STRATEGIC PLAN FOR A STATEWIDE TELECOMMUNICATIONS INFRASTRUCTURE

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EXECUTIVE SUMMARY

The State of Colorado has a window of opportunity for the development of a statewide telecommunications infrastructure. Past network investments have provided beneficial solutions to the problems of the time; but these individual efforts alone are not adequate to meet today's integrated business needs. The State requires a fully developed, scaleable and coordinated statewide telecommunications infrastructure to provide the citizens of Colorado access to government services, educational opportunities and information resources they need to keep Colorado's economy competitive, locally and abroad.

Currently, Colorado is seen as a leader in high-tech jobs but lags in technology investment. There is a growing disparity between rural and urban communities. An ever widening "telecommunications gap" is leaving rural communities further behind and greatly impairing their ability to compete economically. Colorado desires a strong economy with solid growth; a statewide telecommunications infrastructure is a critical component in making this happen. Equitable and affordable access to such technology throughout the state will ensure our ability to meet this need and better position the state for future growth.

Based upon information provided by the Commission on Information Management approximately $270 million in new information technology projects are scheduled to begin over the next two years. Many of these require advanced telecommunications services that are readily available in only a few areas of the state. As a result some of these projects are at risk of failing to fulfill their intended goals.

Without a coordinated telecommunications plan, state agencies, schools, libraries and institutions of higher education will continue to purchase telecommunications services in a piecemeal fashion. This often duplicates service in a community, or even the same building. Acquiring services in this manner slows development efforts by not providing sufficient incentive for the private sector to fund and build-out the needed infrastructure.

This *Strategic Plan for a Statewide Telecommunications Infrastructure* is the mechanism that will prepare Colorado for the new millennium. Its goal is to fully develop a statewide telecommunications network through private/public partnerships, based on demand aggregation and the State's commitment to being an anchor tenant throughout the state. The benefit is to unify and concentrate efforts to ensure that maximum value is achieved in the shortest time. The following recommendations are submitted for consideration by the 1998 General Assembly.

1. Legislation mandating the participation of all state agencies, including higher education, in the aggregation of telecommunication circuits to optimize the economies of scale;
2. One-time capital funding of $13.5 million to acquire Customer Premise Equipment to aggregate State circuits over a telecommunications infrastructure;
3. Spending Authority increase of $7 million annually to fund ongoing private sector operation and management of the telecommunications infrastructure;
4. Three additional full-time equivalent positions to augment the Central Coordination Authority for the oversight and planning of the telecommunications infrastructure. This requires an additional $161,000 of spending authority;
5. Establishment of a Community Incentive Funding program to enable communities to aggregate local demand and assist them in connecting to the statewide telecommunications infrastructure; and
6. Continued examination of alternative and innovative investment strategies to facilitate infrastructure development.

The benefits to be gained by implementing these recommendations are great, and so will be the challenges if the opportunity passes untouched. Someone once said "Imagine the possibilities." The time to make imagination a reality is now.

STRATEGIC PLAN FOR A STATEWIDE TELECOMMUNICATIONS INFRASTRUCTURE

1.0 INTRODUCTION

The State of Colorado finds itself making isolated network investments without a fully developed (i.e., scaleable and coordinated) network to meet the business needs of the State. This is a critical year for determining the future of Colorado's telecommunication infrastructure. Based upon information collected by the Commission on Information Management (IMC) through its annual planning process, approximately $270 million in new State information technology projects are scheduled to begin during the next two years. These new projects and upgrades to current State systems have been designed with the presumption that advanced telecommunications services will be available wherever and whenever needed. This is not always the case. Based upon numerous discussions with individuals conducting business in rural Colorado, these advanced services are not available across the state; and those advanced services that can be obtained are often only available through the expense of "backhauling" the service to the nearest population center in which the service can be found. Backhaul charges may drive up circuit costs by a multiple of four or more times what it would cost if the service were available locally. Many projects have had to be scaled down or cost estimates dramatically increased due to the lack of local infrastructure in rural areas. These examples remind us that the best-planned projects can still be at risk of failure due to an infrastructure unable to support its requirements.

Without a coordinated telecommunications plan, state agencies, schools, libraries and institutions of higher education will continue to purchase telecommunication services in a piecemeal fashion. This often leads to needless duplication of service into a single community, or even to the same building, resulting in excessive costs that could have been avoided with a shared telecommunications network. Additional impacts of the current model are slowed infrastructure development, fragmentation of the State's ability to deliver services throughout Colorado and an increased risk of failure for new information technology projects.

Upgrading the State's telecommunication infrastructure through the aggregation of existing and impending demand will provide many benefits to state agencies, schools, libraries and institutions of higher education. Access to increased capacity, expanded local services, and reduced costs, for comparable bandwidths, will be possible by maximizing the combined purchasing power of these groups with the State serving as an "anchor tenant". This role of "anchor tenant" along with private/public partnerships will provide incentives for telecommunications providers to develop infrastructure and accelerate the introduction of new technologies throughout the state, bringing economic development opportunities to traditionally under-served areas.

2.0 OVERVIEW

According to the Colorado Financial Reporting System (COFRS), the State of Colorado is currently spending approximately $14 million annually for telecommunication services with the private sector (e.g., services, line charges, PBXs, moves & changes of circuits and telephones); and $17 million annually for all other telecommunication expenditures (e.g., maintenance, capital equipment and non-capital equipment). No mechanisms or processes are in place to track or coordinate purchase of these services across agency or program boundaries for efficiency, advanced technology access, shared technology, or economies of scale. This *Strategic Plan for a Statewide Telecommunications Infrastructure* proposes, as its foundation, an aggregation of the State's currently fragmented telecommunications purchases. This will facilitate the State's role as a true "anchor tenant" in communities, and accelerate the implementation and availability of this critical infrastructure. The following recommendations are submitted for consideration by the 1998 General Assembly:

1. Legislation mandating the participation of all state agencies, including higher education, in the aggregation of telecommunication circuits to optimize the economies of scale;
2. One-time capital funding of $13.5 million to acquire Customer Premise Equipment (CPE) to aggregate State circuits over a telecommunications infrastructure;
3. Spending Authority increase of $7 million annually to fund ongoing private sector operation and management of the telecommunications infrastructure;

4. Three additional full time equivalent (FTE) positions to augment the Central Coordination Authority for the oversight and planning of the telecommunications infrastructure. This requires an additional $161,000 of spending authority;
5. Establishment of a Community Incentive Funding program to enable communities to aggregate local demand and assist them in connecting to the statewide telecommunications infrastructure; and
6. Continued examination of alternative and innovative investment strategies to facilitate infrastructure development.

2.1 The Authority

This plan is intended to fulfill the provisions of Senate Bill 96-102 (C.R.S. 24-30-1702.5) concerning the Statewide Information Infrastructure. The Commission on Information Management (IMC) is charged with the following tasks:

- To develop and implement requirements for the statewide information infrastructure based on present and future user applications;

- To review existing portions of the statewide information infrastructure to determine the areas of the state in which they exist and whether the existing portions are adequate and usable for present and future user applications; and

- To define and initiate a partnership between the private and public sector for funding and building the statewide information infrastructure, with the understanding that the private sector will build the necessary portions of the statewide information infrastructure.

Additionally, the plan will support the intent of Senate Bill 96-197 (C.R.S. 23-11.5-104), as relating to the investigation and selection of multiple-use networks for “enhanced instruction and information access.”

(*See Appendix A for a complete description of the recent history, legislation, and parallel efforts)*

2.2 The Methodology

The Multi-use Network Task Force (MNT) was assembled in October 1997 to evaluate the State's current and future use of telecommunications and to make strategic recommendations based upon its findings. This inter-departmental task force was comprised of representatives from the Departments of Higher Education, Education (K-12), Personnel/GSS, the Commission on Information Management (IMC) and State Libraries.

The effort was iterative in nature and focused on the areas of: statewide business needs assessment, internal technical analysis, external technical analysis, and reviewing the strategic planning efforts of other states in the area of telecommunications. Of these, primary emphasis was placed upon the statewide business needs assessment. To accomplish a high-level statewide business needs assessment, interviews were held with representatives of the various departments of general government, higher education, K-12 education and libraries to identify their current use of telecommunications and to determine the requirements of projects planned within the next two years. As information was gathered, groups were re-contacted to validate assumptions and seek additional input as a quantifiable plan for a telecommunications infrastructure was developed.

Concurrent with the statewide business needs assessment, the MNT conducted an internal technical analysis to identify the existing telecommunications infrastructure in use by the State. Under the direction of the MNT, a database was developed to capture detailed information on the inventory of current State circuits. Information such as circuit type, function, bandwidth, termination points, and monthly costs were captured to help identify the most appropriate points of aggregation and their associated costs. It is anticipated the network components of future projects will be added to this database to provide a complete picture of the State's telecommunications infrastructure.

The MNT has created a library of information gathered through this process that will be available as an ongoing reference source for future planning and coordination.

*(See Appendix **B,** for details on the MNT methodology.)*

2.3 The Solution

This plan provides a "win-win" solution to the State's information infrastructure needs, access to advanced services for the citizens of Colorado, and a favorable business case for private sector investment. This solution involves aggregating demand of state agencies, the State's commitment to becoming an "anchor tenant" at designated sites, the ability to encourage and sustain local involvement, and commitment from the private sector to develop and install adequate telecommunications facilities. As telecommunications facilities improve throughout the state, an improved environment for economic development will result.

It proposes aggregating the existing and future demand of state agencies for telecommunication services, then leveraging the considerable purchasing power of the State and its community partners to encourage private sector investment in the build-out of an expanded statewide telecommunications infrastructure. This should reduce the vendors' risk of building costly facilities in anticipation of demand and the State's avoidance of investing in a costly private network. Telecommunications service providers have made some effort by improving facilities such as the installation of fiber optic cable. Unfortunately, much of this fiber is "dark" and unused awaiting a sufficient business case to "light" and make available its capacity and capability. Establishing private/public partnerships between telecommunications service providers and the State through an "anchor tenant" relationship should provide an adequate business case for the private sector to commit to this effort. Preliminary conversations with a variety of providers indicate support for this approach.

Based upon past experience and a current assessment, the following objectives were developed:

- Aggregate network management and telecommunications purchasing to maximize the value of resources and ensure that the statewide objectives are met.

- Provide an Aggregated Network Access Point (ANAP) in every county in the state, with bandwidth ranging from 10 Mbps up to 155 Mbps (OC-3c), Asynchronous Transfer Mode (ATM) connection capable of carrying voice, video, and data on a statewide network.

- Establish a cooperative central coordination authority for identification of resources, consultation on connectivity issues, vendor oversight, strategic planning and training.

- Develop a program to assist communities to extend network services from ANAP sites to each public/non-profit user (schools, libraries, health care facilities, local government, etc.) with a need for this capability.

- Use of private/public partnerships to build and extend this statewide network. The only equipment that should be owned by the State is the Customer Premise Equipment (CPE) switch.

(See Section 5.0 of this document for details on the "Proposed Technology".)

2.4 The Benefits

Using Colorado's combined buying power to encourage private sector investment in the area of telecommunications will provide enormous benefit throughout the state. Citizens, businesses and governmental entities will all benefit from the upgraded facilities necessary to meet the objectives of this plan. Rural areas of the state that are currently "at or near" capacity will benefit from additional bandwidth and the advanced services made available by the local telecommunications provider. A more favorable environment for economic development can be achieved, allowing rural communities to compete on the basis of technology as well as quality of life. Educational opportunities can be expanded through distance learning, computer-based training and increased technology literacy. Professionals, life-long learners and non-traditional students can fulfill their educational needs through programs and courses offered electronically by Colorado's colleges, universities and school districts as well as the emerging new consortia of educational providers such as the proposed Western Governor's University.

With the emphasis on education in Colorado and the geographic separation of major population centers, the need for advanced telecommunication services has become essential. Interactive video conferencing has been identified as the single largest future need for education, libraries, non-profit health care providers and general government. Benefits of this technology include distance learning, telemedicine, and a reduced need to travel long distances for meetings. The

demand for interactive video has already reached capacity within the existing Cooperative Interactive Video In Colorado State government (CIVICS) network. This network was originally funded for the Department of Corrections to facilitate video arraignment. While the original purpose of this network has not been fully utilized, the capabilities it offers has exposed a latent demand for this service. Equitable and affordable access to such technology throughout the state will ensure our ability to meet this demand and better position the State for future growth. This plan will accommodate emerging video technologies such as video over IP and MPEG-2.

Additional benefits of this plan include:

- The citizens of Colorado will benefit from a shared electronic highway that serves communities in a manner similar to the current vehicle highway system. Use of the electronic highway by public entities will provide equity and access throughout the state.

- Students and teachers in classrooms in any Colorado community will be able to share instructional materials and access remote information resources. Access to Colorado's largest and best endowed public and academic libraries, and the unlimited resources on the World Wide Web (WWW), will provide valuable opportunities to enhance the quality of education.

- Rural physicians and their patients can consult with specialists at hospitals or medical research centers throughout the country. Rural health care providers at all levels will benefit from reduced isolation from educational resources, increased opportunity for professional consultation, and online reference resources.

- State agencies, schools, libraries and institutions of higher education can pursue new and innovative network applications to improve the delivery of services and information to the citizens of Colorado.

- Telecommunications providers will benefit from dealing with fewer, larger clients and the potential for more rapid diffusion of advanced technologies in the newly aggregated local markets.

3.0 SITUATIONAL ANALYSIS

The current State network environment consists of a collection of specialized networks, reflective of how State government is organized. The descriptions of the various networks are described in detail in Appendix B, Tab-2 of this document. These networks were designed to meet specific programmatic needs defined by individual agencies or consortia. Each network, although effective in solving the individual problems of an agency or group, has not been designed with a planned architecture in mind.

The State of Colorado has a number of network technologies currently in use. While many of these do operate over the same backbone, there is limited integration and planning to maximize their capabilities. Through single agency networks and/or statewide network components, a presence currently exists in every county in Colorado. These networks are not currently compatible and are using different and, in some cases, outmoded protocols. The level of capabilities tends to vary more widely when assessing the networks used by institutions of higher education, schools and libraries. The greatest disparities are at the local facility level. Some of these are currently being addressed by the Technology Learning Grants that are now being implemented. Because installation of these projects have yet to be completed, it is difficult to identify where network technology is lacking.

Current networks addressed by this analysis include the Digital Data Network (DDN), the Colorado Information Network (CIN), the Systems Network Architecture (SNA) networks, and the Cooperative Interactive Video In Colorado State government (CIVICS) network. These networks are part of the existing State network environment that is currently under-developed and which is limited in capability.

All telecommunications users -- not just State Government -- will continue to experience problems if the lack of coordination in existing telecommunications processes continues. Examples of the three elements that present the greatest detriment to the State are outlined below:

- Fragmented Purchasing Practices

  Sites such as the State Services Building could benefit from the introduction of advanced telecommunications services. To satisfy the existing network needs of the building, the State pays for multiple analog lines for the SNA network, frame relay for CIN connectivity, and DS-1 for CIVICS video services. These services could be replaced by a single ATM connection, easing management issues and enhancing the potential network capabilities of the site.

- Increased Risk of Project Failure

  The new information technology projects currently funded face the challenge of an under-developed infrastructure. This adversity affects projects that depend on reliable network services. Without the establishment of a stable, scaleable backbone, the chances for successful implementation of most future projects are reduced.

- Hinders Economic Development

  A large number of communities and regions of the state have begun to form local consortia to address the lack of telecommunications infrastructure and its impact to economic development. These efforts represent the frustration felt in many areas of the state. Many reports of lost opportunities and potential jobs in these areas have surfaced due to an inability to drive upgraded telecommunications facilities into these areas. The Four Corners Area has formed the Fibercom group for this reason. This group has reported that the southwestern part of the state has reached its maximum telecommunications capacity.

  The Colorado Rural Development Council, in its newsletter *Grassroots Clippings*, recommends the establishment of Virtual Enterprise Zones. Telecommunications has been identified as a high priority for economic development within these zones.

*(See Appendix **B** for a description of the MNT methodology and assessment findings.)*

4.0 SOLUTION DETAIL

This section of the *Strategic Plan for a Statewide Telecommunications Infrastructure* details the recommended solution. This consists of the following components: demand aggregation, private/public partnerships, participation and cooperation, a central coordination authority and community incentive funding. The MNT believes that all elements of this plan are necessary for a successful implementation.

The success of this plan also depends on the following guiding principles that ensure the primary objectives of the network are sustained and efforts are focused appropriately. These tenets provide the basic standards for the implementation and operation of this network. In some cases, they describe a desirable outcome, in others they describe a process to be applied to future implementations and applications of the plan.

1. All network installations or upgrades should be conducted within the construct of this plan.
2. Private sector carriers should be used for all services, with the State's presence serving as an "anchor tenant".
3. Equity and access should be considered at all times in terms of creating opportunities to equalize costs between more remote and more urban areas. A goal of implementation should be to eliminate the current penalties assessed for distances and low demand for services.
4. The network must be flexible, allowing for multiple uses of various applications of voice, video, and data to all locations on the network.
5. The network must be scaleable to accommodate future growth and applications that cannot be foreseen at this time.
6. The network must be reliable, with sufficient redundancy and service levels, to allow it to be maintained dependably throughout the state.
7. Participation by State-funded users must be required. At any point in time, depending on a particular agency's or institution's circumstances, a more favorable price for services may be available. The loss of this aggregation of demand may well prove highly detrimental to the overall goal of providing access to advanced services across the State.

8. Attention must be given to the role of regulatory reform to support the availability of advanced technology throughout the State.

4.1 Demand Aggregation & Anchor Tenant

Currently the State has multiple circuits to all 63 county seats in Colorado. These are generally contracted for and operated separately. No consideration was given to the potential of sharing facilities, technology, bandwidth, or cost. Demand aggregation will focus the State's purchasing power, providing it with the leverage to negotiate and acquire equitable pricing and access to advanced telecommunications services. Through its commitment to become an "anchor tenant" at each ANAP, the State will provide the needed stability the private sector requires to implement and support improvements to the existing telecommunications infrastructure. These two concepts form the basis for establishing the desired private/public partnership to fund and build the statewide information infrastructure. Additionally, by accelerating infrastructure deployment and making advanced telecommunications more affordable, a more favorable local economic development environment will result.

In addition to State demand aggregation, other public and non-profit telecommunications clients could ideally participate and increase local aggregation. This would spread the benefits to the wider community by promoting the availability of advanced services. Obtaining these services from the private sector would also make the technology available to private citizens and commercial establishments, making a larger and more viable market for the local telecommunications provider.

Based on State-funded circuits to the 63 county seats and 12 other sites, a series of **Aggregated Network Access Points (ANAPs)** with geographic coverage have been identified. ANAPs define State network service demand for current service levels, anticipated growth, and desired service capabilities. This initial group of 75 ANAP sites may change as significant demand for additional service is identified in other communities. These would include communities with Department of Corrections' sites and other public or non-profit users that in combination with State technology sites will benefit from a local ANAP designation.

*(See Appendix **E** for the preliminary map of 75 designated ANAP sites; Appendix **C** for a technical description of proposed ANAP sites; and Appendix **E,** for a site-by-site description of **existing** State-funded circuits which could potentially be aggregated at each ANAP site.)*

4.2 Private/Public Partnership(s)

This plan does **not** propose the creation of a private, state-owned network for state telecommunication services. Instead, it proposes that the State increase its awareness, coordination, and oversight of its own telecommunications purchasing, project planning, and future demand, with consideration of community and economic development impacts in rural Colorado. The network structure described in this plan will be comprised fundamentally and extensively of services purchased from private sector providers. The consolidation of State telecommunications planning and purchasing will promote the introduction of advanced services by telecommunication providers in lesser-developed areas of the state. These advanced services include frame relay, fiber optic facilities, and ATM technology. In effect, the State will act as a technology development partner with vendors through its "anchor tenant" status.

To ensure equity of access throughout Colorado, the State may need to subsidize the development of portions of the proposed network infrastructure that the private sector finds commercially unattractive or low-priority. The resulting infrastructure investment would benefit the local telecommunications provider and the remote community itself. The State would develop its own infrastructure only as a "last resort," and only when the private sector has chosen not to provide the necessary services or access to advanced technologies. This approach would not accomplish the environment necessary for economic development because the private sector would not have access to those portions of the network subsidized by the State. By promoting the expansion of telecommunications services into rural areas, the long-standing problems of equity of access would be diminished and the quality of electronic access to State supplied information and services would be improved.

4.3 Participation and Cooperation

It is vital to the success of a more efficient State network infrastructure that <u>all</u> departments of government participate and cooperate. This is essential if the anticipated economies of scale gained by aggregation are to be realized. Although interpretation of SB 96-102 (C.R.S. 24-30-

1702.5) could lead to full participation, the MNT recommends new legislation to clearly mandate full participation by all State agencies.

It is also important to implement this aggregation in such a way to allow participation from local government, federally funded projects, other public entities, and non-profits to maximize the benefits for economic development throughout all of Colorado.

Evolution from the current piecemeal approach to purchasing telecommunication services to the managed network proposed in this plan cannot be accomplished in a single year. This is due, among other things, to the logistical complexity of aligning the needs of the large number of telecommunications users and the ability of the telecommunications industry to provide these services across the state. This plan advocates a multi-year process, with an initial emphasis on existing State funded programs and impending network investments by State agencies and its community partners.

4.4 Central Coordination Authority

This plan proposes that a central authority be established to provide control and oversight of the State network infrastructure. The two primary elements related to this activity include a network oversight authority and development and maintenance of an information/resource clearinghouse. The network oversight authority would exist to coordinate vendor-provided network management and maintenance. Tasks would include: developing network priorities, defining and providing technical standards for contract compliance, vendor relations, contract management and acting as a liaison between the end-user and the telecommunications provider. The information/resource clearinghouse would provide data for the aggregation processes on state and local levels and the gathering and processing of ongoing information about telecommunications activity for improved internal coordination and strategic planning. Currently SB 96-102 (C.R.S. 24-30-1702.5) provides the Commission on Information Management with the authority and responsibility to implement appropriate management of the network. The MNT believes the responsibility and authority to perform this task may more appropriately reside within the Colorado Information Technology Services (CITS) Division of the Department of General Support Services. An interagency board with representation of all participating areas should be utilized to provide ongoing guidance.

A suitable long-term strategy must be developed for the actual control and oversight responsibilities of the State network infrastructure. Issues to be addressed include an examination of potential barriers to aggregation, past purchasing practices, the changing regulatory environment, and the practical issue of aligning State agency and program planning agendas toward this goal.

4.4.1 Network Management

The State of Colorado does not currently have in place an administrative or management function that could undertake the day-to-day monitoring and operations of a Statewide telecommunications infrastructure described in this plan. Therefore, based on a review of existing resources and through discussions with various stakeholders, the MNT recommends that the State outsource the management and operation of this infrastructure to the private sector.

4.4.2 Information Clearinghouse (Library and Expertise)

As part of the information-gathering phase of this strategic planning process, the Multi-use Network Task Force created a reference and telecommunications technology library of descriptive, statistical, and cost information about State telecommunications users. These users include the State, Colorado public and non-profit organizations, local governments, higher education, K-12 schools, and libraries. This resource is being created as a shared reference resource for the ongoing tracking and management of Colorado's telecommunications infrastructure. All relevant segments of the marketplace, users, planners, and vendors will be included as the information becomes available.

This library consists of detailed information about existing State telecommunications circuits such as location, bandwidth, and cost. The library also contains information about large public/non-profit telecommunications projects in the State, grant project reports, State agency program data, and summaries of vendor interviews conducted by the MNT staff. This collection of historic and current State network information (capabilities, usage, plans, etc.), along with technology updates, should be maintained as a central resource for ongoing management and coordination of State investment in telecommunication technology.

As an example of the data gathering process, the MNT convened a day long meeting of Higher Education, K-12, and Library telecommunications project representatives on December 11, 1997. The library contains reports from this meeting, as well as network descriptions and maps submitted by groups who were unable to attend. Periodic meetings of this kind may increase the awareness and value of the library as more information is added.

Attention should be given to distributing responsibility for information gathering. Stakeholders in this activity include State Agencies, the Commission on Information Management (IMC), Colorado Department of Education (CDE), Colorado Commission on Higher Education (CCHE), Colorado Advanced Technology Institute (CATI), Colorado State Library and local communities.

4.5 Community Incentive Funding

The investment required to aggregate State Circuits at the 75 ANAP sites described in this proposal does not address "missing mile" issues in the local communities. A need for local funding for aggregation and connection to the ANAPs by participating community organizations exists and is critical to the effective implementation of this plan. Recently, several grant programs have addressed technology investment needs for higher education, education (K-12), libraries, health care, and other users of telecommunications technology in Colorado. These projects have set the stage for the effective use of telecommunications within the participating communities. They are now ready, even eager, for the development of a statewide telecommunications infrastructure.

The MNT has interviewed representatives of many of these programs and involved them in public meetings to discuss issues of the past and potential impacts of public investment in local telecommunications infrastructure. The MNT discovered strong support from these groups for access to technical and other assistance for accelerating vendor implementation of advanced services in Colorado's non-urban areas.

Additional funding will be needed to infuse telecommunications technology into communities to benefit all Colorado school districts, libraries, non-profit health care providers, and government entities to connect into, or otherwise benefit from State network infrastructure investment. An incentive program, referred to as "Community Incentive Funding", should be established to

encourage communities to aggregate their demand and support needs and assist them in reaching the local ANAP. With the State serving as "anchor tenant" for telecommunications technology in a community, the resulting reduction in circuit and "backhaul" charges should accelerate local development and improve the sustainability of local projects. This is particularly true for grant funded projects that may not be sustainable past the expenditure of the grant funds.

The MNT recommends that all State funds distributed to local communities for such purposes be reviewed in the context of this plan and be linked to aggregating community telecommunications demand or reaching the nearest ANAP. Coordination of such funds is necessary for the successful development of user services throughout the State.

4.5.1 Resource Centers

As communities work toward connecting with the local ANAP, they will need access to technical experts, consulting, and training. Because most communities can not afford this type of support, a resource center or centers may need to be established to assist during the initial start-up period. By aggregating these needs, along with information about desired bandwidth, greater community cooperation is encouraged and a more successful local implementation is likely. Resource centers will focus on identifying and resolving local/regional technology barriers, planning and facilitating aggregation of community demand. It is possible that the resource center concept can be implemented within the rural telecommunications program at Colorado Advanced Technology Institute (CATI).

It is anticipated that funding will be available for planning studies, aggregation, and implementation of projects, through the mechanism of "Community Incentive Funding" (see above).

5.0 PROPOSED TECHNOLOGY

This plan proposes development of a backbone network initially comprised of 75 Aggregated Network Access Points or "ANAPs" by private sector telecommunications providers. One ANAP would be located in each county seat, with other sites identified by concentrations of State-funded telecommunications circuits. In contrast to previous descriptions of a State network

infrastructure, the proposed network infrastructure will be defined not by lines on a map, but by points of service and requirements of technology access at each of those points. Each ANAP will have similar capabilities, the only variables being the amount of bandwidth and technology employed at each site.

The proposed technology for this network will use Asynchronous Transfer Mode (ATM) over high speed fiber facilities in well-established infrastructure areas of the State and over multiple T-1 services at sites that currently have lesser developed infrastructure. This design will allow advanced services in urban population centers in the State and will extend advanced technology performance to all ANAPs regardless of their location. ATM provides a base technology that adjusts to the varying demands of voice, video, and data. Another essential advantage of ATM is that it is a scaleable architecture capable of providing service for a high-speed telecommunications backbone as well as for low speed lines used to connect remote sites to the backbone. The scaleability of ATM also applies to the accommodation of network growth. This technology is explained in detail below.

5.1 ANAP Services

The ANAP locations will ideally be interconnected by Asynchronous Transfer Mode services. ATM allows voice, video and data to be carried over the same circuit with competent delivery of each. ATM at the ANAP interconnection level will provide a high capacity service to carry diverse traffic gathered from local communities. This will be accomplished by purchasing ATM services, preferably operated, over fiber optic facilities. The preference for ATM and fiber based technologies is based on the anticipation of increased demand and ease of upgrade to new services and technologies as they are offered.

The essential infrastructure technology to deliver this level of service is Synchronous Optical Network (SONET); a fiber-based technology that is well suited to carry ATM. Another technology, based on copper facilities is DS-3 technology. The DS-3 technology does not have the capability to scale to demand like SONET, but may be used for backbone service in areas lacking fiber optic facilities. The network switches proposed for this project are capable of accommodating either technology for backbone services.

The versatile nature of this architecture is demonstrated by the diversity of ANAP capabilities. The technology is scaleable to offer consistent equipment and facilities for conventional ANAPS and for high traffic sites termed “super ANAPS”.

Conventional ANAPS are sites that are used to aggregate community traffic. They will initially be configured to handle 10 to 20 Mbps ATM service. The super ANAPS are sites identified for large capacity backbone connections, up to 155 Mbps (SONET OC-3c data rate) and above. These super ANAP sites were identified as high traffic sites through several analysis criteria. These criteria include preparation for Internet II presence, high potential usage for video applications using network protocols or conventional switching technologies, and additionally to serve as a conventional ANAP. These super ANAP sites use the same technology and architecture as conventional ANAPS, but differ primarily on the amount of bandwidth required.

ATM service provided by carriers allows the ANAPS to be connected into a network cloud. This means that once physically connected to the cloud, all other sites within the cloud can be reached. This “cloud” architecture only requires a single connection to reach multiple destinations without regard to routes or paths taken by the data.

*(See Appendix **E** for a comparative bandwidth diagram.)*

5.2 ANAP Feeder Lines

Once established, the ANAPs will serve as points-of-presence for the backbone services described above. The ANAP will aggregate network traffic to a common point. The switching equipment will decide whether the intended destination for the session is local and should be switched locally, or is remote and switched across the backbone network. The local loop service will be used to carry traffic to the individual school, library, agency, or other entity from the ANAP switch.

A problem exists in utilizing the advanced services a high-speed statewide backbone brings to end users. It is known commonly as the “last mile” but is referred to in this document as the “missing mile” problem.

- Three components are necessary to provide telecommunications services to an end user. These are the backbone connection, the local switching facility and the subscriber loop service.

    1. The backbone connection will be provided through the ANAP.

    2. The local switch must be capable of providing the appropriate service requested. If ATM switching is required, then the ANAP must have the capability of switching ATM. Many of the smaller local telecommunications providers have elected to not upgrade facilities or do not have the financial resources to acquire this technology.

    3. The third element is the subscriber loop. The subscriber loop provides the wiring to connect customers to the telecommunications provider central office. If the subscriber loop is not capable of providing advanced services due to the length of the loop or the quality of the facilities, it must be replaced or enhanced. It is the local loop that provides access to the ANAP and represents the missing mile connections.

Several advanced service options to provide connectivity to end-users exist. These include:

- xDSL (Digital Subscriber Line) technology is a method to provide multi-megabit (expanded bandwidth) data services over copper subscriber loops. This technology is available in asymmetric mode (transmit and receive rates are not equal) and in symmetric mode where transmit and receive rates are the same. Success of using this technology will depend on the technology deployment of the local provider.

- ISDN (Integrated Services Digital Network) is an older technology that can provide service up to 128,000 bits/sec. It uses two 64,000-bits/sec channels to provide connections. The two channels can be combined to provide the 128,000-bits/sec. total. ISDN is primarily a dial up service and will limit the video capabilities of the sites where it is used, but provides greater bandwidth then a voice grade circuit.

- Frame Relay is an available technology in Colorado. Frame relay is currently used for data only. It cannot carry voice or video, but research is being done to provide multi-media services over frame relay. Products exist to deliver voice over frame relay today. However, their applicability to this network may be limited by the deployment of appropriate technology by the local telecommunications provider. Frame relay is deployed as 64,000 bits/sec, 1.544 MBPS, and 45 MBPS data rates.

  A major problem with the deployment (or the lack of deployment) of frame relay in Colorado is that additional charges are required to "backhaul" the service to the nearest frame relay switch. If the local provider does not have a frame relay switch installed, the customer must pay for the frame relay service plus the cost of carrying that service from the customer's site to the nearest population center in which frame relay exists. This "backhaul" charge can be considerable.

6.0 IMPLEMENTATION STRATEGY

Implementation of this *Strategic Plan for a Statewide Telecommunications Infrastructure* will prove to be a very complex process. The project duration will be driven primarily by the rate of infrastructure build-out by private sector telecommunications providers in response to the State's efforts to aggregate demand and integrate existing networks. The MNT currently estimates a two to three year duration for achieving full operation of the backbone infrastructure, including all 75 ANAPs, with local community efforts continuing beyond this time-frame. The implementation process must be tightly synchronized with the Community Incentive Funding process. It will be the responsibility of the Central Coordination Authority to ensure that the necessary capacity and capabilities are available at the local ANAP location when communities are ready to connect their aggregated traffic to the statewide network.

Over the next few weeks, the MNT will continue to share information and solicit input toward the ongoing planning process. In addition, the MNT will transition its focus to the development of a formal request for proposal (RFP) for the statewide telecommunications infrastructure. Once funding is authorized and the Central Coordination Authority is established, evaluation of RFP responses, inventory of current state telecommunications contracts, and site visits to identify specific ANAP locations can commence. Keys to the success of this project include, establishing

the 75 ANAPs as soon as possible and gaining full cooperation of all state agencies and institutions of higher education.

6.1 Funding Mechanism

A key in developing a statewide telecommunications infrastructure must be maximizing the value received from the current investment and minimizing redundant expenditures. Cost efficiencies realized in the more developed areas of the State must be reinvested in technology access in less developed areas of the State to achieve a goal of equitable access. Due to the cost and complexity of maintaining a statewide telecommunications infrastructure, the State has determined the need for outsourcing network management and operations.

This report provides an assessment of current spending at proposed ANAPs and provides cost detail information in support of aggregation. Aggregated sites can provide a better value for the funds the State is already spending. The preliminary assessment, completed as part of the preparation of this report, suggests that aggregation will improve capacity and technology access for most state agency programs for modest additional cost.

In brief, the estimated cost for the proposed network is:

- Capital: $13.5 million (One time cost)
  Capital categories include:
  1. Telecommunications Installation Costs
  2. Customer Premise Equipment (CPE) Costs
  3. Equipment Installation
  4. Site Preparation

- Operating: $13 million annually ($7 million additional spending authority)
  ($6 million of this will be offset by existing expenditures)
  Operating categories include:
  1. Access Costs
  2. Backhaul Costs
  3. Local Loop Interconnect

4. Maintenance Costs

- Personal Services: $161,000 per year additional spending authority
  (3 additional FTE)
  The new FTE are:
  1. Network Analyst II (2)
  2. Programmer Analyst III (1)

The network cost components from the $270 million in recommended IT projects to be implemented in the next two years should also be incorporated into this aggregated network strategy to help offset the annual operating cost.

Participation by other public and non-profit sector stakeholders will draw additional investment into the targeted communities. Public libraries, health care, and K-12, for example, channel significant federal funding and other grant resources into telecommunications technology development in the state. In the past five years alone, public library projects have brought approximately one million dollars of grant funding per year into the State for telecommunications development for citizen access to Library resources. Consolidating these resource investments on a local level will result in improved access to telecommunications technology for entire communities.

The participation of stakeholder organizations and the alignment of their investments in telecommunications technology with State goals will significantly promote the process of statewide infrastructure build-out. In addition, the Central Coordination Authority (See section 4.4.) should participate in grant funding processes, such as the U. S. Department of Commerce's TIIAP program. These funding sources are commonly used to facilitate technology development projects that are advantageous to State infrastructure development goals.

Funding alone will not resolve the State's problems in infrastructure development. The process of obtaining telecommunications technology and services must also be addressed. Preliminary assessment of the State's network capabilities undertaken for this report discovered that purchasing practices for State telecommunications services fragment and diffuse the potential

power of the State's current investment. This contributes to the under-development of telecommunications capabilities in and to many of Colorado's rural communities.

Other sources of funding may exist, such as the benefits derived from the State's highway right-of-way, the Universal Service Fund, other federal initiatives, and grant funding.

7.0 OBSTACLES/BARRIERS

Many issues may surface to hinder the process of establishing this statewide network. These obstacles and barriers include:

- The failure to gain full participation and cooperation from all state agencies, including higher education. The anticipated economies of scale to be gained from aggregation can easily be lost or scattered through pursuit of unique agency solutions.

- The State's ability to compel the private sector to make infrastructure investments in sparsely populated rural Colorado. The State's "anchor tenant" investment may still not be adequate in some areas to justify a major vendor investment.

- The rapidly changing regulatory environment.

- Sustainability of local participant projects with one time grant funding or other temporary financial assistance is a problem. Related issues include funding availability, TABOR amendment restrictions, and local priorities.

- Maintaining up-to-date and appropriate technology as well as the adoption of reasonable and enforceable standards in an environment where technology is evolving rapidly

8.0 SUMMARY

Investment in Colorado's telecommunications infrastructure must start now. The State has a window of opportunity to effectively and efficiently aggregate the states telecommunications demand and develop a coordinated telecommunications infrastructure. As the $270 million in

new information technology projects are implemented and new projects are allowed to develop independent networks, it will be harder to coordinate these activities and minimize future costs for telecommunications.

With a comprehensive telecommunications plan, state agencies, schools, libraries, and institutions of higher education will purchase telecommunications services in a coordinated fashion. Failure to adopt this plan will slow development efforts by private sector vendors. Impacts of the State's current approach are fragmented purchasing practices causing redundant expenditures, increased risk of failure for information technology projects, and hindered economic development. All telecommunications users -- not just State Government -- will continue to experience problems if the lack of coordination in telecommunications processes continue.

Thus a new paradigm based on the following objectives, and related recommendations, is needed.

- Aggregate network management and telecommunications purchasing to maximize the value of resources and ensure that the statewide objectives are met.

    1. Legislation mandating the participation of all state agencies, including higher education, in the aggregation of telecommunication circuits to optimize the economies of scale.

- Provide an Aggregated Network Access Point (ANAP) in every county in the state, with bandwidth ranging from 10 MBPS up to 155 MBPS (OC-3c), Asynchronous Transfer Mode (ATM) connection capable of carrying voice, video, and data on a statewide network.

    2. One-time capital funding of $13.5 million to acquire Customer Premise Equipment (CPE) to aggregate State circuits over a telecommunications infrastructure; and

    3. Spending Authority increase of $7 million annually to fund ongoing private sector operation and management of the telecommunications infrastructure.

- Establish a cooperative central coordination authority for identification of resources, consultation on connectivity issues, vendor oversight, strategic planning and training.

4. Three additional full time equivalent (FTE) positions to augment the Central Coordination Authority for the oversight and planning of the telecommunications infrastructure.

- Develop a program to assist communities to extend network services from ANAP sites to each public/non-profit user (schools, libraries, health care facilities, local government, etc.) with a need for this capability.

5. Establishment of a Community Incentive Funding program to enable communities to aggregate local demands and assist them in connecting to the statewide telecommunications infrastructure.

- Use of private/public partnerships to build and extend this statewide network. The only equipment that should be owned by the State is the Customer Premise Equipment (CPE) switch.

6. Continued examination of alternative and innovative investment strategies to facilitate infrastructure development.

Adoption of this plan will set the needed direction for making a statewide telecommunications infrastructure a reality.

Glossary

Access - For the purposes of this document, the ability to purchase services that provide end-user telecommunication capability such as Internet access, video conferencing, and statewide business networking. (See **Equity.**)

ACLIN -Access Colorado Library and Information Network - A statewide network for access to library catalogs and a variety of other information resources, ACLIN is an Internet-based service which provides no-cost dial-up access and graphical Internet access statewide. ACLIN is operated under the auspices of the State Library that is a part of the Colorado Department of Education.

Advanced Services - For the purposes of this document, the most current technology available in urban areas. Examples include Asynchronous Transfer Mode, Integrated Services Digital Network, Frame Relay and Digital Subscriber Loop services.

Analog - A signal that varies in a continuous manner (as contrasted with a digital signal); typically describes dialup or leased lines using modems as end devices.

ANAP -Aggregated Network Access Point – A region where the analysis of services, both existing and proposed is centered. This analysis is focused on aggregation of circuits into a shared, multiple-use backbone providing greater bandwidth and capability than individual circuits are able to provide. For planning purposes, an ANAP is used to measure carrier service levels and the availability of telecommunication circuits in a surrounding geographic area. Also included are their anticipated short-term growth needs and the potential participation of other public sector and non-profit entities.

Anchor Tenant - A major client or business that can provide leadership and motivate additional participation for local investment in infrastructure and service development.

ATM – Asynchronous Transfer Mode - A cell switching transmission protocol based on 53 byte fixed-length cells. ATM, because of a process known as adaptation, is capable of transmitting multimedia services (voice, video, and data) on one network.

Backbone - The high-speed lines and equipment that form the primary pathways within a network. Backbone networks provide interconnection between other networks. In the context of this plan, the backbone connects the ANAP locations.

Bandwidth - A measure of capacity for a specific circuit, usually expressed as bits per second.

Backhaul – The practice of bringing demand to a service rather than bringing service to the location where it is required. A term used to describe the charges resulting from a circuit required to connect a location without requested service to a site where the service is offered. Backhauling adds considerable expense to network connections because it commonly uses circuits with that are priced by distance.

Capability/Capacity - Terms for the purposes of this document that describe the functional specification for a network location or ANAP. This functional specification is based on service used and bandwidth capacity.

Carrier - A Telecommunications provider registered with the Public Utility Commission that offers telecommunications transmission services.

CATI - Colorado Advanced Technology Institute

CCHE - Colorado Commission on Higher Education

CDE - Colorado Department of Education

CIVICS - Cooperative Interactive Video in Colorado State government - The CIVICs network provides video conferencing, distance education, and telemedicine capabilities to 48 sites located around the state. CIVICS provides two-way interactive video conferencing.

Circuit - A switched or dedicated communications path (or line) with a specified bandwidth (transmission speed/capacity).

Community Incentive Funding - A new term. Proposed funding to aggregate local traffic and develop telecommunications technology of various kinds (K-12, Library, Health, etc.) in Colorado communities.

CPE - Customer Premises Equipment – A telecommunications carrier term describing any equipment that is owned and operated by the customer. Typically, some type of network equipment is required to distribute the network to offices, buildings or other sites on a customer site.

DDN -Digital Data Network - A network created in 1989 to provide fractional T-1 services for government sites. The DDN consists primarily of DS-1 leased lines with some reliance on the digital microwave for alternate paths or redundancy. The DDN has approximately 65 nodes (served locations) and almost 430 circuits. DDN carries primarily data and video traffic for the ***SNA Network*** and the ***CIVICS Network***

Digital - A discrete or discontinuous signal which transmits audio, data, and video as bits (binary digits, zero or 1) of information. Digital technology typically describes technology that is more current and because of its capabilities offers higher speed devices or services.

DS-3 - A designation of circuit capacity. A DS-3 circuit has a bit rate capability of approximately 45 million bits/second, which is equivalent to 28 DS-1 circuits at 1.5 million bits/second

Equity - For the purposes of this document, the ability to purchase advanced telecommunication services, without significant cost penalty because of location.

Fiber Optic - A technology using high purity, hair-thin fibers of glass to transmit information (voice, video, data). The bandwidth or capacity of fiber optic cable is much greater than conventional cable or copper wire.

Frame Relay - A form of switching protocol used for wide-area network connectivity. Frame relay can be purchased specific data rates. It is commonly used today for data transmission, and much work is being done by vendors to provide service for voice and video.

IMC - The Commission on Information Management

Infrastructure - A term used to describe the existing form of an extensive, underlying technology which supports services or enables activities for a specific population or geographic area. For example, the State and Interstate highway systems, local water systems, the power grid, and the telephony network.

Internet - The global network consisting of many interconnected networks. The Internet connects computers at universities, research labs, government, commercial, and military sites around the world.

IP (Internet Protocol) – A network language developed by the Department of Defense and others, commonly known as TCP/IP. This protocol suite is not proprietary to any single vendor. The TCP/IP protocol is used on the Internet.

ISDN – Integrated Services Digital Network –An international standard for digital communication services. ISDN typically provides two 64,000 bit/sec channels that can be used for either voice or data. ISDN is commonly used as a dialup service.

ISP - (Internet Service Provider) - A commercial organization that provides access to the Internet via dial-up and dedicated connections.

LATA - Local Access and Transport Area- These areas were originally defined by the 1984 telecommunications divestiture and subsequent actions. The LATA is a regulatory and geographical area that determines carriers that can provide service within the LATA area and the carriers who can cross the LATA boundary and provide service between LATA's.

LEC - Local Exchange Carrier - An acronym that refers to the local service provider(s) for telecommunications services. In rural areas, these were traditionally independent telephone companies. There are two varieties of LEC in the new re-regulated environment: an **ILEC** (incumbent) has provided services in an area, is certified by the FCC, and meets the definition in 47 U.S.C. 251(h) as of January 1, 1998; a **CLEC** ("competitive" LEC) is a new, competitive service provider in an area.

Local Loop - A general term describing the telephone lines comprising the infrastructure between a user location or building the carriers' local central office. It is sometimes referred to as a subscriber loop.

Megabit - A measure of data transmission speed - 1,000,000 bits per second or approximately 125,000 characters per second.

MBPS (Megabits per second) - **Abbreviation** for megabit per second.

MNT - Multi-use Network Task Force

Multiple-use Network - A network infrastructure that uses shared capacity and purchasing power for many uses and customers. A multiple-use network also provides a potential for operation efficiencies and rapid expansion of capacity to accommodate increasing demand.

Network - A collection of hardware, software, and leased service resources used to establish, link, and switch communication paths between its terminals.

Non-profit (-user) - A non-commercial organization that is defined by the IRS as a non-profit.

OC-3 - A SONET data rate specification. An OC-3 circuit has a bit rate capability of 155.52 megabits per second.

Private/Public Partnership - A business strategy in which a public entity and a vendor or provider of services pursue mutual advantages in the ethical provision of services.

Private Sector - A non-government or public company typically a commercial business.

Public Sector (-user) - A government or government supported entity of some kind, such as a public library.

PVC - Permanent Virtual Circuit - In switched networks such as frame relay and ATM, PVC defines a logical defined circuit between two locations. A PVC is a path existing inside the cloud technology.

Redundancy - The ability to provide an alternate network path or backup equipment to avoid failure of service.

Scaleable - A term used to describe technology which can be "sized to fit" a range of locations from high demand to low demand areas. It also applies to providing services for diverse needs.

SNA Network - Systems Network Architecture- The SNA network uses the Systems Network Architecture (SNA) protocol, which is employed primarily by IBM-type mainframes. It generally uses a front-end processor as a main network device, and uses remote controllers to distribute messages to each terminal. The CITS data center is the hub site for the State SNA network.

SONET - Synchronous Optical Network - A high speed, fiber optic based telecommunication technology.

Switch – Hardware and software used to provide the ability to for a network to determine the destination of a frame or cell. The switch then routes the frame or cell through its hardware to the appropriate circuit for transmission. The capability of switch configuration in a local central office is a determining factor for the services and advanced technologies are available in that local serving area.

Subscriber Loop - The infrastructure that provides service from a customer building to the local central office network connection.

T-1 – (also known as DS-1) A classification of service. A T-1 circuit has a bit rate capability of 1.544 megabits per second, and is capable of carrying 24 single line telephone circuits.

TIIAP - Telecommunications and Information Infrastructure Assistance Program - A grant program from the U.S. Department of Commerce, National Telecommunications and Information Administration, established by Congress in FY 1994 to assist non-profit organizations and units of state and local government. These projects are often used to fund projects that contribute to the building of a national information infrastructure.

xDSL (- Digital Subscriber Line) - A new technology which can provide multi-megabit data services over copper subscriber loops.