviated most of the limitations associated with IMTS, with an attendant marked increase in subscription to service. Today there are approximately 13 million cellular telephones in service.

The trend toward a service economy, with its mobility requirements and desire by users for immediate access and availability to their constituencies (whether it be office, suppliers or customers), has imposed much higher demands on the wireless industry. As a result, several types of services are available to the general public or are in the development stage.

Alternatives Include:

1. Cordless Telephones (CT2 standard) - This technology has been available in analog radio form for several years and more recently in digital form. Advantages are low cost, one telephone number and easy deployment, since this is a customer premise equipment based technology. Disadvantages include limited geographic coverage due to the inability to roam to any foreign base station, interference problems due to the frequencies used and limited privacy because of the limited number of channels available.

2. Cellular Telephone Service (FCC DPCRTS standard) - This technology has been available in analog radio form since approximately 1983 with nearly complete coverage in Minnesota today. (See Appendix XI.) This system is just beginning to be deployed in a digital format in the United States. The digital cellular network, when deployed, will be the cadillac of available technologies in that it has the advantages of being available in either mobile or portable forms, is easily deployed from the subscriber's standpoint (no connections are necessary; merely acquire the set,) is a fully featured service, provides one number access, has high channel capacity, provides extremely clear quality, is relatively private for an over the air service, and is available in most areas. These advantages come at a high price for both the subscriber equipment and service and are complicated by hurdles generated by industry standards groups, legislators, regulators and jurists.

3. Personal Communications Service (CT3 and other standards) - This standard, which is really an amalgamation of several existing technologies (CT2, paging, voice mail, etc.) is currently under trial in several U.S. locations by several prospective suppliers.

> MCI Telecommunications Corporation will form a broad based consortium of companies to seek an FCC license for a nationwide personal communications network.
>
> In the past year, four cable television company operators have devised tests for personal communications services. The tests are designed to demonstrate that cable plant can provide portable telephone service efficiently. Tele-Communications Inc. and McCaw Cellular are testing PCS in Ashland, Oregon; Cox Enterprises is testing PCS in San Diego; Comsat is testing it in Trenton, New Jersey; and Cablevision Systems Corporation is testing it in Lynbrook, New Jersey.
>
> GTE Corporation is conducting a 15 month test of personal communications services involving 3,000 customers in Tampa, Florida.

PCS is promising to be a low cost, high feature service enabling a user many of the advantages listed for cellular. Lower cost is proposed to be achieved through use of lower power units (meaning less range), smaller coverage areas and elimination of some of the roaming, hand-off and call delivery functions standard with that technology. Thus this technology is targeted at a market which is intended to be locally portable, not highly mobile.

PCS Licensing[6]:

PCS licensing was authorized through the Omnibus Budget Reconciliation Act to the FCC to use competitive bidding to award PCS licenses. On September 23, 1993, as a first step in the process, the FCC allocated 160 MHz in the 2 GHz emerging technologies bands for PCS. The Commission allocated 40 MHz for unlicensed PCS devices. This allocation was channelized into two 20 MHz blocks. One block is for devices that will provide voice-like services (isochronous: 1890-1900 and 1920-1930 MHz), and the other block is for devices that will provide data-like services (asynchronous: 1900-1920 MHz).

The remaining 120 MHz was allocated for licensed PCS services. It was channelized into two 30 MHz blocks, one 20 MHz block and four 10 MHz blocks. The Commission adopted Major Trading Areas (MTAs) as the service area size for the two 30 MHz blocks. The service areas adopted for the one 20 MHz and four 10 MHz blocks were Basic Trading Areas (BTAs). There are 51 MTAs and 492 BTAs, as defined by the Rand McNally Atlas. (See Appendix XII.) The channel blocks, frequencies, and service areas for the licensed PCS allocation follow:

Channel	Block	Frequency (MHz)	Service Area
A	(30 MHz)	1850-1865/1930-1945	MTA
B	(30 MHz)	1865-1880/1945-1960	MTA
C	(20 MHz)	1880-1890/1960-1970	BTA
D	(10 MHz)	2130-2135/2180-2185	BTA
E	(10 MHz)	2135-2140/2185-2190	BTA
F	(10 MHz)	2140-2145/2190-2195	BTA
G	(10 MHz)	2145-2150/2195-2200	BTA

The FCC believes that this scheme will ensure competition and foster diversity among providers and services. The licensing term is set for ten years and renewal requirements will be similar to those for cellular license renewals. To reduce speculation, the FCC proposed that interested parties put a portion of the license money "up front" to participate in the auction. Licenses can aggregate up to 40 MHz in any one service area (unless they are subject to the cellular restriction - see below) and can aggregate markets. There are also build-out requirements. The PCS licenses will be required to offer service to at least one-third of the population in each market area within five years, two-thirds within seven years, and 90 percent within 10 years.

[6]The following information is reprinted with permission from the October 4, 1993 issue of the Washington Weekly Report, Copyright 1993, Organization for the Protection and Advancement of Small Telephone Companies.

Rural Telephone Companies Given Special Preference: The Omnibus Budget Reconciliation Act requires the FCC to include safeguards in its auction process to ensure development and rapid deployment of the new services to the public, including those in rural areas. The FCC also is required to distribute the licenses among a wide variety of applicants, including small businesses, businesses owned by members of minority groups and women, and rural telephone companies. The 20 MHz "C" block has been designated as the channel block for these four entities. One of the 10 MHz blocks may also be designated for them. The FCC also is seeking comment on setting aside blocks of spectrum for competitive bidding by the four designated groups, spreading the payment of the license over time, and requiring less money "up front." The FCC has not defined rural telephone company and will seek proposals of appropriate definitions in a separate rulemaking.

Cellular Restrictions: Many believed that cellular providers would be prohibited from providing PCS in their service areas. While there are some restrictions, they are not as far reaching as was first anticipated. Cellular licensees are permitted to participate in PCS outside of their existing service areas. The cellular licensee may also participate in any area (including their own service areas) where they serve less than 10 percent of the population of the PCS service area. For purposes of this rule, cellular licensees are defined as entities which have an ownership interest of 20 percent or more in a cellular system. Cellular licensees are also afforded the opportunity to compete for one of the existing 10 MHz channels in their existing service areas. Except to the extent that they are cellular licensees, and subject to those restrictions, LECs will be allowed to apply for the licenses on the same basis as other applicants.

Disagreement at the Commission: Beyond the basic framework, the FCC was not unanimous in its decision. More details and clarification are expected when the order is released.

Future Trends:

Wireless usage is growing rapidly (at the rate of 11,000 users per day nationally in the cellular sector). As a result, radio spectrum requirements are being generated well beyond original estimates by either the industry or the FCC (original projections were for 900,000 subscribers by the year 2000.) Spectrum management methods are currently being developed as noted above. Industry and FCC trends are toward assignment of radio spectrum for narrowband uses (voice and low speed data) while migrating broadband (video and high speed data) to terrestrial transport methods such as fiber or coaxial cable. Speculation is that broadcast video and voice will literally exchange their respective methods of delivery, wire vs. airwaves, in the future.

Recommendation:

The MTSG recommends that the deployment and development of the wireless communications infrastructure be left to the market demand for the service.

G. Potential Regulatory Issues

As described above, one of the benefits of the Market Demand/Deployment Scenario is that it will preserve an environment where competition among providers of advanced communications or information services may develop. For example, cable companies could compete with local companies to bring fiber to the home and the advanced communication services which go with it. As this type of new market structure develops, regulation will need to change and adapt in order to insure that customers receive the same quality of service at reasonable prices and to provide a fair competitive opportunity for regulated entities. If that type of market results from the Market Demand/Deployment Scenario, the following issues should be addressed:

Exclusive Franchise. Today, an LEC is granted an exclusive franchise for the territory it serves. If the Commission grants certificates to additional companies to provide substitutable services in the same territory as an existing provider, the exclusive franchise may erode and eventually disappear. Entities receiving certificates to provide service should assume both rights and obligations. Obligations, such as for universal service, should be shared on an equal basis by all providers.

Quality of Service. Today, Commission rules and monitoring ensure the quality of service to the consumer. If competitive suppliers enter the market, customer choice may be sufficient to insure acceptable levels of service. However, with a vital service such as telecommunications, some quality of service oversight will continue to be in the public interest.

Fair and Equitable Competitive Opportunities. In a competitive environment, all existing and potential competitors must have equal opportunity to compete. Inappropriate entry and exist barriers caused by legal and regulatory rules should be eliminated or modified so that all players are impacted similarly. The determination of what is "fair and equitable", and how fast transition should take place for various groups of services, are issues to be dealt with by the regulators. Furthermore, government owned networks that would compete with the public switched network should not be constructed.

Interconnection Issues. Interconnection must be required to the maximum extent technologically feasible. Reasonable and consistent technical standards must be developed to insure maximum interconnectability. Regulators will need to address interconnection and compensation issues between providers during the transition to full and open competition.

Investment and Earnings. If a fully competitive market exists so that a sufficient number of providers are present to ensure that prices are driven to cost, regulation of companies' earnings should be lessened. Customer demand and the opportunity for increased revenues will drive the providers' investment strategies and pricing will be determined by customer demand and production costs.

Section V: Summary of Recommendations

Short Term Goal Recommendations

Digital Switching: All exchanges must be served by digital switches by January 1, 1998. By January 1, 1995, all providers of basic local service should submit a plan to the Commission for the provision of digital switching by the January 1, 1998 deadline or request an extension or waiver.

- There are approximately 105 switches, serving 65,758 access lines, that will be replaced by January 1, 1998. If an average cost of between $350 and $500 per access line is used to estimate the cost of the upgrades, then replacing these 105 switches results in a total cost of between $23 million and $33 million.

- Current industry plans (with the exception of analog stored program control switches) call for the replacement of all switches to digital by January 1, 1998. Therefore, the current industry plans are consistent with the study group's goals. This recommendation will ensure that the industry adheres to the current plan without unnecessary deferrals. No costs beyond what is already planned would be incurred. For some LECs, current plans may include requests for local rate increases.

- An extension or waiver may be appropriate because the recommendation may disproportionately affect particular companies. Additionally, some companies may have to deploy significant resources in order to meet this standard.

Digital Interexchange Facilities: All exchanges must be interconnected by digital interexchange facilities by January 1, 1998. By January 1, 1996, all providers of basic local service should submit a plan to the Commission for providing digital interexchange facilities or request an extension or waiver.

- This recommendation is consistent with current industry plans. There would be no costs associated with this recommendation beyond what is already planned. The industry anticipates spending approximately $16.1 million by January 1, 1998 for the provision of digital interexchange facilities. (The industry anticipated spending $28.5 million in 1991 and 1992 on digital interexchange facilities.)

Single Party Service: **All providers of basic local service must offer single party lines to customers upon request by January 1, 1995. By July 1, 1994, all providers of basic local service should submit a plan to the Commission for implementing this recommendation or request an extension or waiver.**

- This goal is consistent with current industry plans. There would be no costs associated with this goal beyond what is already planned. Since 99.2 percent of the access lines in Minnesota are already provided with one party service, the expense associated with meeting the January 1, 1995 date is approximately $28.3 million.

Touchtone Service: **All providers of basic local service must equip all lines with touchtone and provide touchtone to all subscribers without separate charge by January 1, 1995. By July 1, 1994, all providers of basic local service must file a plan with the Commission to eliminate the separate touchtone charge or request an extension or waiver.**

- An extension or waiver may be appropriate if costs and customer demand justify it. There is a trend to include touchtone as part of basic local service. Until recently, touchtone has been priced far in excess of its cost in order to produce revenue for the local exchange carrier. When touchtone is included in the definition of local service, regulators are confronted with decisions concerning revenue recovery through local rates for the former "premium" touchtone revenue stream.

Custom Calling Features: **All providers of basic local service must offer basic custom calling features to all subscribers by January 1, 1998. By July 1, 1997, all providers of basic local service must file a tariff with the Commission for the provision of basic custom calling features or request an extension or waiver.**

- Custom calling features are currently offered to 97 percent of the access lines in Minnesota. To reach 100 percent of the access lines in the State by January 1, 1998, there would be no additional costs beyond those identified for upgrading all switches to digital, as discussed above. As the current industry plans are consistent with MTSG goals, no additional costs would be incurred to achieve this goal.

Equal Access: **All subscribers should have access to multiple long distance providers on a presubscribed (1+) basis for interLATA calls by January 1, 1998. By January 1, 1996, all providers of basic local service should submit a plan to the Commission for providing interLATA equal access or request an extension or waiver. A recommendation on the timeframe for providing intraLATA equal access and presubscription should be deferred to Docket No. P-999/CI-87-697.**

- Unlike other goals, achievement of this goal requires the participation of providers of local service and telecommunications carriers. Currently, Minn. Stat. § 237.74, subd. 2, requires that "No telecommunications carrier shall unreasonably limit its service offerings to particular geographic areas unless facilities necessary for the service are not available and cannot be made available at reasonable costs." If providers of basic local service are required to provide interLATA equal access capability, Minn. Stat. § 237.74, subd. 2, provides a means for the Commission to ensure that carriers, in addition to AT&T (the current ubiquitous carrier), appear on the ballot to provide end users with a choice of interLATA long distance carrier.

- It has been estimated that the cost of providing interLATA presubscription on an end office basis is approximately $48 per access line. To meet the above goal, 65,758 access lines have to be provided with interLATA equal access by January 1, 1998, for a total cost of approximately $3,150,000. These costs would be divided between the interstate and intrastate jurisdiction. The costs to provide equal access are generally recovered by the LECs from the IXCs through a per minute of use charge. End users may see these costs as a pass through from the IXC in the form of higher interstate and intrastate toll rates.

- In Docket No. P-999/CI-87-697, a study committee is looking at the specific costs of providing intraLATA equal access and presubscription, including switch manufacturers' ability to provide the service and the costs of provision. The study group submitted current cost and availability information to the Commission on August 16, 1993. Parties had 20 days to file comments. The Commission will likely take up this issue of implementing intraLATA equal access and presubscription during the Fall of 1993. Since this is an open and ongoing proceeding before the Commission, with many parties participating, the study group did not believe it was appropriate to make a recommendation in this report.

Intermediate Goal Recommendations

<u>SS7</u>: SS7 trunk signalling for call set up should be deployed ubiquitously throughout the State by the year 2000.

- This will require considerable additional investment in central office generic software that will enable SS7 capabilities to be deployed at the end office level. The principle advantages include more efficient and faster call set up and the ability to deliver CLASS services on an interexchange or extended area service basis.

- SS7 is the next generation of network infrastructure. The LECs in Minnesota have already expedited significant resources to deploy SS7 capability in order to comply with the FCC's 800 database order. Since SS7 technology will pervade the network, its costs will be recovered from numerous services including local service, 800 database service, LIDB and CLASS.

- The MTSG believes that the public interest will be served through continued deployment of SS7 capabilities throughout the State.

<u>ISDN</u>: Provide information on ISDN features and availability and leave further ISDN deployment and penetration in the State to customer demand and individual company offering.

- While ISDN is an improved telecommunications technology, it is slow in developing and, at this time, has little market demand nationally or in Minnesota.

<u>Custom Local Area Signalling Services (CLASS)</u>: **In extended area service (EAS) markets, where one of the exchanges obtains CLASS service, the exchanges with EAS to that exchange should also obtain CLASS services within three years. If the local service providers are not able to deploy CLASS within the three year period, these carriers should submit their plans for CLASS deployment in the affected exchanges to the Commission.**

- This recommendation generally follows precedent set by the Minnesota Legislature in legislation which requires the ubiquitous capability of CLASS by January 1, 1995 in the seven county Twin Cities metropolitan area. While this legislation provided a one year window, the MTSG recognizes that market and economic conditions require additional flexibility for markets in greater Minnesota.

- No further recommendations regarding CLASS are provided considering that the Commission Order in Docket No. P-999/CI-92-992 may be subject to appeal and is, therefore, still an open docket.

Long Term Recommendations

Broadband

If economic efficiency and governmental and budgetary constraints are given the greatest weight, then the second scenario, i.e. the Market Demand/Deployment Scenario, is recommended. Furthermore, this scenario recognizes the fact that broadband infrastructure and services are already being deployed and provided in Minnesota where market demand has materialized. Although the MTSG estimates that ubiquitous deployment of advanced network services would not be accomplished until 2015, this is not out of line with the goals of other countries, such as Japan and Germany, which are considered proactive.

If policymakers feel that societal and economic benefits justify the advancement of broadband deployment sooner than would be accomplished by the above scenario, then the MTSG recommends that they consider a version of the industry/public joint action scenario. This would require that a detailed and comprehensive study be undertaken to fully evaluate how the broadband network infrastructure components of distribution, interoffice and ATM/packet switching could be deployed in a manner that would ensure ubiquitous deployment of interactive voice, data, imaging, video, multi-media and information services to these public/social institutions throughout the State. The study would need to incorporate an extensive inventory of current services/infrastructure (since many of these entities may already have some form of broadband service). Additionally, the study would need to complete an extensive needs analysis for these institutions to determine what infrastructure needs exist. Furthermore, the study would need to incorporate a vision of how the infrastructure would be utilized to benefit Minnesota. The study should be completed by a group composed of representatives from all providers and representatives of the affected institutions.

The MTSG recommends that a broadband/broadband-like services tracking mechanism be instituted so that policymakers can track the advancement of the infrastructure over time. This would help in assessing the deployment of infrastructure, market demand and geographic coverage, for example. Because advanced network services may be offered by many different entities, the tracking mechanism must be flexible enough to track such services regardless of the provider.

Wireless

The MTSG recommends that the deployment and development of the wireless communications infrastructure be left to the market demand for the service.

Regulatory

As a new type of market structure (Market Demand) develops, regulation will need to change and adapt in order to insure that customers receive the same quality of service at reasonable prices and to provide a fair competitive opportunity for regulated activities. In that event, the following issues should be addressed: exclusive franchise, quality of service, fair and equitable competitive opportunities, interconnection standards, and investment and earnings.

APPENDIX I

Minnesota Telefutures Study Group Members

The following participants were active members at the time of the final report:

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Joann Anderson
AT&T

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The following people participated in study group activities:

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George Revering
Midwest Telephone Company

Rod Scheel
Otter Tail Power Company

Scott Schipper
U S WEST Communications

APPENDIX II

MINNESOTA TELEFUTURES STUDY GROUP

CHARTER

The Minnesota Telefutures Study Group (MTSG) is a task force composed of representatives of Minnesota's telecommunications industry and its state agencies, established for the purpose of describing the telecommunications infrastructure required to further enhance Minnesota's leadership in telecommunications beyond the year 2000 and for determining what steps will be required to implement it.

The MTSG was formed at the request of the Minnesota State Public Utilities Commission to develop a comprehensive set of recommendations covering industry and government actions required to further position the State's telecommunications industry to deliver the latest enhanced telecommunications services required by the citizens of Minnesota.

The MTSG will develop recommendations for what it believes is the most likely and appropriate future deployment of telecommunications networks in Minnesota, as well as recommendations to the Commission for actions by the Minnesota Legislature, state regulatory and other agencies that would support the proposed infrastructure. In addition to its own research, the MTSG will evaluate proposals developed by others.

The MTSG will propose a comprehensive framework for implementing its recommendations. These recommendations and framework of implementation plans will be completed for review by the Commission by the fall of 1992.

June 1991

APPENDIX III

Bibliography

Connections, December 1987, Heathrow, Florida, Fiber City.

Consideration for a Redefinition of Universal Service: Results of a Policy Research Project, Susan G. Hadden and Frederick Williams, University of Texas at Austin, July 1991.

Divestiture Revisited, Forbes Magazine, 3-18-91.

Executive Summary, NTIA Telecommunications Infrastructure Report.

NTIA Infrastructure Study, USTA Federal Issues Binder.

Report on Cerritos to the FCC, 4-1-90, GTE California, Inc.

State Infrastructure Development Activities, Randy Young for MTSG.

Survey on Current Perceptions of Telecommunications as a Strategic Tool for Economic Development, Great Lakes Telecommunications, Doherty Rumble & Butler, October 1991.

Telecommunications Deregulation at the State Level: An Empirical Evaluation, Milton Mueller, University of Nebraska at Omaha, 19th Annual Telecommunications Policy Research Conference, September 1991.

Telecommunications Reports, excerpt on NTIA task force on National Telecommunications Infrastructure.

Tennessee PSC Blazes Path Into Telecom Infrastructure Frontier, Telephony, August 1991.

The Arrival of the Information Age, a background paper presented to the Kansas Telecommunications Consortium.

The Technology Behind Heathrow, Telesis 1989.

Trends in Telephone Service, FCC News, February 1992.

Universal Service in Japan: A Model for the US?, Sarah A. Lyons, April 1991, University of Texas, Austin.

Universal Telephone Service, Ready for the 21st Century, Institute for Information Studies (Northern Telecom and Aspen Institute--Rural Economic Policy Program).

US Communications Policy: Issues for the 1990's, Conference Remarks by Kent B. Foster, President, GTE Operations, sponsored by US General Accounting Office, 2-11-91.

USTA Broadband Presentation.

Wiring Minnesota: New State Goals for Telecommunications, The Citizens League Report, 1989.

APPENDIX IV

November 25, 1991

Minnesota Telefutures Study Group (MTSG)

Technology Data Request

Company: ______________________________

Contact Person: ____________________ Phone No. ____________

1. What are your plans to achieve 100% digital switch deployment expressed as the number of digital access lines and the percent of total access lines? What are your projected capital and non-capital costs for this digital switch deployment? Non-capital costs refer to those one-time expenses associated with the conversion such as rearrangements and changes (maintenance), generic software, records and facility assignment work, and cutover activities.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	200
a. Number of Digital Switches											
b. % Digital Switches of Total Switches											
c. Number of Digital Access Lines (000)											
d. % Digital of Total Access Lines											
e. Capital Costs ($000)											
f. Non-Capital Costs ($000)											

2. What are your projected penetration rates for touch-tone and custom-calling features by year?

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
a. Touch-tone (% of total access lines											
b. Custom calling features (% of total access lines subscribing to any custom calling feature)											

3. What are your plans to achieve 100% inter and intraLATA equal access capability? What are your projected capital and non-capital costs by year for inter and intraLATA equal access? Non-capital costs are defined in Question 1.

a. IntraLATA Equal Access	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. Number of Switches											
2. % of Total Switches											
3. Number of Access Lines (000)											
4. % of Total Access Lines											
5. Capital Costs ($000)											
6. Non-Capital Costs ($000)											

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
b. InterLATA Equal Access											
1. Number of Switches											
2. % of Total Switches											
3. Number of Access Lines (000)											
4. % of Total Access Lines											
5. Capital Costs ($000)											
6. Non-Capital Costs ($000)											

4. What are your plans to achieve 100% SS7 deployment? What are your projected capital and non-capital costs by year? Non-capital costs are those defined in Question 1.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
a. SS7 Deployment by Access Lines (000)											
b. % SS7 Deployment of Total Access Lines											
c. Capital Costs ($000)											
d. Non-Capital Costs ($000)											

5. What are your plans to achieve 100% CLASS type services capability and 100% penetration? What are your projected capital and non-capital costs? Non-capital costs are defined in Question 1.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
a. CLASS Capability											
1. Number of Switches											
2. % of Total Switches											
3. Number of Access Lines (000)											
4. % of Total Access Lines											
5. Capital Costs ($000)											
6. Non-Capital Costs ($000)											
b. CLASS Penetration											
1. Number of Access Lines Subscribing											
a) Business											
b) Residence											
2. % of Total Access Lines											
a) Business											
b) Residence											

6. What are your plans to achieve 100% ISDN capability and 100% penetration. What are your projected capital and non-capital costs? Non-capital costs are defined in Question 1.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	200
a. ISDN Capability											
1. Number of Switches											
2. % of Total Switches											
3. Number of Access Lines (000)											
4. % of Total Access Lines											
5. Capital Costs ($000)											
6. Non-Capital Costs ($000)											
b. ISDN Penetration											
1. Number of Access Lines											
a) Business											
b) Residence											
2. % of Total Access Lines											
a) Business											
b) Residence											

7. What is your current digital interoffice facility penetration based on interoffice route miles, and the percent of total interoffice route miles? What are your projected capital and non-capital costs to achieve 100 percent digital interoffice facilities? Non-capital costs are defined in Question 1.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
a. Number of interoffice route miles											
b. Number of Digital Route Miles (000)											
c. % of Total Route Miles											
d. Capital Costs ($000)											
e. Non-Capital Costs ($000)											

8. What is your deployment of analog interoffice facilities, fiber optic interoffice facilities, and other digital interoffice facilities (digital microwave/T-carrier)? These three amounts should equal the total number of interoffice route miles (7a.).

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
a. Number of Non-Fiber Digital Route Miles (000)											
b. Number of Fiber Optic Route Miles (000)											
c. Number of Analog Route Miles (000)											

9. What year have you begun or do you expect to begin to deploy broadband capability to any segment of your operating territory? Please show the year, number of networks, number of access lines and circuits with that capability, percent of total access lines, and projected capital and non-capital costs. Non-capital costs are defined in Question 1. Broadband capability, applications, and networks are defined as any arrangement at 1.544 mgb/s or greater.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
a. Number of Broadband Applications/Networks											
b. Number of Broadband Access Lines (000)											
c. Number of Broadband Circuits											
d. % of Total Access Lines (000)											
e. Capital Costs ($000)											
f. Non-Capital Costs ($000)											

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
a. Number of Broadband Applications/Networks										
b. Number of Broadband Access Lines (000)										
c. Number of Broadband Circuits										
d. % of Total Access Lines (000)										
e. Capital Costs ($000)										
f. Non-Capital Costs ($000)										

Should you have any questions on this data request or need assistance in preparing the data, please don't hesitate to call Mike Nowick at 612/296-7311 or John Duda at 612/448-8211.

APPENDIX V

NETWORK REQUIREMENTS

TYPE OF SERVICE		SUBSCRIBER LOOP			INTER OFFICE FACILITY				SWITCHING					
		TWIST PAIR	COND PAIR	FIBER TO PREM	TWIST PAIR	COND PAIR	MICRO WAVE	FIBER	ANALOG NONCOMM CTRL	ANALOG COMMON CTRL	ANALOG STR PRO CTRL	DIGITAL	DIGITAL BROAD BAND	DIGITAL OPTIC (1)
1	POTS													
2	T TONE DIALG													
3	CUST CALL FTR													
4	CENTREX	(5)												
5	EQUAL ACCESS										(6)			
6	SS7													
7	CLASS	(5)												
8	ISDN										(2)			
9	DATA ≤ 64KB											(3)		
10	DATA 64KB - 1.544MB											(3)		
11	SCAN VIDEO											(3)		
12	FULL VIDEO												(3)	
13	SWTCH>1.544M B BROAD BAND												(3)	
14	SELF HEALING TO SUB											(4)		
15	SELF HEALING INTER OFFICE											(4)		

NOTES:

(1)	Optic fiber ports only
(2)	Requires adjunct processor
(3)	Required only if switched service is necessary
(4)	Digital transmission switching devices required at subscriber or office site
(5)	Enhanced services require conditioned pair
(6)	IntraLATA/interLATA requires digital switch

APPENDIX VI

BEFORE THE MINNESOTA PUBLIC UTILITIES COMMISSION

Don Storm	Chair
Tom Burton	Commissioner
Cynthia A. Kitlinski	Commissioner
Dee Knaak	Commissioner
Norma McKanna	Commissioner

In the Matter of a Commission Initiated Investigation into the Provision of Custom Local Area Signaling Services in Minnesota

ISSUE DATE: June 17, 1993

DOCKET NO. P-999/CI-92-992

ORDER ESTABLISHING CONDITIONS FOR THE PROVISION OF CUSTOM LOCAL AREA SIGNALING SERVICES

PROCEDURAL HISTORY

I. Proceedings to Date

On August 28, 1992 the Commission issued an Order opening an investigation into whether, and under what conditions, Minnesota telephone companies should be allowed to provide Custom Local Area Signaling Services.[1] These services, popularly known as CLASS services, give subscribers new ways to monitor and control incoming and outgoing calls. Since the services operate by capturing (and sometimes disclosing) the number of the calling party, they change the traditional relationship between caller and callee, raising privacy issues and changing settled expectations. The best-known and most controversial CLASS service is Caller ID, which gives called parties the originating telephone numbers of incoming calls.

The Commission opened the investigation because it was clear that Minnesota telephone companies would soon begin filing requests to offer CLASS services. (In fact, the Commission had just authorized Mankato Citizens Telephone Company to conduct a six-month trial of CLASS services within the Mankato exchange.)[2] Since CLASS services raise major policy issues common to all companies, the Commission concluded it would be best to address them in a generic proceeding.

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[1] Custom Local Area Signaling Services is a term coined by BELLCORE for services offered by the Bell Operating Companies. Other local exchange carriers offer these services under different names. In the interest of simplicity, the Commission will refer to these services using BELLCORE terminology.

[2] <u>In the Matter of Mankato Citizens Telephone Company's Proposal to Study Custom Local Area Signalling Services</u>, Docket No. P-414/M-92-576, ORDER APPROVING STUDY AS MODIFIED (August 24, 1992).

The August 28 Order invited comments from interested persons and established filing deadlines. Initial comments were to be filed within 60 days; reply comments were to be filed 30 days later. The following parties filed formal comments: the Minnesota Department of Public Service; the Residential Utilities Division of the Office of the Attorney General; the Minnesota Telephone Association; the Minnesota Business Utility Users Council; the Minnesota Coalition for Battered Women; Richard Neumeister; David Frankel; Charles Baker; U S WEST Communications, Inc.; Vista Telephone Company of Minnesota; GTE North - Minnesota and Contel of Minnesota d/b/a GTE Minnesota; and AT&T Communications of the Midwest, Inc.

The Commission also received 32 letters and 169 phone calls from members of the public. The public focused almost exclusively on a single service, Caller ID, with opinion fairly sharply and evenly divided.

The Commission held hearings in the matter on May 6 and May 7, 1993. Formal parties presented oral argument; members of the public presented oral comments. The Commission met to consider the matter on May 12, 1993.

Having reviewed the entire record in this proceeding, and having heard the arguments of counsel and the comments of the public, the Commission finds that it is in the public interest to authorize CLASS services in Minnesota, for the reasons and under the conditions set forth below.

FINDINGS AND CONCLUSIONS

II. Description of CLASS Services

CLASS services are enhanced services delivered by new "out of band" technology which allows the network to carry more information about each call, and to offer more options for handling each call, than was possible in the past. There are eight basic CLASS services, described below. Operational details vary from company to company. Not every company has the capacity to offer or chooses to offer every facet of every service. Over 30 states have authorized the provision of CLASS services in some form.

A. Caller ID

Caller ID is the CLASS service with the greatest potential to change existing communication patterns. The service transmits to the called party the number of the telephone line from which the call is placed. With the necessary software, it can also transmit the name of the line's subscriber. The name and number appear on the display line of a small electronic terminal attached to the customer's telephone or inside wiring. Caller ID also transmits the originating numbers (and names if applicable), dates, and times of all unanswered calls. This information is stored and displayed by the electronic terminal.

CLASS technology makes it possible for callers to block the transmission of their names and numbers, either on a per-call or per-line basis. Calls for which the caller has blocked the originating information appear on the terminal display as "private" or "anonymous." Callers using blocked lines can "unblock" individual calls, assuming available technology is in place.

CLASS technology also makes it possible for subscribers to refuse all "blocked" calls before they are completed. This feature is called Anonymous Call Rejection.

B. Last Call Return

Last Call Return allows a called party to call the originating number of the last unanswered call by dialing a standard code. If the originating number is busy, Last Call Return software will keep trying to place the return call for 30 minutes. Last Call Return also typically gives the called party the originating number of the last unanswered call.

C. Continuous Redial

Continuous Redial allows a caller to continue trying to reach a busy number without continuing to redial manually. The feature is activated by dialing a standard code. Once activated, system software keeps redialing the number, whether or not the caller's line is in use, for 30 minutes. When the line being called is open, the software signals the calling party.

D. Priority Call

Priority Call allows a subscriber to assign a distinctive ring and a distinctive call waiting signal for calls from up to 15 originating numbers. The subscriber can program the software himself or herself to change the designated numbers at any time.

E. Selective Call Acceptance

Selective Call Acceptance allows subscribers to program their telephones to prevent the completion of all calls except those from designated numbers. The subscriber can designate up to 15 originating numbers and can change them at will. The feature can be used as frequently or infrequently as the subscriber chooses.

F. Selective Call Rejection

Selective Call Rejection allows subscribers to designate up to 15 originating numbers from which they will not accept calls. It also allows subscribers to add to the list of rejected numbers the originating number of the last call received, whether or not the subscriber knows that number.

G. Selective Call Forwarding

Selective Call Forwarding allows a subscriber to program his or her telephone to automatically forward calls from up to 15 originating numbers to a different telephone number. The subscriber can reprogram the list of designated numbers at any time.

H. Call Trace

Call Trace allows a subscriber to establish a record of the time, date, and originating number of a call he or she believes should be traced. The service is activated by dialing a standard code. Tracing is effective whether or not the caller blocked the transmission of originating information. The originating number is not released directly to the subscriber, but is available for the use of law enforcement authorities. Some companies offer mediation or intervention services to customers experiencing harassing or annoying calls. With customer consent, the originating number is also available to company employees providing these services.

III. Summary of Commission Action

The Commission finds that there are no legal barriers to the provision of CLASS services in Minnesota. The Commission finds that the benefits of CLASS services outweigh their drawbacks and that they are in the public interest, subject to regulatory safeguards to protect the vulnerable and maximize consumer choice. The Commission will establish those safeguards and will set conditions on CLASS services to serve the following goals: to promote public understanding of CLASS services; to prevent improper use of information obtained through CLASS services; to ensure that appropriate distinctions between business and residential customers are maintained; and to develop a solid base of information on the performance of these services in Minnesota.

IV. The Legality of CLASS Services

The Residential Utilities Division of the Office of the Attorney General (RUD-OAG) questioned the legality of CLASS services' transmission of originating information in the absence of affirmative consent by the calling party. (The called party has consented by purchasing CLASS services.) These concerns were based in part on the Minnesota Privacy in Communications Act, Minn. Stat. §§ 626A.01 et seq. (1992), and in part on constitutional privacy rights. The RUD-OAG believed these concerns required polling subscribers on whether they wanted originating information transmitted for their outgoing calls and installing line blocking for all subscribers who answered no and for all subscribers who failed to respond. The Department and Richard Neumeister expressed similar concerns.

The Commission finds no statutory or constitutional barrier to authorizing CLASS services without the blocking requirements advocated by the RUD-OAG.

While the Commission has conducted its own analysis of the legality of CLASS services, the Commission notes that its conclusion that CLASS services are legal is shared by every court and regulatory commission which has considered the issue, with the exception of the Supreme Court of Pennsylvania. Furthermore, the Pennsylvania decision holds little relevance for Minnesota, since Pennsylvania's wiretap statute, unlike Minnesota's, requires the consent of all parties to a conversation for lawful interception to occur. Barasch v. Public Utility Commission, 605 A.2d 1198 (Pa. 1992).

A. The Privacy in Communications Act

The provisions of the Privacy in Communications Act at issue generally prohibit the "interception" of telephone communications and the use of devices to record the originating and terminating numbers of telephone communications. Minn. Stat. §§ 626A.02, subd. 1 (a); 626A.35, subd. 1. Both prohibitions are lifted with the consent of one party to the communication. Minn. Stat. §§ 626A.02, subd. 1 (d); 626A.35, subd. 2 (3).

1. The Prohibition Against "Interception"

The Commission finds that CLASS services' transmission of originating information about incoming calls does not constitute an interception within the meaning of the statute. The statute defines "intercept" as follows:

> Intercept. "Intercept means the aural or other acquisition of the contents of any wire, electronic, or oral communication through the use of any electronic, mechanical, or other device.
>
> Minn. Stat. § 626A.01, subd. 5 (1992), emphasis added.

It defines "contents" as follows:

> Contents. "Contents," when used with respect to any wire, electronic, or oral communication, includes any information concerning the substance, purport, or meaning of that communication.
>
> Minn. Stat. § 626A.01, subd. 8 (1992).

The Commission finds that the "contents" of a communication relate to what was said, not by whom it was said, to whom it was said, or the numbers of the telephone lines over which it was said. The words "substance, purport, and meaning" all relate to the message itself, not the identities of the parties. The United States Supreme Court reached the same conclusion in United States v. New York Telephone Company, 434 U.S. 159 (1977), although the Court in that case was addressing different issues.

The Commission also finds that, even if the identities of the parties were considered part of a communication's "contents," CLASS services would fall under the statutory exception allowing interception with the consent of one party:

> It is not unlawful under this chapter for a person not acting under color of law to intercept a wire, electronic, or oral communication where such person is a party to the communication or where one of the parties to the communication has given prior consent to such interception unless such communication is intercepted for the purpose of committing any criminal or tortious act in violation of the constitution or laws of the United States or of any state.

Minn. Stat. § 626A.02, subd. 2 (d) (1992).

2. The Prohibition Against Trap and Trace Devices

The Privacy in Communications Act also generally forbids the use of trap and trace devices, which are defined as follows:

> Trap and Trace Device. "Trap and trace device" means a device which captures the incoming electronic or other impulses that identify the originating number of an instrument or device from which a wire or electronic communication was transmitted.

Minn. Stat. § 626A.39, subd. 4 (1992).

Caller ID, and CLASS services generally, capture and identify the originating numbers of incoming calls. CLASS technology therefore operates as a trap and trace device within the meaning of the Privacy in Communications Act. However, the Act clearly allows the installation and use of a trap and trace device with the consent of the subscriber to the line on which it is installed:

> Exception. The prohibition of subdivision 1 [against the installation of a trap and trace device] does not apply with respect to the use of a pen register or a trap and trace device by a provider of electronic or wire communication service:
>
> (3) where the consent of the user of that service has been obtained.

Minn. Stat. § 626A.35, subd. 2 (1992).

The Commission finds the language of the statute clearly allows the use of trap and trace technology with the consent of the subscriber. It does not require the consent of every subscriber who calls the line on which the technology has been installed. The Commission concludes CLASS services do not run afoul of the Privacy in Communications Act.

B. Constitutional Considerations

No party seriously challenged the constitutionality of authorizing the provision of CLASS services. Parties did, however, refer to constitutionally protected privacy rights as consistent with protecting the privacy of telephone numbers.

The Commission believes there are no constitutional barriers to authorizing CLASS services for two reasons: first, regulatory decisions governing the provision of service by private companies generally do not constitute state action and do not involve constitutional rights; and second, the interest in limiting disclosure of one's telephone number does not rise to the level of the fundamental privacy interests protected by the Constitution. These principles were explained in detail by the South Carolina Supreme Court, which addressed the constitutionality of CLASS services in Southern Bell Telephone and Telegraph Company v. Hamm, 409 S.E.2d 775 (S. Car. 1991). The Commission concurs with the Court's analysis in that case.

The absence of constitutional constraints does not denigrate the seriousness of the privacy issues raised by interested parties, however. The Commission has considered privacy interests carefully in its analysis of whether CLASS services are in the public interest.

V. Public Interest Analysis

A. Introduction

Caller ID is the only CLASS service to generate significant controversy and public comment in this proceeding. (Last Call Return caused controversy only to the extent that it, like Caller ID, discloses the originating number of the calling party.) Since all significant issues raised by CLASS services are raised by Caller ID, the Commission will focus on Caller ID in determining whether CLASS services are in the public interest.

By giving a called party the number of the line on which a call originates (and sometimes the name of the line's subscriber), Caller ID shifts the existing balance of power and privacy between caller and called party. Although different blocking options will change the degree to which the shift occurs, the shift is basically in favor of the called party. Caller ID gives called parties more information about each call than is currently available, allowing them to make more informed choices about whether or not to answer. It reduces the need to answer "just in case." It also deprives callers of the ability to prevent reciprocal contact by not disclosing their telephone numbers. It changes the terms under which people communicate by telephone.

The practical effects of Caller ID cannot be fully understood without a significant amount of experience with the service in operation. Parties on both sides of the issue are in general agreement, however, on what its potential benefits and drawbacks appear to be. They disagree on how those benefits and drawbacks should be balanced in determining the public interest.

B. Benefits of Caller ID

Caller ID can be a valuable time management/personal control tool for business and residential customers. Eliminating the need to treat every call as equally important can free small business owners for more productive activities and give residential customers more privacy and tranquility in their homes. Caller ID also appears to discourage harassing and obscene calls; reports of such calls have dropped in other jurisdictions in exchanges in which Caller ID has been introduced. Also, several members of the public who commented in this proceeding said they had received threatening or distressing calls they could have avoided had they known the originating number of the call.

Caller ID also provides public safety and personal security benefits. Without Caller ID, emergency calls to hospitals, poison control centers, and other emergency facilities without enhanced 911 capability cannot be traced, at least not expeditiously. With Caller ID, it is possible to locate people who call those facilities and are then unable to provide location information. Caller ID can also be helpful to persons with disabilities that prevent them from getting to the phone before the last ring. The record of originating numbers of missed calls can help combat the frustration and isolation often produced by limited mobility.

Finally, a representative of Minnesotans with hearing impairments of different severities stated Caller ID would be a useful tool for them. The record of missed calls would be helpful, since hearing impaired persons often miss the ringing or flashing light signifying a phone call. The simultaneous transmission of originating information would be also be helpful, since hard-of-hearing persons who use standard telephones often have difficulty recognizing callers' voices.

C. Drawbacks of Caller ID

Clearly, the most significant drawback of Caller ID is its potential to jeopardize the safety and emotional security of people who have been the targets of domestic violence. These people are often legally unable to end all contact with their abusers and remain in danger if their whereabouts are known. Inadvertent disclosure of a victim's telephone number could endanger him or her; inadvertent disclosure of a shelter's telephone number could endanger all residents and jeopardize the viability of the shelter itself. For these reasons, organizations serving battered women and other victims of domestic violence have filed comments opposing Caller ID.

Law enforcement agencies have expressed concern about protecting undercover operations from inadvertent disclosure, but appear to have concluded blocking technology will provide adequate protection.

Opponents of the service argue that Caller ID could have a chilling effect on people's willingness to seek sensitive medical, mental health, social, and legal services. They argue that it could burden professionals who need to contact clients or patients from their homes, but do not wish to disclose their home telephone numbers.

The service's opponents also see grave potential for its abuse by businesses, and even by government agencies. They fear businesses and agencies would "redline" certain callers, or classes of callers, and refuse calls they have an obligation to accept. They are concerned that businesses might compile consumer profiles on callers and sell them, causing a proliferation of annoying telephone solicitations and counteracting the benefits of Caller ID for residential customers.

Finally, opponents object on privacy grounds to the automatic transmission of originating telephone numbers. They believe telephone numbers are private, by tradition and common understanding, and that Caller ID flies in the face of that cultural norm. In their view, Caller ID provides material benefits to a few and compromises the privacy of many.

D. Balancing the Interests

The Commission has balanced the competing claims for and against Caller ID and other CLASS services and concludes that the introduction of CLASS services is in the public interest, subject to regulatory safeguards to protect the vulnerable and maximize consumer choice.

The fact that Caller ID changes traditional expectations and relationships does not mean that it should be prohibited. Technological advances always carry the potential for change. In this case the status quo -- the network's failure to provide any originating information about incoming calls -- is an accident of technology, not the result of a conscious policy decision. The anonymity with which telephone calls can be placed today is the result of direct dialing technology. Before that technological advance, all calls were operator-assisted, and callers' identities were much less private.

Furthermore, the Commission sees no sound policy basis for treating as the norm the practice of placing calls without simultaneously disclosing one's identity. Determining identities is an initial step in any two-way communication; prompt disclosure of the calling party's identity will generally benefit both parties.

Of course, the complicating factor is that Caller ID does not disclose the caller's identity; it conveys information about the access line from which the call is placed -- its number and, in some cases, the name of the line's subscriber. This disclosure is not altogether innocuous. People often wish to limit the release of their telephone numbers, for the same reasons they like to know who is calling when the phone rings. They want to protect the privacy of their homes from unwelcome intrusions. Ironically, Caller ID carries the potential both for greater control over unwanted calls and for more unwanted calls. For these reasons, both supporters and opponents of Caller ID relied on the privacy of the home as an argument in support of their positions.

The Commission believes regulatory safeguards can avert the dangers and prevent the abuses unrestricted Caller ID could inspire. Line blocking, together with vigorous educational efforts and direct contacts with social services providers, can ensure adequate protection to persons who have experienced domestic violence. Standard tariff provisions can prohibit the sale of Caller ID data and the violations of consumer privacy that would entail. The security of law enforcement undercover operations can be protected by requiring telephone companies to contact local law enforcement agencies before the service goes into effect.

Similarly, as long as callers have and understand the option of blocking the transmission of originating information for their calls, the "chilling effect" on sensitive communications should not materialize. Neither should professionals be deterred from using their home phones to serve patients and clients. Individuals can weigh the privacy value they place on their telephone numbers and block or not block accordingly. Although blocking could also prevent businesses or government agencies from "redlining" or practicing discrimination in telephone contacts with the public, the Commission considers these concerns speculative and will not presume that businesses or government agencies would conduct themselves in clear violation of law and public policy.

Given the Commission's ability to protect the vulnerable through blocking technology, education, and tariff requirements, the Commission will authorize Caller ID. The Commission will closely monitor the service's performance over the next three years to ensure prompt correction of any unforeseen problems or abuses.

E. Blocking Requirements

The record in this proceeding shows that Caller ID will meet the perceived needs of some customers, be of no consequence to some, and be a source of irritation to others. The Commission concludes that consumers should have as much choice as possible about how they are affected by the service. Persons willing to pay to have information about incoming calls should be able to do so; persons wishing to withhold originating information from called parties should be able to do so; and the public's response to these options should be a controlling factor in future decisions about the form the service should take. Maximizing consumer choice is a goal the Commission generally affirms. It is especially appropriate in this case.

1. Residential Blocking

The Commission believes that every residential customer should have access to per-line and per-call blocking and will so require. Per-call blocking will be available free of charge to all residential customers at all times. Per-line blocking will be available at all times for a one-time, cost-based service order fee. This fee will be waived for at least one 90-day period at the introduction of the service, and for a 90-day period for new customers joining the network. Per-call and per-line blocking shall be fully operational on the day the service goes into effect.

To ensure informed consumer choice, companies introducing Caller ID will be required to engage in vigorous educational programs before the service goes into effect. Since billing schedules (and billing insert schedules) are staggered for some companies, the Commission will require that each customer receive educational materials on Caller ID and have a chance to opt for line blocking at least 30 days before the service becomes effective.

Customers will receive line blocking only if they choose it. Customers who indicate no choice will not receive it, although they, like all residential customers, will have full access to per-call blocking. The Commission believes that customers with a strong privacy interest in their telephone numbers will make an affirmative choice for line blocking. Customers who do not make an affirmative choice can be assumed to be indifferent, just as customers who do not request unlisted or unpublished numbers are assumed to be indifferent. In such cases the general policy of telephone number accessibility prevails.

Customers shall be allowed to remove line blocking without charge, in accordance with policies favoring telephone number accessibility and consumer choice.

2. Business Blocking

Blocking originating information for business calls presents a different set of issues than blocking originating information for residential calls. Protecting the privacy of the home is the main reason for liberal residential blocking policies. Protecting the privacy of the home is rarely an issue for business customers; disclosure of business numbers rarely carries the risk of disrupting home life. Furthermore, as recent legislation directed at controlling telemarketing demonstrates, business calls are more often unwelcome intrusions on home life than personal calls. Finally, encouraging the transmission of originating information for business calls will increase the value of Caller ID to subscribers by reducing the number of calls they have to consider answering "just in case." For these reasons, blocking will be available to business customers on less generous terms than to residential customers.

The Commission will prohibit companies from providing per-line blocking to business customers in the absence of demonstrated need. Law enforcement agencies, shelters for battered persons, and government agencies engaged in undercover investigations are exempt from the requirement to demonstrate need; they will receive per-line blocking on request. Other customers shall demonstrate need under criteria set forth in company tariffs. Disputes about need for per-line blocking will be resolved by the Commission. Once need has been demonstrated (or assumed), per-line blocking will be provided free of charge.

At the request of business customers (but not without a request), companies may provide per-call blocking, subject to a per-call fee. Companies shall exempt from the fee customers who have demonstrated a need for per-call blocking, and law enforcement agencies, shelters for battered persons, and government agencies engaged in undercover investigations. As with per-line blocking, criteria for receiving free per-call blocking shall be set forth in company tariffs, and disputes will be resolved by the Commission.

The Commission believes these blocking requirements will protect the privacy of business subscribers (and their clients, patients, and customers), while still promoting the goal of providing called parties with as much information about each call as possible.

3. Last Call Return

As mentioned earlier, Last Call Return raises serious privacy issues because, due to software anomalies, in some applications it transmits to the called party numbers that have been blocked. The Commission will prohibit companies from offering Last Call Return unless they have technology in place to prevent the transmission of blocked numbers.

VI. Regulatory Classification

In 1987 the Minnesota Legislature enacted legislation classifying specified telephone services as "emergingly competitive" and establishing a procedure whereby these or other services could be classified as "effectively competitive." Minn. Stat. § 237.59 (1992). Services in either of these two categories were made subject to streamlined regulatory procedures, on the assumption that market forces would help keep prices low and quality high. Trusting the discipline of the marketplace to supplement regulation, the Legislature made filings on competitive services subject to less intense scrutiny and shorter time frames than filings on noncompetitive services. Minn. Stat. §§ 237.57-.61 (1992). One of the categories of services classified as "emergingly competitive" under the 1987 legislation was "services not previously offered prior to August 1, 1987." Minn. Stat. § 237.59, subd. 1 (18) (1992). Many parties in this proceeding argued that CLASS services fall into this category. The Commission disagrees.

First, many CLASS services were offered, in different forms and under different names, prior to August 1, 1987. Priority Call (its distinctive Call Waiting component) and Selective Call Forwarding are variations and refinements of Call Waiting, a custom calling feature available before August 1, 1987. Call Trace provides the same service that has long been available through mechanical trap and trace devices; providing the service through upgraded technology does not make it a new service. At most, then, CLASS services are a combination of new and old, competitive and noncompetitive services.

When dealing with past cases involving both competitive and noncompetitive services or service elements, the Commission has found the most reasonable approach is to treat the entire service package as noncompetitive.[3] The Commission continues to consider this the best approach. If the competitive and noncompetitive aspects of a proposal are so inextricably linked that the company cannot separate them for filing or marketing purposes, it makes little sense for the Commission to try to separate them in examining a proposal to offer them. It is also sound regulatory policy to resolve any doubt about the classification of a service or service element in favor of noncompetitive treatment and full regulatory protections. Finally, treating combination services as noncompetitive removes the risk of companies attempting creative "bundling" of competitive and noncompetitive services and service elements to evade proper classification and review.

The Commission is particularly comfortable with treating CLASS services as noncompetitive, since in reality they are technical improvements on basic local service. Their purpose is to make local service more responsive to contemporary needs for greater control over incoming calls. They are, at their core, basic local services.

Finally, at present CLASS services are offered only by local exchange carriers operating in a monopoly environment. It would be at odds with the spirit of the 1987 legislation to classify such services as emergingly competitive. If in the future competitors emerge, the Commission, on its own motion or at the request of any party, can begin a proceeding to consider classifying CLASS services as emergingly competitive. Minn. Stat. § 237.59, subd. 2 (1992).

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[3] In the Matter of U.S. Link Proposing to Offer Operator Services and a New Pricing Plan for Associated Toll Services, Docket No. P-645/EM-91-112, ORDER AUTHORIZING OPERATOR SERVICES AND ASSOCIATED TOLL SERVICES (June 19, 1991). See also, In the Matter of a Proposal by Teleconnect to Make Several Changes in its Minnesota Price List, Docket No. P-478/EM-90-163, ORDER APPROVING TWO PRICE LIST CHANGES AND DISAPPROVING PRICE INCREASES FOR TRAVEL SERVICE AND DIRECTORY ASSISTANCE (November 8, 1990).

VII. Conditions Under Which CLASS Services May Be Offered

The Commission will authorize CLASS services subject to regulatory conditions designed to protect the vulnerable, maximize consumer choice, and provide a solid base of information to guide future decisionmaking. In addition to the blocking requirements detailed above, the Commission will impose the following requirements.

A. Public Education

Public understanding of CLASS services is crucial to its success and to avoiding customer confusion. The Commission will therefore require that any application to provide CLASS services include a detailed description of a proposed public education program, including copies of materials the company plans to distribute to customers and members of the public.

B. Law Enforcement Notification

As noted above, companies will be required to notify all law enforcement agencies in their service areas of their intention to offer CLASS services before filing an application with the Commission to provide them.

C. Protecting Consumer Privacy

Companies offering CLASS services will be required to file proposed tariff provisions prohibiting the sale of data collected through Caller ID or other CLASS services.

Applications to offer Caller ID shall also include a detailed description of the security measures the company plans to use to protect from unauthorized disclosure calling party information stored in data bases in CLASS-equipped offices.

D. Reporting Requirements

The Commission will require annual reports from companies for the first three years they offer CLASS services, to ensure that any unforeseen problems or abuses are detected and corrected promptly. These reports will include the following information: the number of CLASS-equipped exchanges and access lines; the number of customers subscribing to each CLASS service; the number of subscribers who have chosen per-line blocking; the number of business customers that have requested per-call blocking; the number of subscribers, business and residential, who have used per-call blocking; and the total revenues collected from CLASS services.

The Commission will also require an annual report from the Department of Public Service to help the Commission evaluate the performance of CLASS services and identify any need for further regulatory action. That report will include the following information: a summary of the annual reports filed by telephone companies offering CLASS services; the Department's assessment of public acceptance of CLASS services, together with the factual basis for that assessment; and any Department recommendations on how CLASS services should be structured or provided in the future.

ORDER

1. The Commission authorizes the provision of CLASS services in Minnesota subject to the conditions set forth in this Order.

2. No company may offer CLASS services until its application to do so has been approved by the Commission.

3. Applications to provide CLASS services shall include at least the following items:

   a. a detailed description of the services to be offered, including a list of exchanges where the services will be offered, and proposed rates and tariffs;

   b. detailed description of a proposed public education program, including copies of materials the company plans to distribute to customers and members of the public;

   c. a detailed description of the security measures it plans to use to protect from unauthorized disclosure calling party information stored in data bases in CLASS-equipped offices;

   d. tariff provisions prohibiting the sale of data collected through Caller ID or other CLASS services;

   e. a report on company contacts with local law enforcement agencies on company plans to offer Caller ID, including the response of law enforcement agencies.

4. No company may offer Last Call Return service until it has technology in place to prevent that service from transmitting blocked numbers.

5. All companies offering Caller ID shall implement the per-call and per-line blocking requirements applicable to business and residential customers set forth in the text of this Order.

6. All companies providing CLASS services shall file reports on or before March 1 of each of the first three years they offer CLASS services. Those reports shall include the following information:

   a. the number of CLASS-equipped exchanges and access lines;

b. the number of customers subscribing to each CLASS service;

c. the number of subscribers who have chosen per-line blocking;

d. the number of business customers that have requested per-call blocking;

e. the number of subscribers, business and residential, who have used per-call blocking;

f. the total revenues collected from CLASS services.

7. On or before May 1 of each of the first three years any company offers CLASS services in Minnesota, the Department of Public Service shall file a report on the operation of CLASS services, including at least the following information:

a. a summary of the annual reports filed by telephone companies offering CLASS services;

b. the Department's assessment of public acceptance of CLASS services, together with the factual basis for that assessment;

c. any Department recommendations on how CLASS services should be structured or provided in the future.

8. This Order shall become effective immediately.

BY ORDER OF THE COMMISSION

Mark E. Oberlander for

Richard R. Lancaster
Executive Secretary

(S E A L)

APPENDIX VII

Detailed Description of CLASS Features

Automatic Call Back (ACB - outgoing - A=*66 D=*86):

An outgoing call management feature which will enable the subscriber to have the system redial the last number called from his station. This will apply regardless of whether the original call was answered, unanswered, or encountered a busy tone. The system will monitor the calling and called lines and will attempt to connect the call for up to 30 minutes. The activation of this feature can be canceled by the customer when desired.

Automatic Recall (AR-incoming - A=*69 D=*89):

An incoming call management feature which will enable a subscriber to have call set up performed automatically to the calling party of the last incoming call. This will apply whether the incoming call was answered, unanswered, or encountered a busy tone. Two level feature activation applies to Automatic Recall and allows the subscriber to hear the number of the last incoming call prior to deciding whether or not to recall that number.

Calling Number Delivery (CND - incoming A=*65):

Enables the customer to receive the calling number on incoming calls. The number will be delivered to the called party's Customer Premise Equipment (CPE) in the interval between the first and second ring. The calling number will remain for the duration of the call and can be viewed from the display on the CPE. Also known as Caller Identification (Caller ID).

Calling Number Delivery Blocking (CNB - outgoing A=*67):

Allows the calling party to suppress his directory number so that the called party with Calling Number Delivery does not receive the information. The called party will receive a "private" message instead of the calling party's directory number. CNB can be made available to all subscribers on an office wide basis without usage sensitive billing, or on a per station basis with usage sensitive billing.

Customer Originated Trace (COT - incoming A=*57):

Allows the subscriber to initiate a trace on the last incoming call by dialing an activation code. The call will be traced automatically, and the print out of the originating directory number and the time the call was made will be forwarded to a predetermined location, not to the subscriber. The subscriber then contacts the telephone company or law enforcement agency to determine further action.

This feature can be assigned as a station option on either a usage sensitive or a flat rate basis, or office wide on a usage sensitive billing basis.

Distinctive Ringing/Call Waiting (SDR - incoming A=*61):

An incoming call management feature which will allow the subscriber to define a list of calling directory numbers that will provide the subscriber with special incoming call treatment. Any incoming calls on this list will be indicated by a distinctive ringing pattern or a distinctive call waiting tone. Terminating calls from telephone numbers which are not on the list, or which cannot be identified, will be given standard treatment.

Selective Call Acceptance (SCA - incoming A=*64):

Allows customers to define a list of calling directory numbers that will be accepted. Any calling numbers not on that list will be routed to announcements and rejected. The calling party not on the acceptance list will receive an announcement stating that the call is not presently being accepted by the called party. Subscribers can review and change the list of accepted directory numbers as desired.

Selective Call Forwarding (SCF - incoming A=*63):

Allows the subscriber to have certain terminating calls forwarded to a designated remote station. The activity will occur whenever a call is received from a telephone number which has been indicated on a list of numbers, referred to as the Selective Call Forwarding screening list. Terminating calls from telephone numbers which cannot be identified or have not been indicated on the list will be given standard terminating treatment.

Selective Call Rejection (SCR - incoming A=*60):

Allows the subscriber to define a list of calling directory numbers to be screened. Any calling numbers on this list will be routed to announcements and rejected. All other calls will be treated normally. The calling party on the rejection list will receive an announcement stating the call is not presently being accepted by the called party.

A = Activate Code D = Deactivate Code

(Source: Northern Telecom Technical Education Manual for DMS-10 CCS7/CLASS Translations, August 1992, Course #0239)

APPENDIX VIII

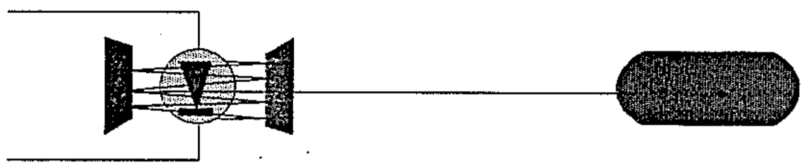
NORTH AMERICAN* DIGITAL HIERARCHY
vs EUROPEAN DIGITAL HIERARCHY

	NAME	RATE	CAPACITY
NORTH AMERICA	DSO	64 Kb/s	1 Voice Chan
EUROPE	CEPTO	64 Kb/s	1 Voice Chan
NORTH AMERICA	DS1 (T1)	1.544 Mb/s	24 DSOs
EUROPE	CEPT1 (E1)	2.048 Mb/s	24 DSOs
NORTH AMERICA	DS1C (T1C)	3.152 Mb/s	2 DS1s
EUROPE	———	———	———
NORTH AMERICA	DS2 (T2)	6.312 Mb/s	4 DS1s
EUROPE	CEPT2 (E2)	8.448 Mb/s	4 CEPT1s
NORTH AMERICA	DS3 (T3)	44.736 Mb/s	28 DS1s
EUROPE	CEPT3 (E3)	34.368 Mb/s	16 CEPT1s
NORTH AMERICA	DS4NA	139.264 Mb/s	3 DS3s
EUROPE	CEPT4 (E4)	139.268 Mb/s	4 CEPT3s
NORTH AMERICA	———	———	———
EUROPE	CEPT5 (E5)	564.992 Mb/s	4 CEPT4s

* and Japanese

SONET

A NEW FAMILY OF STANDARD, HIGH -SPEED, SYNCHRONOUS DIGITAL CHANNELS



ELECTRICAL	LINE RATE (Mb/s)	OPTICAL
STS - 1	51.840	OC - 1
⋮	⋮	⋮
STS - N*	N X 51.840	OC - N+
⋮	⋮	⋮
STS - 256	13,271.040	OC - 256

* SYNCHRONOUS TRANSPORT SIGNAL LEVEL N

+ OPTICAL CARRIER - LEVEL N SIGNAL

HIGH BANDWIDTH TRANSPORT
SOME NEAR-TERM
OPTICAL CARRIER RATES

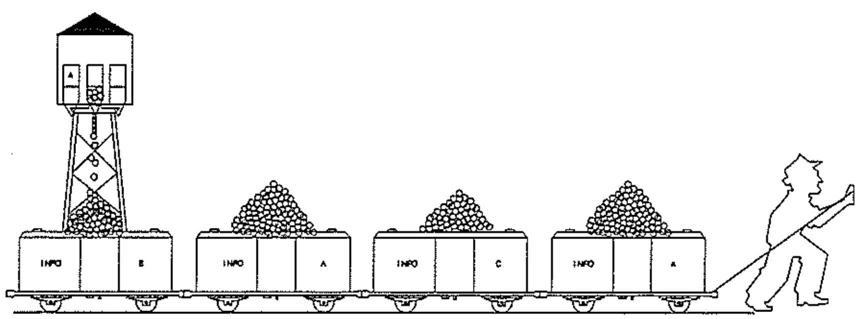
STS LEVEL	LINE RATES (Mb/s)	OC Level	#64Kb/s Channels
STS - 1	51.84	OC - 1	672
STS - 3	155.825	OC - 3	2,016
STS - 12	622.08	OC - 12	8,064
STS - 24	1244.16	OC - 24	16,128
STS - 48	2488.32	OC - 48	32,256

APPENDIX IX

WHAT IS ASYNCHRONOUS TRANSFER MODE?

AT ITS SIMPLEST, ATM IS A NEW METHOD OF FORMATTING, MULTIPLEXING, CROSS-CONNECTING AND SWITCHING INFORMATION IN 53-BYTE CELLS

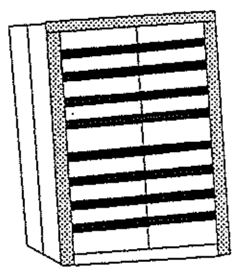
(~ "PACKETS")



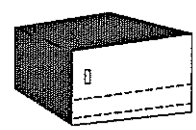
WHAT IS ASYNCHRONOUS TRANSFER MODE?

AT ITS MOST GRANDIOSE, ATM IS A REVOLUTIONARY CHANGE TO THE ENTIRE NETWORK, REQUIRING:

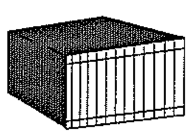
NEW SWITCHES



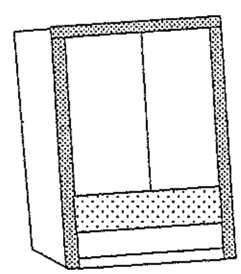
NEW HUBS



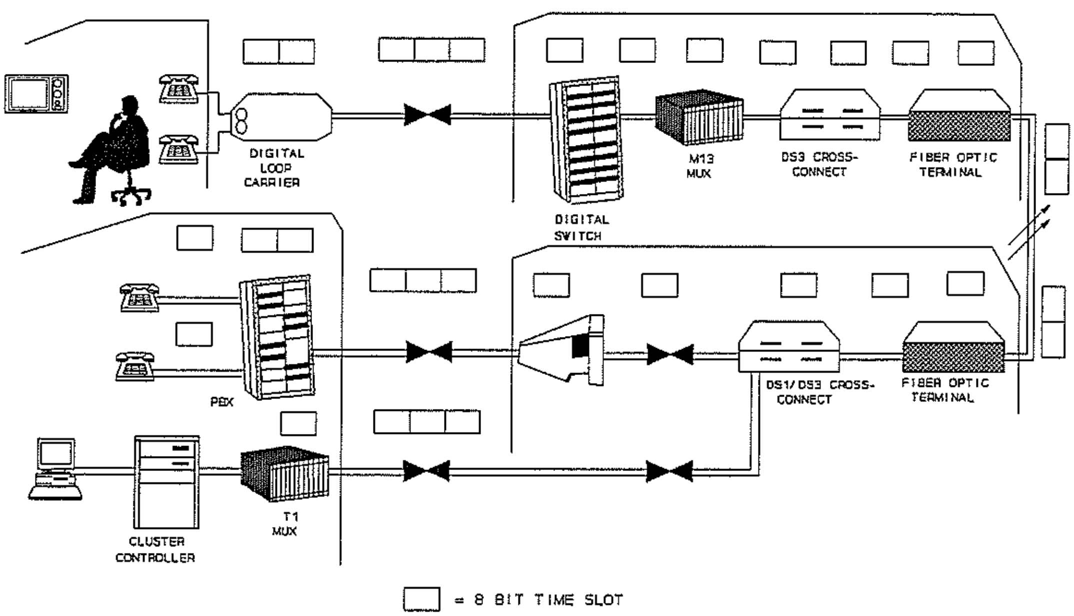
NEW MULTIPLEXERS



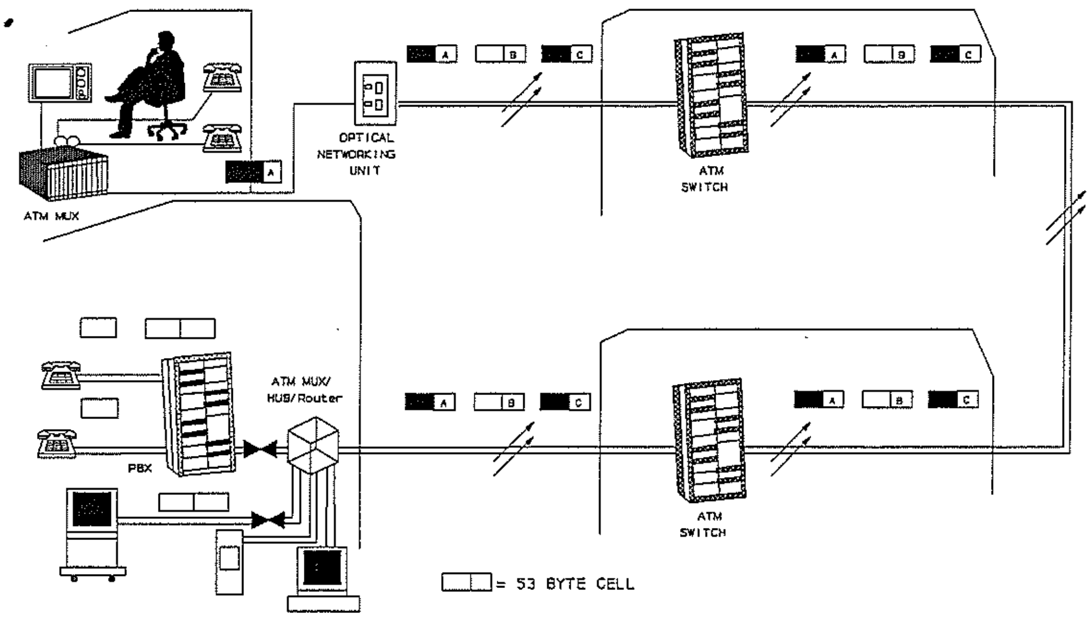
NEW CROSS-CONNECTS



TODAY'S DIGITAL NETWORKS ARE DESIGNED TO MOVE 8-BIT TIME SLOTS

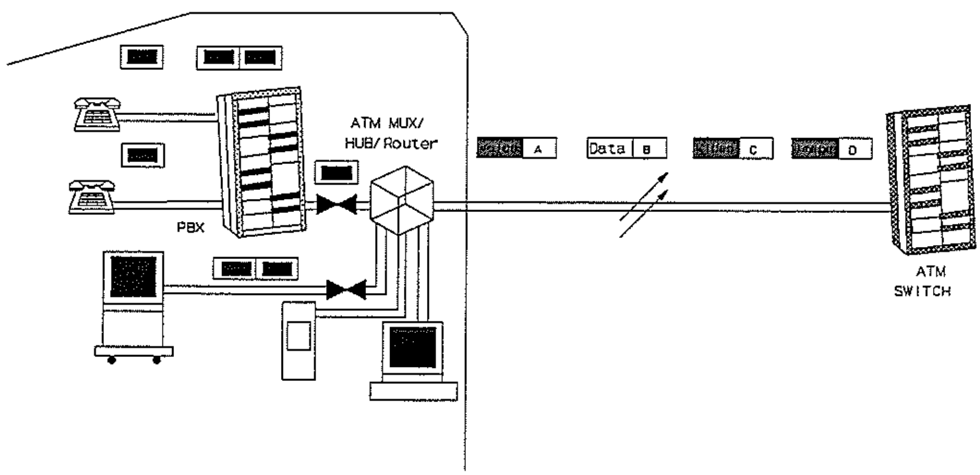


TOMMOROW'S NETWORKS WILL BE DESIGNED TO MOVE 53-BYTE "TIME SLOTS"

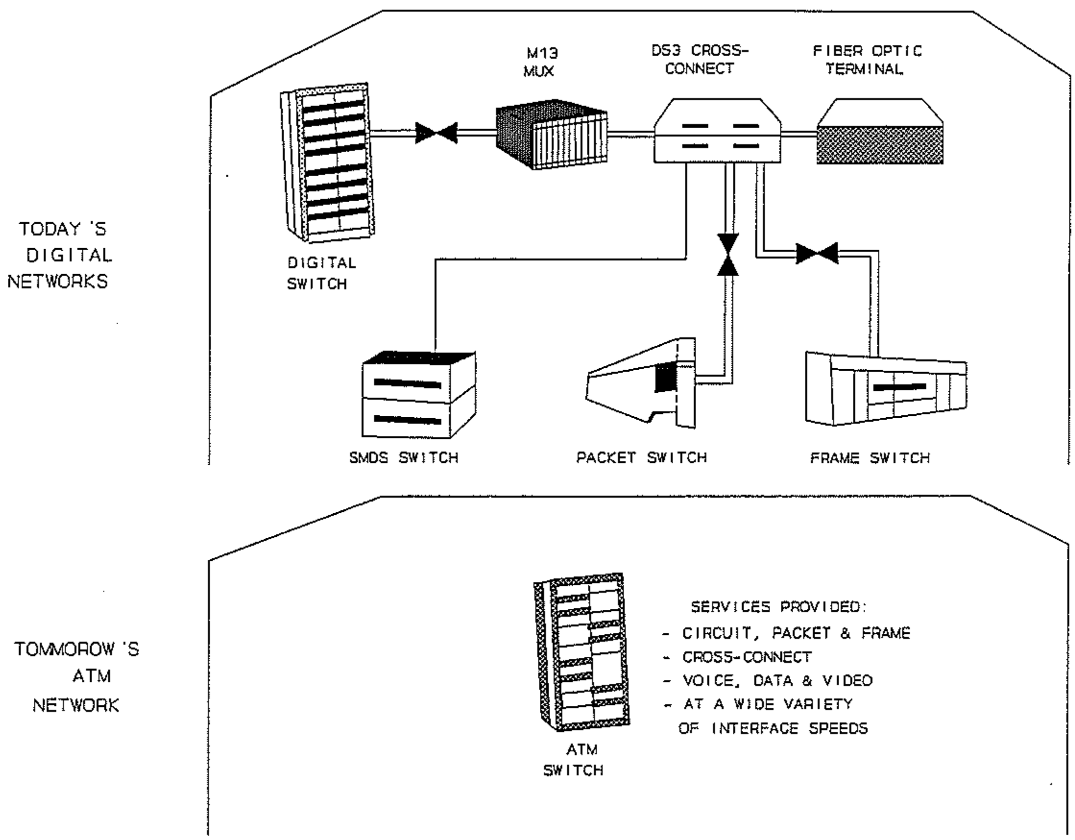


MOST OF ATM'S ADVANTAGES RESULTS FROM ONE KEY TECHNICAL ATTRIBUTE

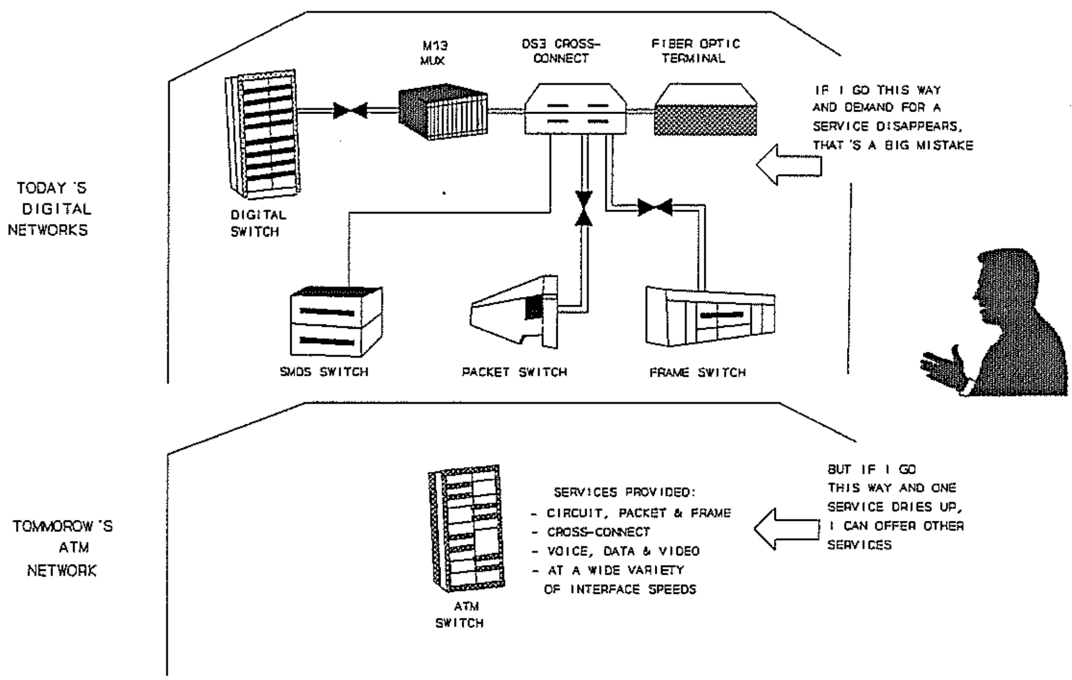
ALL TRAFFIC TYPES CAN BE MIXED ON THE SAME ATM NETWORK



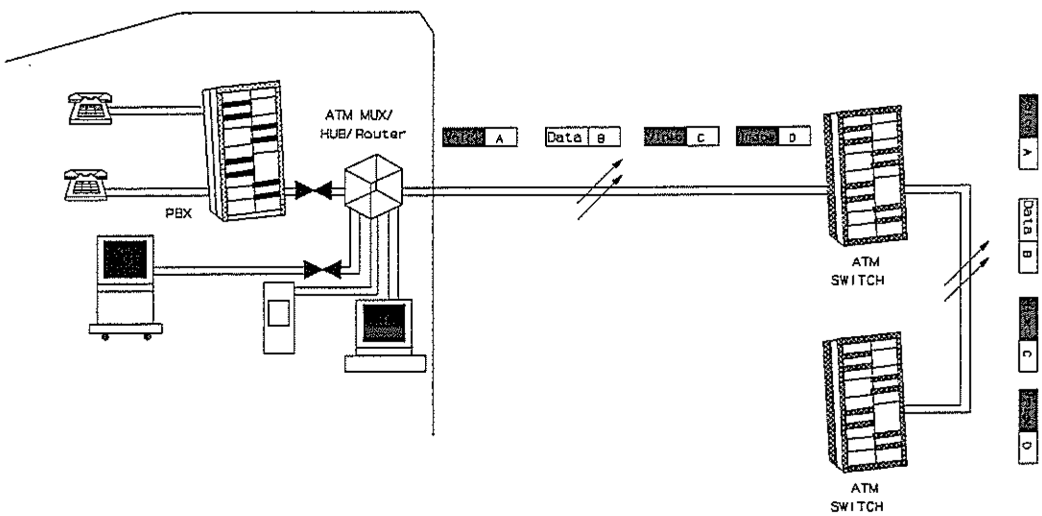
A MAJOR NETWORK EFFICIENCY OF ATM IS THE REDUCED NUMBER OF CENTRAL-OFFICE "BOXES" AND OVERLAY NETWORKS

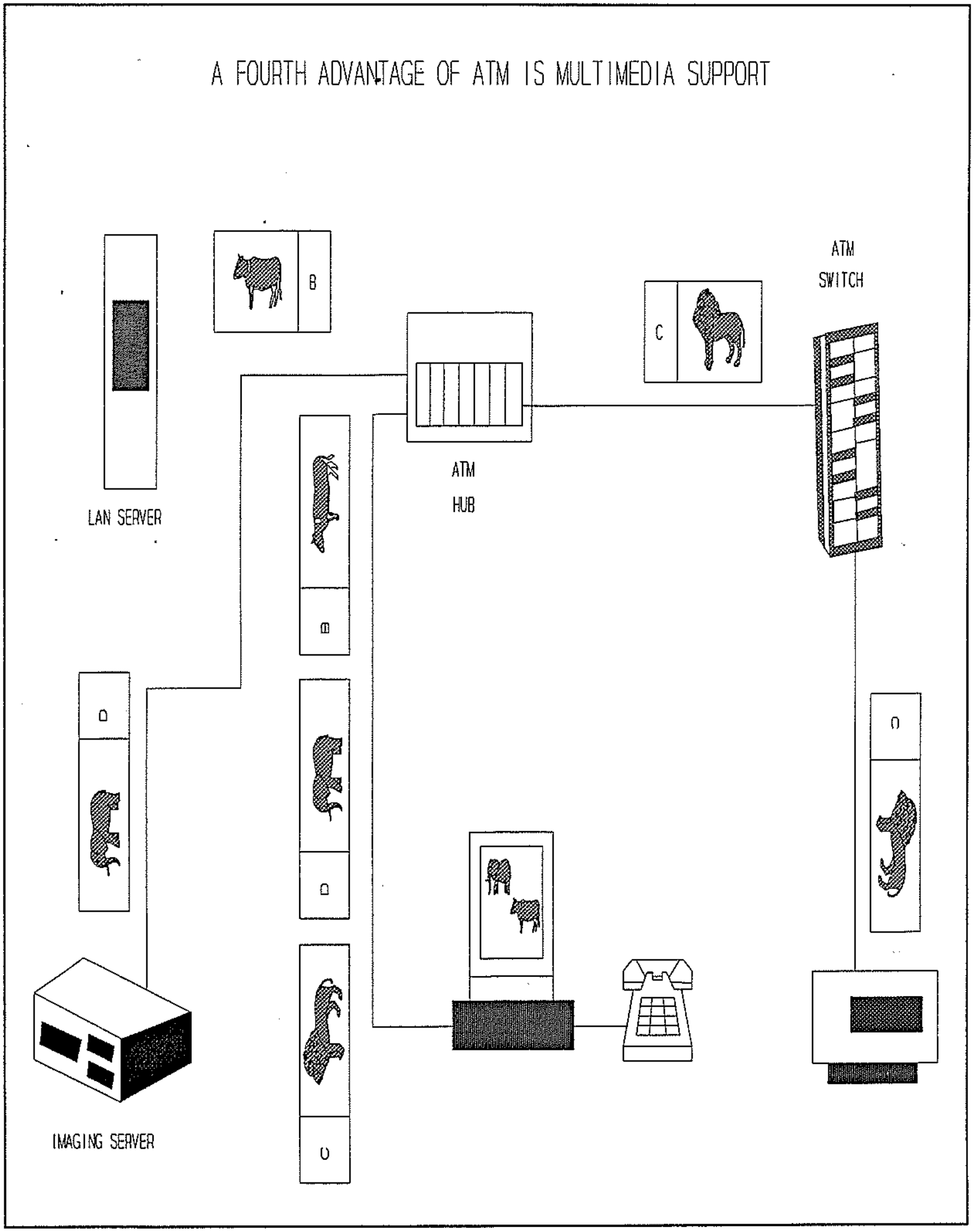


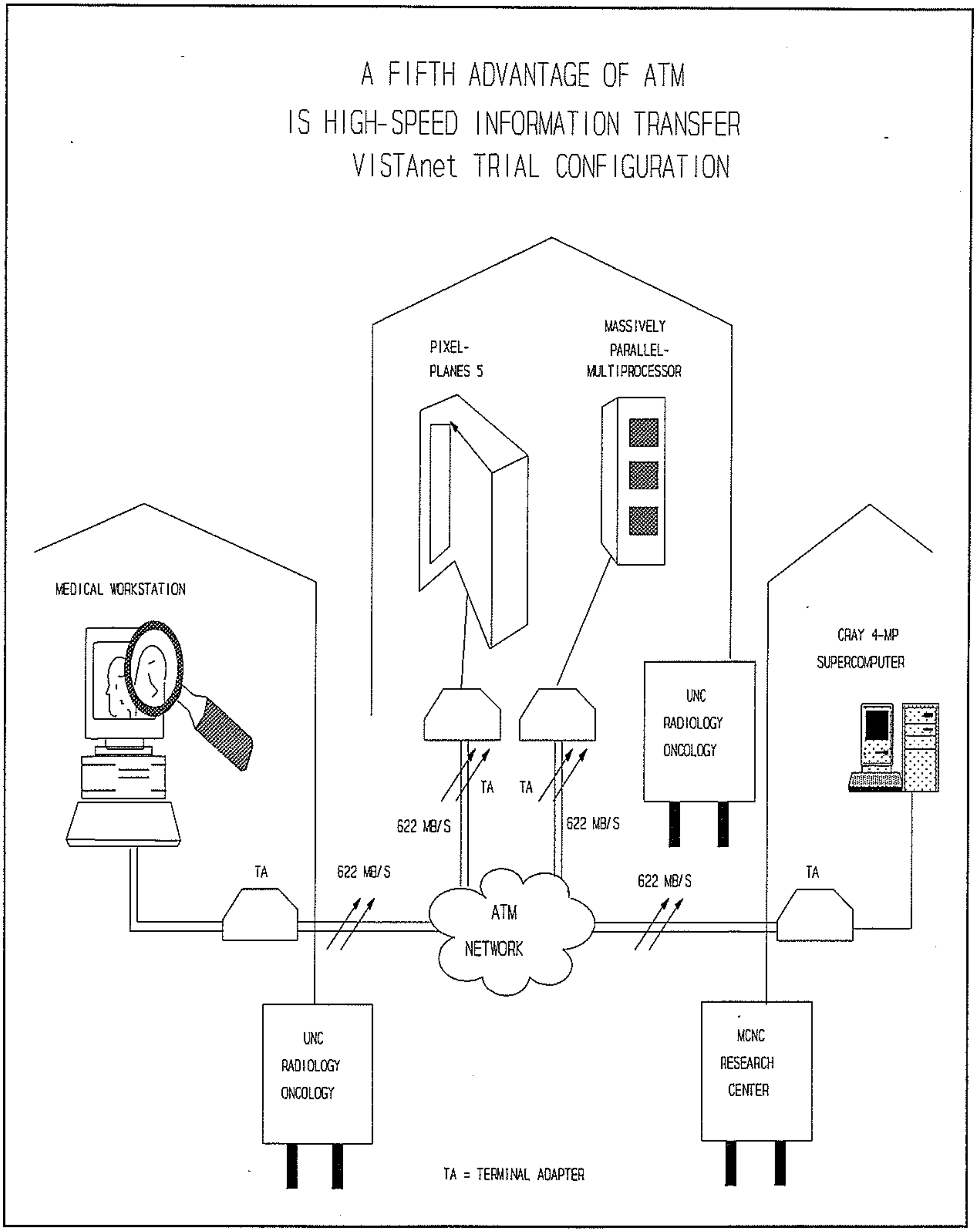
SECOND ADVANTAGE OF ATM IS PROTECTED INVESTMENT
AS USER DEMAND CHANGES



A THIRD ADVANTAGE OF ATM
COST SAVINGS FROM TRAFFIC INTEGRATION AND STATISTICAL
MULTIPLEXING ON ACCESS AND BACKBONE




A FOURTH ADVANTAGE OF ATM IS MULTIMEDIA SUPPORT
B
C
ATM
SWITCH
ATM
HUB
LAN SERVER
IMAGING SERVER


A FIFTH ADVANTAGE OF ATM
IS HIGH-SPEED INFORMATION TRANSFER
VISTAnet TRIAL CONFIGURATION
PIXEL-
PLANES 5
MASSIVELY
PARALLEL-
MULTIPROCESSOR
MEDICAL WORKSTATION
CRAY 4-MP
SUPERCOMPUTER
UNC
RADIOLOGY
ONCOLOGY
TA
TA
622 MB/S
622 MB/S
TA
622 MB/S
622 MB/S
TA
ATM
NETWORK
UNC
RADIOLOGY
ONCOLOGY
MCNC
RESEARCH
CENTER
TA = TERMINAL ADAPTER

ADVANTAGES OF ATM

EXECUTIVE SUMMARY

- REDUCED NUMBER OF NETWORK "BOXES"
- PROTECTED INVESTMENT FOR THE CARRIER
- INTEGRATED STATISTICALLY MULTIPLEXED ACCESS AND BACKBONE
- MULTIMEDIA SUPPORT
- HIGH-SPEED INFORMATION TRANSFER

APPENDIX X

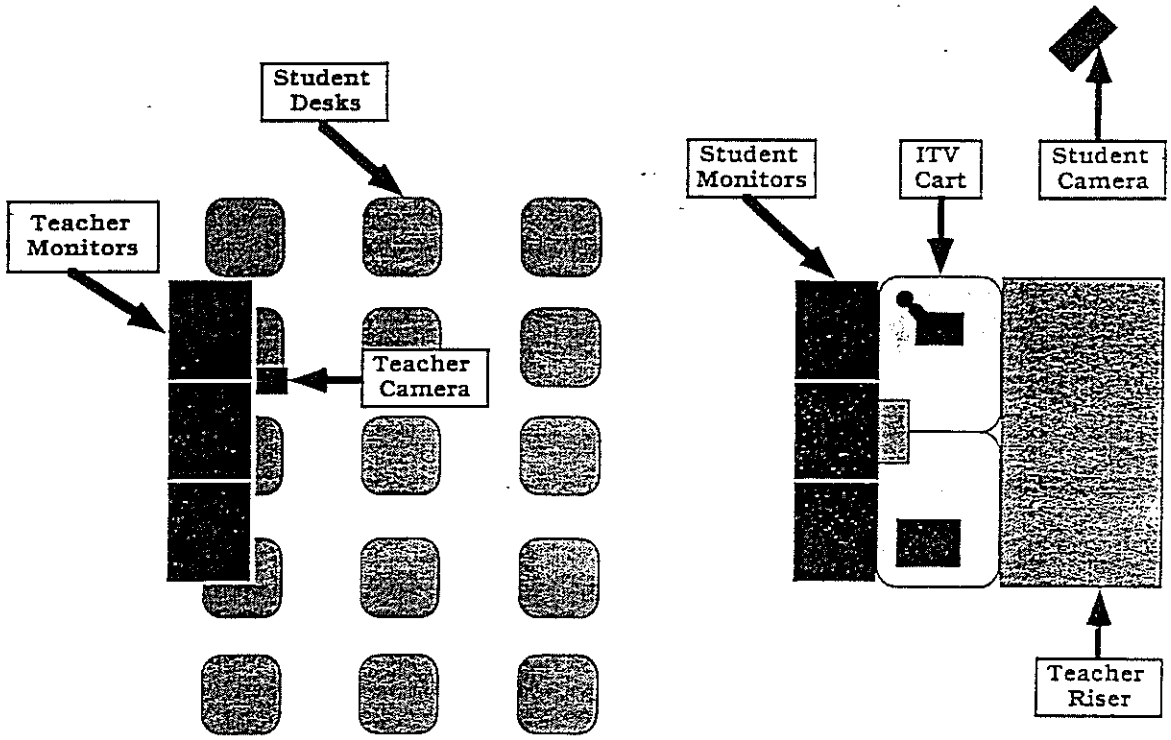


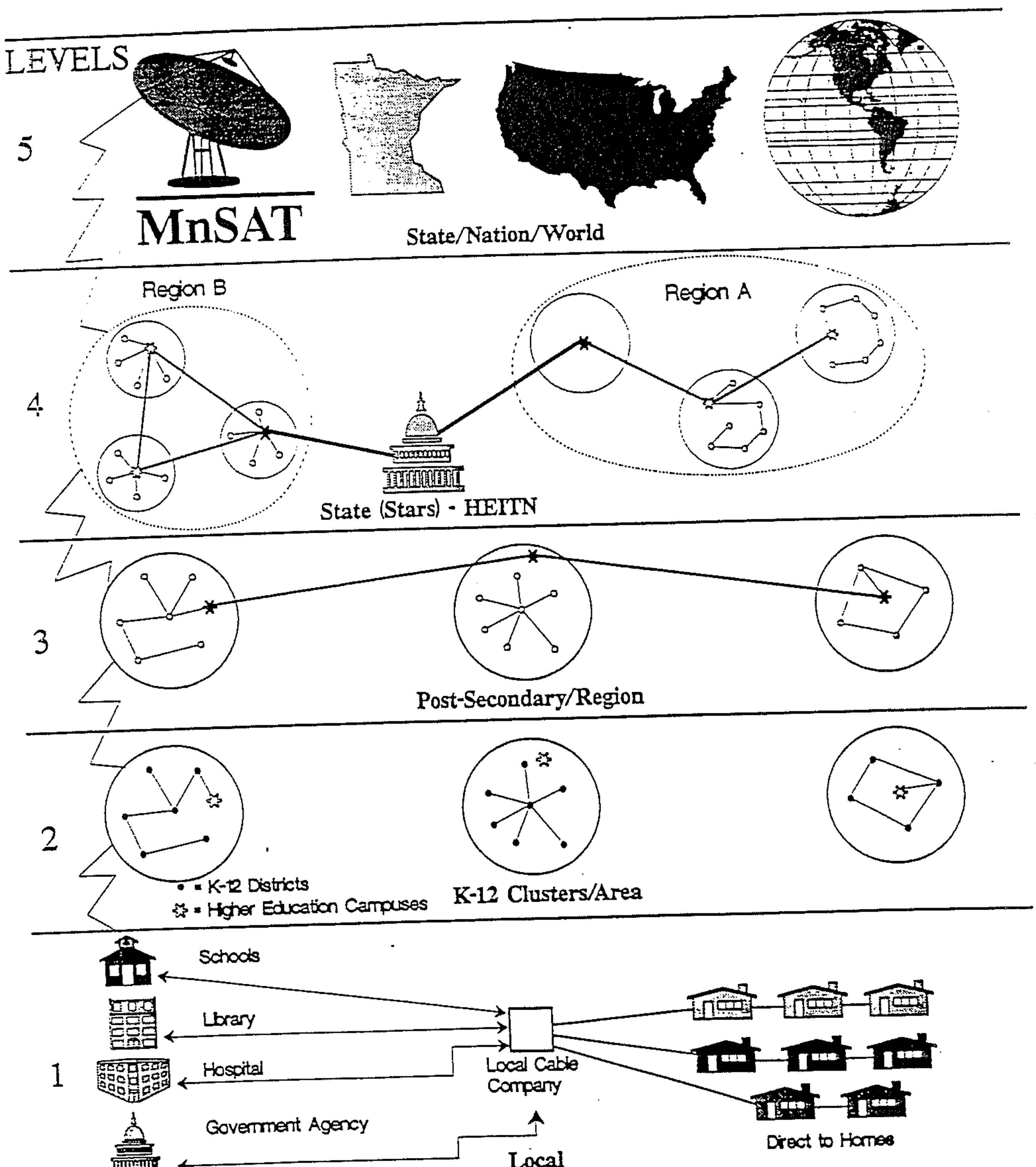
Diagram by Jerry Abraham, M-SEI Cooperative
Minnesota Department of Education, Distance Education for All Ages in Minnesota

Classroom design

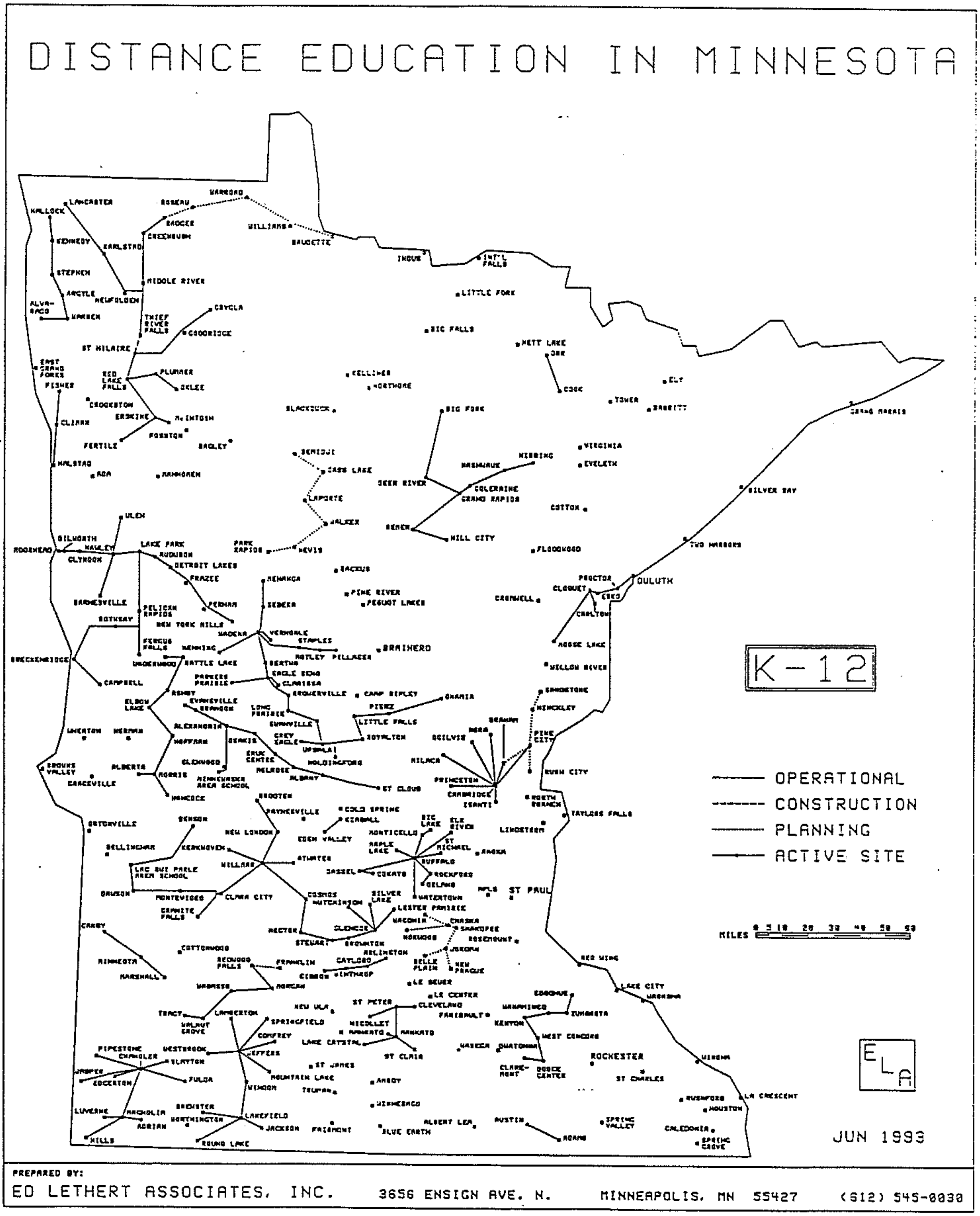
When you observe a two-way interactive television classroom, you will see a relatively normal class going on except the students will be talking to their teacher through a television monitor. Fellow classmates from other sites may also be seen on television monitors in the front of the room. While students may be separated by many miles, they can clearly see and hear each other at all times. Three cameras capture the action in the classroom. One is focused on the teacher. Another camera is focused on the students and a third camera zooms in on visual materials or demonstrations on the teacher's desk. The teacher selects the signal to send by using a push button switcher . Microphones pick up the students' and teachers' voices from anywhere in the classroom. Class materials are sent via facsimile, courier or U.S mail.

The classroom diagram on the opposite page depicts a typical television classroom design. Actual classrooms are all custom designed. The number and arrangement of monitors and student seating may vary.

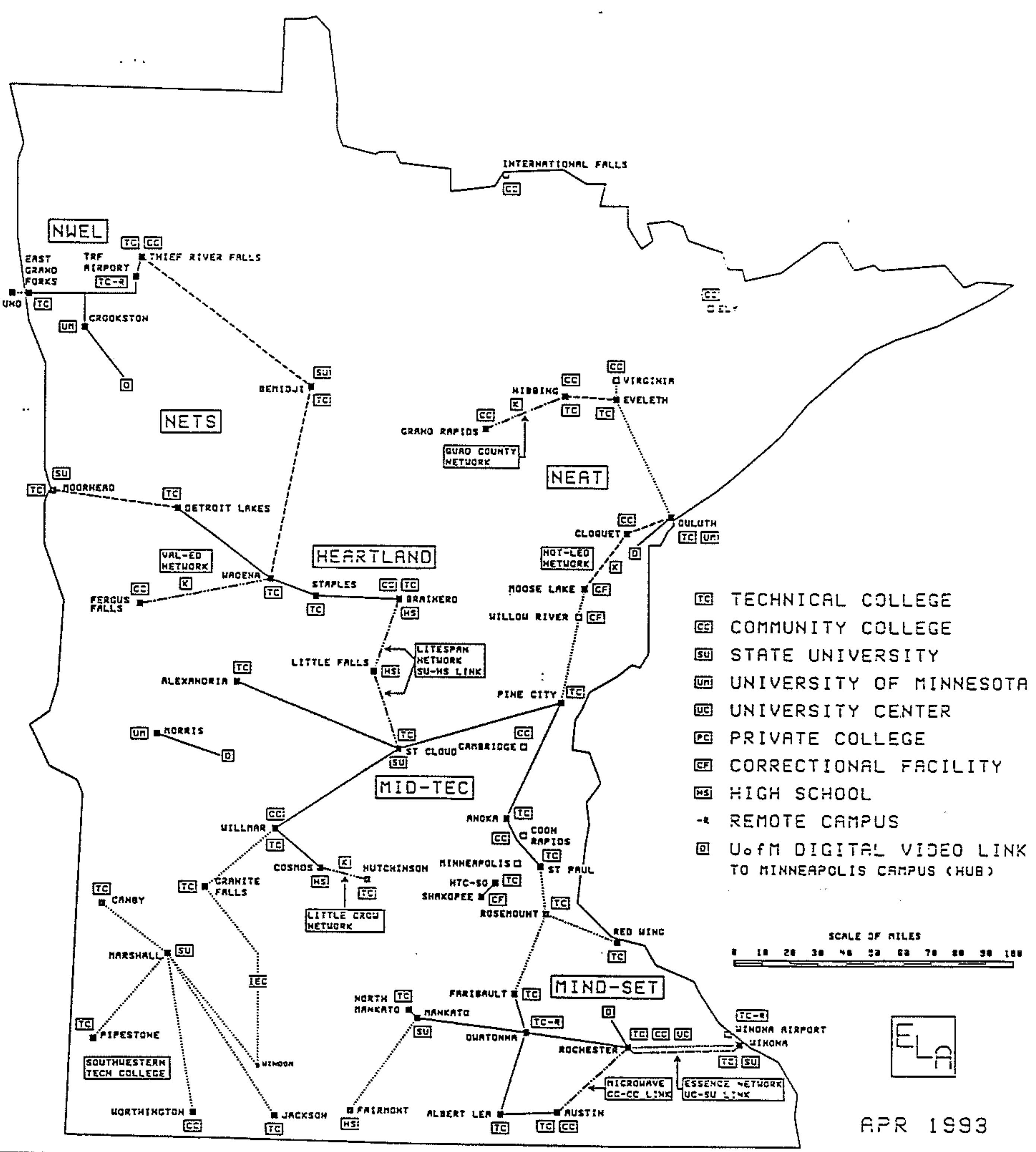
Educational Communication Networks



Penny Dickhut
State Board of Technical College

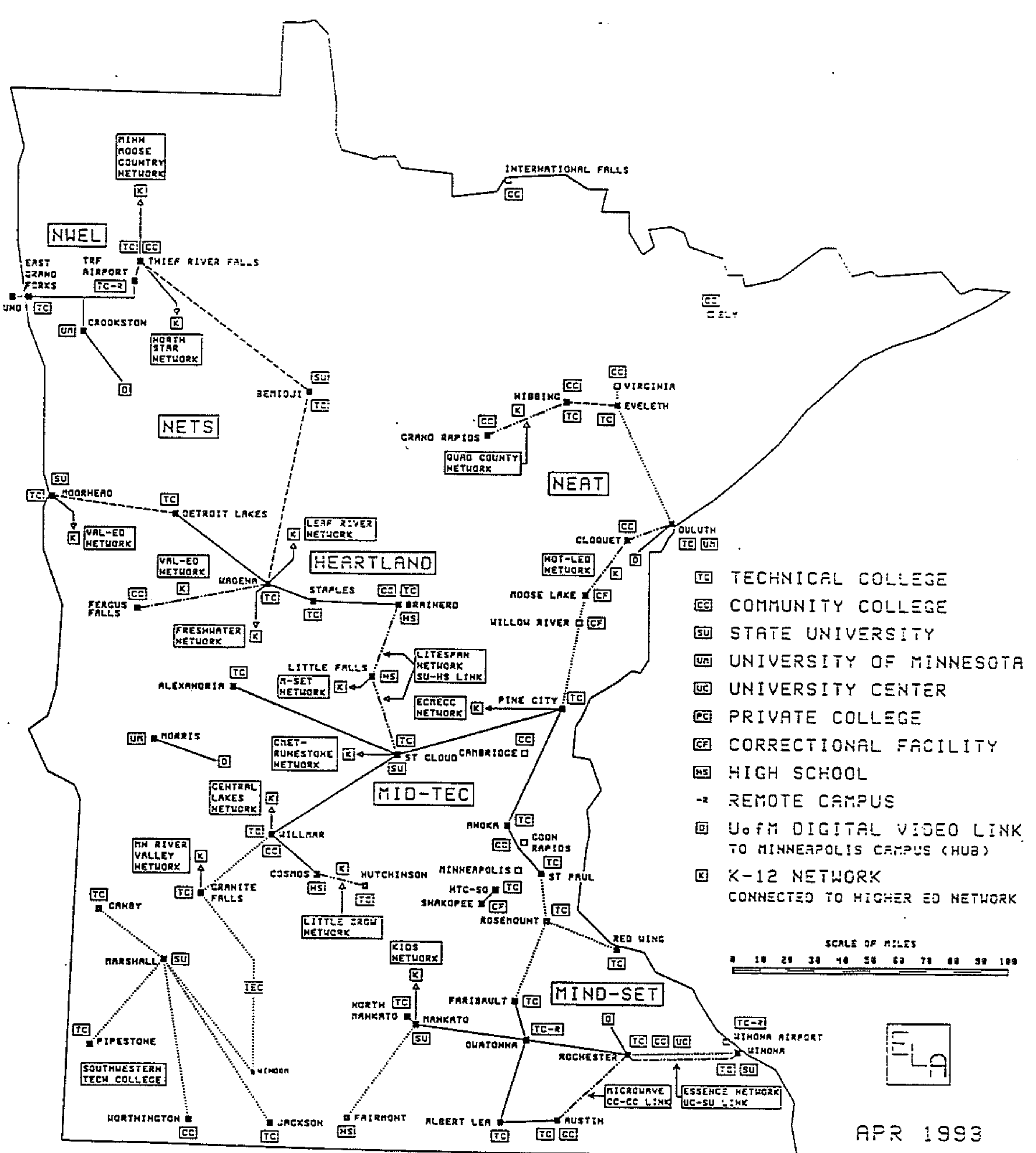

DISTANCE EDUCATION IN MINNESOTA
K-12
OPERATIONAL
CONSTRUCTION
PLANNING
ACTIVE SITE
MILES
DULUTH
BRAINERD
ST PAUL
ROCHESTER
E L A
JUN 1993
PREPARED BY:
ED LETHERT ASSOCIATES, INC. 3656 ENSIGN AVE. N. MINNEAPOLIS, MN 55427 (612) 545-0030

HIGHER EDUCATION VIDEO NETWORKS



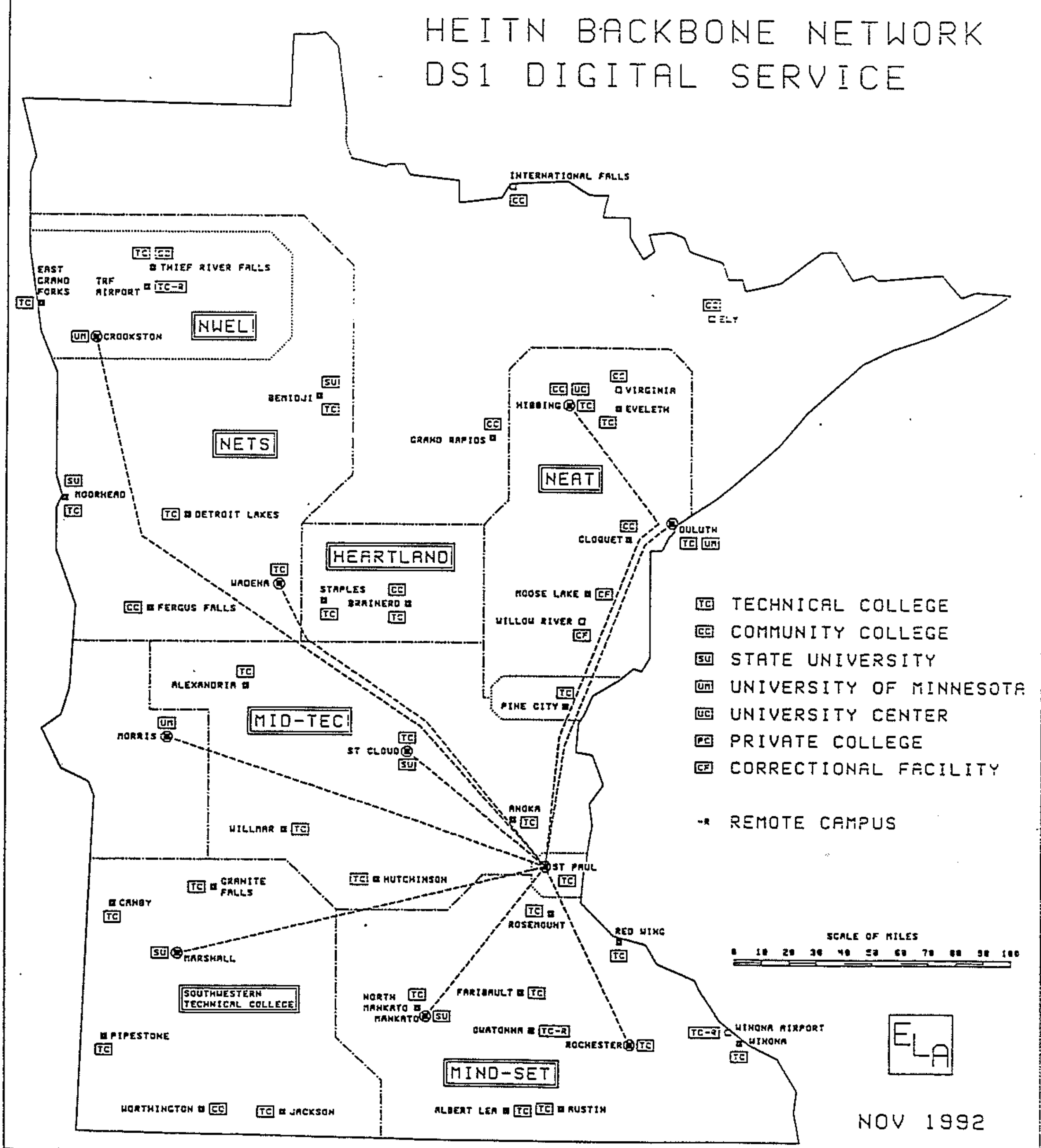
ED LETHERT ASSOCIATES, INC. (612) 545-0030
3656 ENSIGN AVENUE N. MINNEAPOLIS, MINNESOTA 55427

HIGHER EDUCATION VIDEO NETWORKS



ED LETHERT ASSOCIATES, INC. (612) 545-0030
3656 ENSIGN AVENUE N. MINNEAPOLIS, MINNESOTA 55427

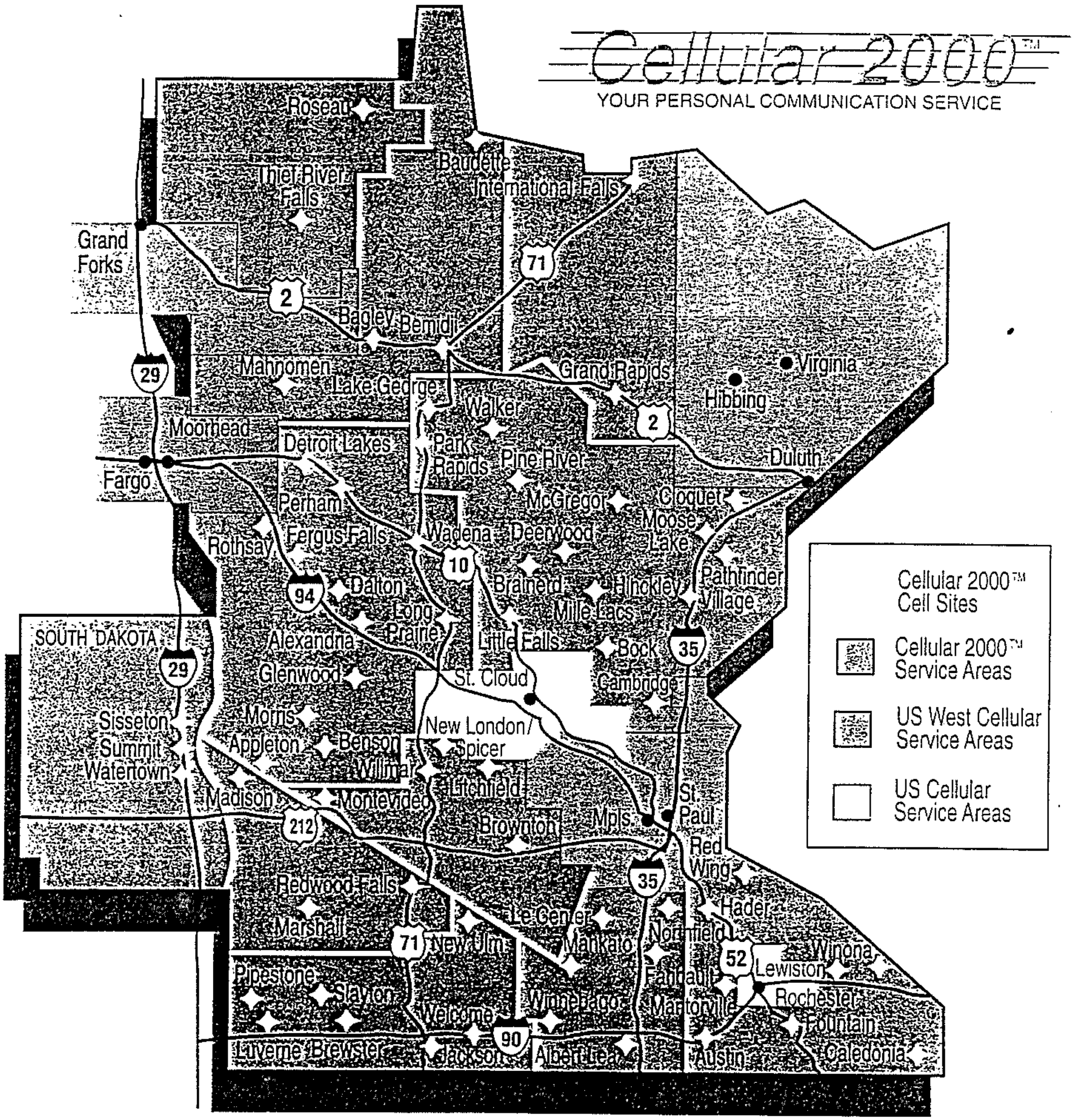
HIGHER EDUCATION VIDEO NETWORK



ED LETHERT ASSOCIATES, INC. (612) 545-0030
3656 ENSIGN AVENUE N. MINNEAPOLIS, MINNESOTA 55427

APPENDIX XI

Cellular 2000™ Cell Sites



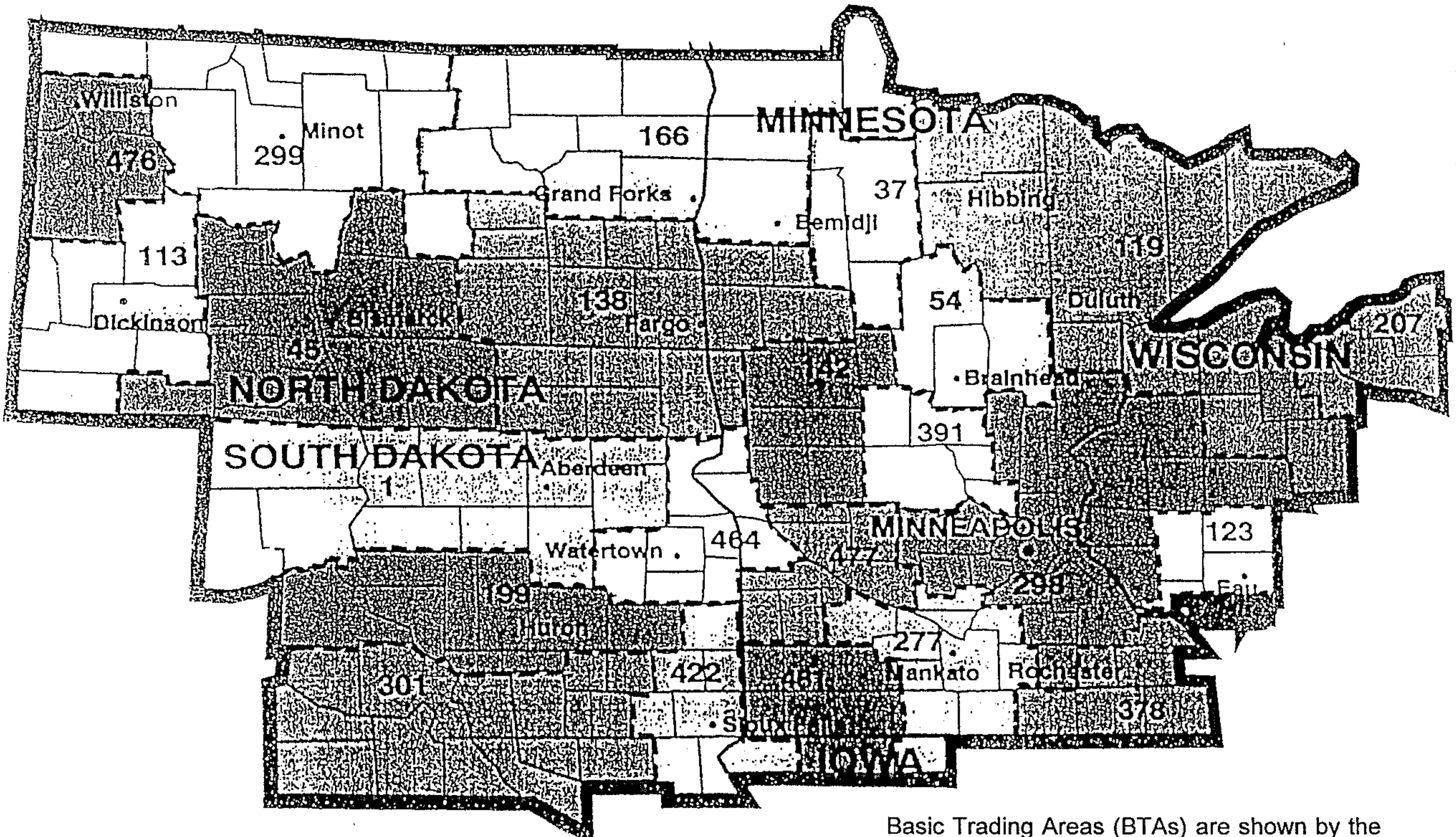
1-800-450-TALK

7/93 5M

APPENDIX XII

MINNEAPOLIS

MAJOR TRADING AREA



Basic Trading Areas (BTAs) are shown by the shaded areas, separated by a dashed line.

APPENDIX XIII

GLOSSARY OF TERMS

ABS	Alternate Billing Systems.
ACCESS CHARGES	The fees paid by long distance carriers to local telephone carriers for the use of local lines to originate and terminate long distance calls.
ADSL	Asymmetric Digital Subscriber Line.
AIN	Advanced Intelligent Network.
AG	Minnesota Attorney General
AMTU	Association of Minnesota Telephone Utilities. An organization for small telephone companies.
ANALOG	A signal that varies in a continuous manner (as contrasted with a digital signal).
ANI	Automatic Number Identification.
ANSCII	American Standard Code for Information Interchange. A code used for computer data communication.
ATM	Asynchronous Transfer Mode.
AT&T	American Telephone and Telegraph Company.
AUDIOTEX	An interactive audio information service available for a fee to users of touchtone telephones.
BANDWIDTH	The capacity of a communications channel expressed in hertz (cycles per second).
BAUD	A variable unit of data transmission speed usually equal to one bit per second.
BAUDOT	Data code used in telegraph services named after its inventor.
BETRS	Basic Exchange Telephone Radio Service; a radio-based telephone system for serving isolated areas.
BISDN	Broadband ISDN. (See ISDN)

BITS	Binary Digits; a measurement of information flow. A kilobit is a thousand bits, megabit is a million bits, gigabit is a billion bits.
BOC	Bell Operating Company. The BOCs are grouped under seven regional holding companies (RHCs or RBOCs).
BROADBAND CHANNEL	A communication channel, such as microwave, coaxial cable, satellite, or fiber optics, that transmits data at rates of 45 megabits (million bits) per second or higher. (See Narrowband Channel)
BTAs	Basic Trading Areas as defined by the Rand McNally Atlas. Used by the FCC to define service area sizes for Personal Communications Services licensing.
BYPASS	Telecommunications transmissions that avoid part of all of the public switched network.
BYTE	Eight bits, or a single character or letter of the alphabet.
CAPS	Competitive Access Providers.
CCITT	International Telegraph and Telephone Consultative Committee.
CELLULAR TELEPHONE SERVICE	Mobile telephone service using a series of transmitters in local areas or cells. The transmission changes frequency as the driver moves between cells. The system allows frequencies to be reused, thus providing much greater capacity than older mobile systems. Cellular telephone calls are connected into the public switched network.
CENTREX OR CENTRON	A service that uses the telephone company's central office switch to provide internal switching and other features for businesses and organizations. It may be used instead of a customer premises PBX.
CLASS	Custom Local Area Signalling Services.
CO	Central Office.
CODEC	Coder/decoder. Equipment used to digitize and sample a video signal, and to regenerate an analog video signal at the receiving end.
COMPRESSED VIDEO	Digitized video that requires less bandwidth than standard motion video through use of codecs.
CPB	Corporation for Public Broadcasting.

CPE	Customer Premises Equipment.
DPS	Minnesota Department of Public Service.
DOA	Minnesota Department of Administration.
DIGITAL	A discrete or discontinuous signal, which transmits audio data and video as bits (binary digits) of information (as contrasted with an analog signal).
DPCRTS	Domestic Public Cellular Radio Telephone Service.
DS	Digital signalling. DS1--24 channels; DS3--45 Mb/s; DS0--64Kb/s.
DTMF	Dual Tone Multi-Frequency. Describes push button or touchtone dialing.
E911	Enhanced 911 Emergency Service. The caller's telephone number, location and other important information are stored in a computer and automatically displayed for the dispatcher when a 911 call is received.
EAS	Extended Area Service. The ability to call an extended area for a flat monthly rate instead of paying a toll charge for each call.
EDI	Electronic Data Interchange. The use of computers and telecommunications technologies to process common transactions such as invoices, shipping notices, and bills, that traditionally have entailed the transfer and processing of paper documents.
EKG	Electrocardiogram.
ELECTRONIC MAIL	The use of telecommunications for sending textual messages. Messages are stored in users' "mailboxes" for retrieval on demand. ("E-Mail")
EMT	Emergency Medical Technician.
EQUAL ACCESS	The ability to make a long distance call using a preselected long distance carrier by dialing 1 plus 10 digits (1+ dialing).
ESP	Enhanced Service Provider.

EXTERNALITIES	An economist's term for consequences external to an economic transaction. Negative externalities include environmental pollution that creates costs or disadvantages for people not pay to the economic transaction. Positive externalities include general economic benefits resulting from telecommunications services beyond those reflected in the carriers' revenues.
FACSIMILE (FAX)	Equipment that transmits and receives documents over telephone lines.
FCC	Federal Communications Commission.
FIBER OPTICS	Strands of hair-thin glass through which light transmits telecommunications signals.
FITL	Fiber In The Loop.
FTTC	Fiber To The Curb.
FTTH	Fiber To The Home.
GATEWAY	Connection between networks using different protocols. Also the connection between a telecommunications carrier and an information provider.
GPS	Global Positioning System. A satellite-based system for position location.
GROUPWARE	Software for shared use by multiple users in a work group.
GTE	General Telephone and Electronics.
HDSL	High Speed Bit Rate Digital Subscriber Line.
HDTV	High Definition Television.
ISDN	Integrated Services Digital Network; an evolving set of international standards for a digital public telecommunications network.
ITFS	Instructional Television Fixed Service. A microwave frequency allocated by the FCC for educational use.
IXC	Interexchange Carrier.

KILOBITS	Thousands of bits of data (Kbits).
LAN	Local Area Network. Network linking computers at a single location.
LATA	Local Access and Transport Area. The geographical area within which Bell operating companies may carry traffic without violating the terms of the MFJ barring them from long distance services.
LEC	Local Exchange Carrier.
LIDB	Line Information DataBase.
LIFELINE	Fund to help low-income telephone subscribers maintain access to basic local telephone service.
LIGHTWAVE	Signals pulsed through optical fibers on a beam of light.
LINK UP AMERICA	Program to provide federal assistance for half the cost of installation and deposit charges for residential telephone service up to $30.
LT	Line Termination.
MAN	Metropolitan Area Network. A network linking computers at several sites in an urban area.
MBUUC	Minnesota Business Utility Users Council.
MCI	A major long distance carrier (formerly Microwave Communications Inc.)
MEANS	Minnesota Equal Access Network Systems, Inc.
MEGABITS	Millions of bits of data (Mbits).
MFJ	Modified Final Judgment. The judicial Consent Decree that broke up AT&T in 1984.
MTA	Minnesota Telephone Association. An organization of all telephone companies in Minnesota.
MTAs	Major Trading Areas as defined by the Rand McNally Atlas. Used by the FCC to define service area sizes for Personal Communications Services licensing.

MTSG	Minnesota Telefutures Study Group.
MICROWAVE	Radio communication using particularly high frequencies (and therefore particularly short wave lengths); for example, 4 gigahertz (4 billion cycles per second).
MODEM	Modulator/Demodulator. A device for converting digital data into analog signals for transmission over ordinary telephone lines and converting received analog signals to digital data for computer processing.
MSA	Metropolitan Statistical Area.
NARROWBAND CHANNEL	A communication channel such as copper wire or part of a coaxial cable channel that transmits voice, facsimile or data, but not high speed data or video. (See Broadband Channel)
NARUC	National Association of Regulatory Utility Commissioners.
NECA	National Exchange Carriers Association.
NT	Network Termination.
NTIA	National Telecommunications and Information Administration, U.S. Department of Commerce.
OC	Optical Carrier.
OPTICAL FIBER	See Fiber Optics.
OSPS	Operator Service Position System.
OTA	Office of Technology Assessment, U S Congress.
PACKET SWITCHING	Figurative "envelopes" of data, from one or more sources, addressed to a common destination. When a packet is "full," a circuit is seized only for the time needed to zap the data in a burst to its destination.
PBX	Private Branch Exchange. A private telephone switch located on customer's premises, and used for internal communications.
PCN	Personal Communications Network. A proposed network composed over a variety of wireless services including cordless telephones, wireless private branch exchanges, and wireless local area networks.

PCS	Personal Communications Service. Provided by a PCN network.
PNB	Pacific Northwest Bell. Now a part of U S WEST Communications.
POP	Point Of Presence. The point at which an interexchange carriers' circuits connect with local circuits for transmission and reception of long distance calls.
POS	Point of Sale. For example, electronic cash registers.
POTS	Plain Old Telephone Service.
PRICE CAP	A regulatory approach that sets the maximum price telephone companies can charge for a designated group of services. The set price may change over time, based on inflation and targets for improvements in productivity.
PSAP	Public Safety Answering Point. The place receiving calls in a 911 Network.
PTFP	Public Telecommunications Facilities Program administered by the National Telecommunications and Information Administration.
PUC	Minnesota Public Utilities Commission.
RAN	Rural Area Network. A phrase referring to the aggregation of multiple applications on a shared network in locations where duplicate networks would not be feasible economically.
RATE OF RETURN	A method of regulation that defines the total revenue a telephone company requires to provide services. The revenue requirement includes operating expenses, depreciation and taxes, and a "fair" return on its capital investment ("rate base").
RBOC	Regional Bell Operating Company or Regional Holding Company. One of the seven companies formed by the AT&T divestiture, including Ameritech, Bell Atlantic, BellSouth, NYNEX, Pacific Telesis, Southwestern Bell, and U S WEST.
REA	Rural Electrification Administration, U S Department of Agriculture.
RHC	Regional Holding Company. More commonly called RBOC.
RHEC	Rural Health Education Center.

RSU	Remote Switch Unit.
SATELLITE	A communications relay device orbiting the earth to permit communication among earth stations.
SCP	Service Control Point.
SEAS	Signalling Engineering and Administration System.
SMDS	Switched Multi-Megabit Data Service.
SMS	Service Management System.
SONET	Synchronous Optical NETwork. A family of optical transmission channels for transmission speeds that range from DS3 to 2.4 Gb/s.
SPCS	Stored Program Control Switching.
SS7	Signalling System 7. A control system for the public telephone network that allows telephone company computers to communicate directly with each other for routing calls, using signaling circuits separate from the circuits used for the telephone calls themselves.
SSP	Service Switching Point.
STP	Signalling Transfer Point.
TAP	Telephone Assistance Plan. Established to help economically deprived Minnesotans pay their telephone bills.
TACIP	Telephone Assistance for Communication-Impaired Persons. A plan to assist these customers in communicating by telephone.
T-CARRIERS	A family of high speed, digital transmission systems. A T1 carrier has a capacity of 1.544 megabits per second.
TELEMEDICINE	Use of telecommunications for medical diagnosis, patient care, and health education.
TELEX	A public switched network connecting teletypewriters or other devices transmitting at 50 bits per second.
UNIVERSAL SERVICE	Refers to the goal of providing basic telephone service to virtually every household.

USTA	United States Telephone Association.
USWC	The Bell regional holding company serving Minnesota.
VAN	Value Added Network. A data communications system in which special features, such as protocol conversion or database access, are added to the underlying transmission capabilities.
VIDEOTEX	An interactive video-based information service.
VOICE MAIL	A voice messaging system in which spoken messages are recorded for later play-back or transfer to others.
VSAT	Very Small Aperture Terminal. A device for satellite communications.
WAN	Wide Area Network. A computer network covering a large geographical area.
WATS	Wide Area Telephone Service.