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Colorado Multi-Use Network

Annual Report – 2004

Submitted to: Information Management Commission
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Submitted by: Division of Information Technologies
Department of Personnel & Administration
State of Colorado

Executive Summary

The Multi-Use Network (MNT) concept was formulated in the February 1998 "Strategic Plan for a Statewide Telecommunications Infrastructure" and authorized as a state program by SB 96-102. Its goal was to connect urban and rural communities across the state, bridging the digital divide. Its method was to use the public sector as an anchor tenant for telecommunications investment. It had five principal goals, listed in Table 1. The project was completed and a final report submitted by the MNT Task Force to the Governor and the Information Management Commission in October 2003. This report is the first of a planned series of annual updates covering the progress of the MNT in achieving the five main program goals and provides a baseline for annual reassessment of progress in achieving the MNT program's intent.

Table 1 lists the five major program goals of the MNT and, for each, defines and quantifies a performance metric for that goal as of September 2004.

Table 1: Summary of MNT Outcomes as of September 2004

	Goal	*Metric*	*Outcome*
1	Aggregate all state data communications	Participation of state agencies in MNT Number of MNT connections Total cost of backhaul charges	**All executive branch data circuits have been aggregated on the MNT.** **There are 2,636 connections to the MNT.** **Backhaul charges have been eliminated on all state circuits.**
2	Serve as anchor tenant	Additional participation in the MNT from political subdivisions	**674 non-state agency public entities connect to the MNT, an increase of 58% from last year.**
3	Enhance access for the private sector	Percentage of rural population reached by MNT partners. Availability of broadband DSL/cable/wireless	**63% of rural municipal population has ATM access.** **Rural county seats average 3 broadband options; all but 4 have at least 1.** **Two-thirds of Qwest ANAPs have DSL.**
4	Promote rural economic development	Metro/rural gap in percentage workforce employed by high technology firms	**Metro high tech job concentration exceeds rural by 5 to 1: (Metro = 10%; Rural = 2%).**
5	**Improve educational opportunity**	**Participation of schools in federal E-rate program**	**60% of Colorado school districts participate in the E-rate program. In 2004, 2,756 E-rate requests were submitted, totaling $47.5 million.**

Network Overview

Under the MNT program, Qwest and its partners built a statewide fiber optic network spanning all of Colorado's county seats:

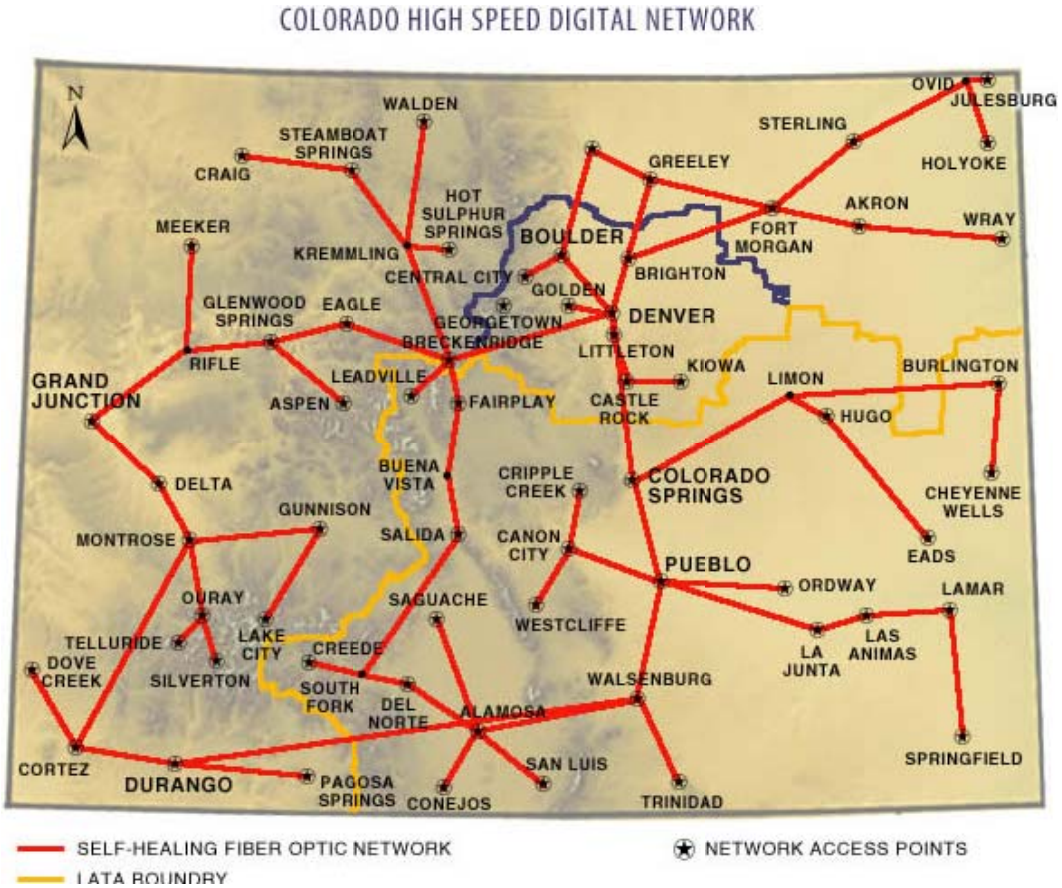


Figure 1: Colorado High Speed Digital Network (CHSDN).

The fiber network keeps traffic among MNT users in the state. Alternatively, if different public sector users selected different communications and Internet providers, connections among them might occur at telecommunications nodes far removed from Colorado, engendering time lags and service degradation.

This network, owned and operated by Qwest and its partners, is called the Colorado High Speed Digital Network (CHSDN) and is available for use by the public, e.g., individuals, businesses, etc.

The State serves as the anchor tenant on the CHSDN. Using the ATM cloud, five large telecommunications switches and wholesale access to the Internet, the Division of Information Technologies has created a sub-network of the CHSDN called the MNT.

The MNT provides cost-effective, quality, high-speed broadband data communications and Internet access to Colorado's public sector: e.g., state agencies, schools, colleges, libraries, hospitals and local government. For more information on the MNT, see http://www.mnt.state.co.us.

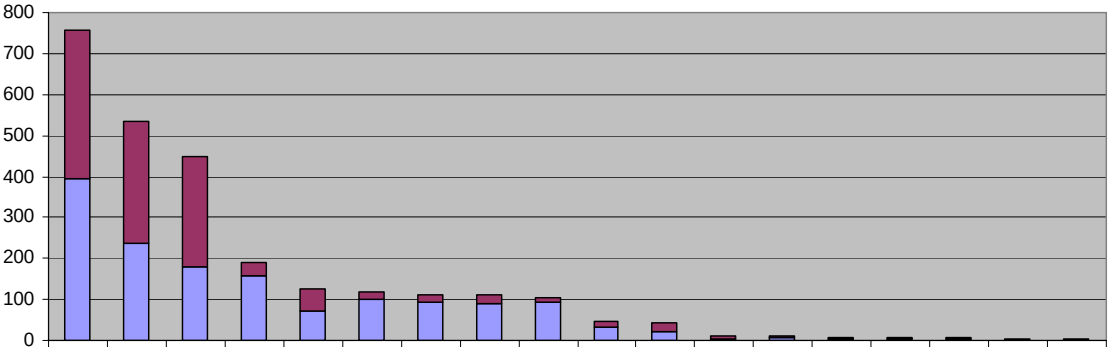
Goal 1 – Aggregate State Data Communications

METRIC:

Volume of traffic on the MNT network, participation by department.

RESULTS

- As of July 24, 2004, MNT supported 2,636 connections, including 1,502 ATM and 1,134 Frame Relay. With minor exceptions[1], this comprises all of the State's Executive Branch data connections. (Note there is one connection for each end of a circuit, one into and one out of the ATM cloud.)
- Total bandwidth billed for on a monthly basis by the MNT is 3.4 terra bits per second (3.4 million Mbps).
- All Executive branch departments have converted all their data traffic to the MNT. The degree and extent of MNT connections by department is illustrated in Figure 2.



	Human Services	Public Safety	Revenue	Non-State	Transportation	Judicial	Corrections	Personnel	Natural Resources	Higher Education	Sec_Of State	Agriculture	Health	Education	Labor-Employment	Local Affairs	Governor	Regulatory Agenci
FRAME RELAY	361	300	266	30	52	18	17	21	10	14	22	7	5	3	3	1	3	1
ATM	395	236	181	159	72	100	93	89	94	32	22	5	7	5	5	5	1	1

Figure 2: MNT Connections by Department (as of August 30, 2004)

- There are no backhaul charges, except $180 on one circuit.[2]
- Statistics on the number of connections per site suggest minimal opportunity for further aggregation, with a median of 1, mode of 1, and average of 3.2 connections per site. There are only 52 sites with 4 or more connections out of 813 sites total.
- Among all MNT connections, there are a substantial number of slow-speed connections (1,046 connections running under 1 Mbps), roughly 50% more at 1 Mbps and T1 connections (1,586 connections running 1 Mbps and over). Figure 3 summarizes all connections by bandwidth.

[1] The Division of Information Technologies, Communications Branch, has only 21 non-MNT Qwest circuits. These circuits are primarily point-to-point T-1s for DDN and analog tail circuits for CBI. All are being supplanted by other projects.

[2] This is a non-state T1 circuit paid for by non-state public sector client of the MNT terminating in Woodland Park.

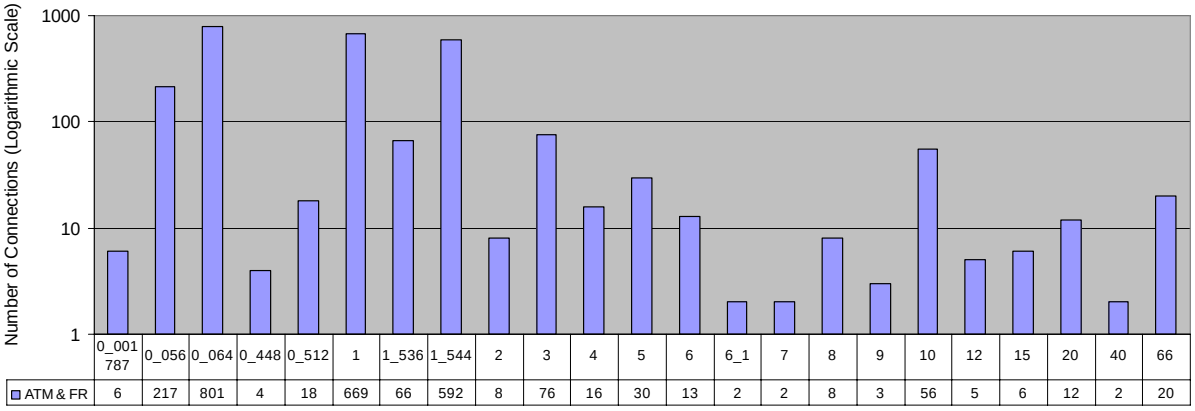


Figure 3: Number of Connections by Connection Speed (number of connections plotted on logarithmic scale)

- The MNT aggregates traffic at two levels.

  The MNT project was designed and built as an ISO Layer-2 transport aggregation project. However, early in deployment it was realized that full ISO Layer-3 services with Internet was the highest need of our customers. The project was expanded to include these services. At Layer-2, aggregation was accomplished at the ANAPS in each county. The Layer-3 network aggregation was accomplished farther back in the network, at the Region CAPs (Central Aggregation Point). The CPOP (County Point of Presence) project, implemented through a shared router located in a single physical location occupied by a number of entities, attempted to push the Layer-3 aggregation point further forward in the network all the way out to the county. In those locations where sufficient aggregations of "like" customers were present, this model was successful.

  There are many locations where this model is not yet cost-effective. Where the likely aggregation point is beyond the ANAP, at a building where there may be state agencies and non-state agencies such as county government, schools and libraries, problems arise with Layer-3 aggregation and a CPOP model does not provide benefit. This is because most state agencies have high security requirements for the traffic transported. Many have contracts with specific performance Service Level Agreements (SLAs). Finally, fiscal and billing relationships related to network management are also issues for many state agencies. In sum, at the Layer-3 network periphery, co-mingling TCP/IP traffic becomes problematic.

  There are new technologies just now finding general acceptance and deployment. Virtual Private Networking (VPN) is starting to become a workable solution to the Layer-3 aggregation. But this solution is not without significant costs in new hardware all the way up and down the network from the client to the server. Client applications must also be VPN-aware. In large statewide applications, the schedule and funding for significant application changes occurs in a multi-year planning and implementation cycle. Given these and other issues, it will still be common to find multiple, individual MNT circuits in the same building. This is not all bad, as we have produced savings through aggregation of traffic at Layer-2 at the ANAP in each county. The MNT Program will continuously press for aggregation farther and farther out closer to our customers, always being mindful of their security requirements.

- A number of agencies fall outside the scope of the MNT, but are interconnected with the MNT where appropriate. These include:

  The Judicial Branch. This is a separate branch of government and does not fall under the scope of the MNT Executive Order. However, a Memorandum of Agreement is in place between the Division of Information Technologies and the Judicial Branch outlining a pilot implementation during FY04. To date, the MNT includes 118 connections for the Judicial Branch. These connections serve the entire 719 area code for the Judicial Branch.

  Colorado Department of Transportation. CDOT owns or leases fiber optic conduit and cable along state highway rights of way which forms the backbone of the CDOT's Intelligent Highway System.

  Higher Education. Higher education has a long track record in statewide networking in Colorado. In fact, higher education founded the state's first Internet service, Colorado SuperNet, in 1984. Higher education had numerous OC-3 circuits in place as the MNT deployment began connecting its campuses to the Front Range GigaPoP (FRGP), a connecting point to the commodity Internet and Internet-2. By joining the FRGP, the MNT and higher education networks interconnect, forming a seamless, statewide network.

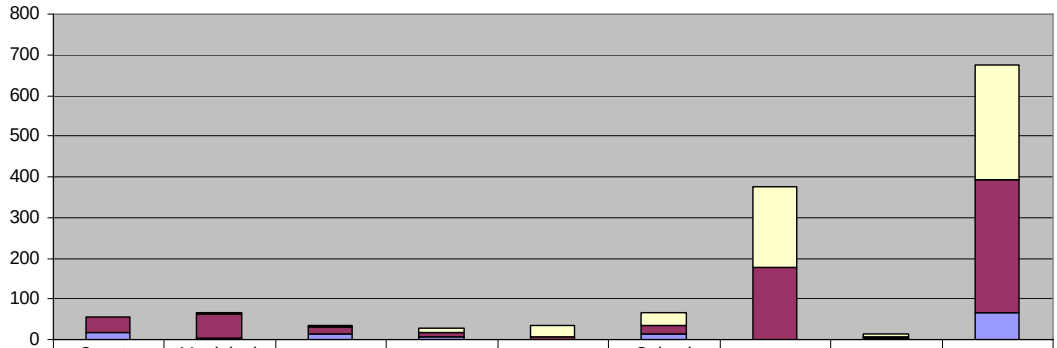
Goal 2 – Serve as Anchor Tenant

METRIC

Local public entity participation, by type of political subdivision.

RESULT

- 674 non-state agencies are connected to the MNT, this represents a 58% increase from last year.[3]
- 65 non-state agencies are direct, paying customers of the MNT (bottom columns in Figure 4).
- An additional 328 (middle columns in Figure 4) are connected "behind" MNT customers acting as community and regional aggregators such as Beanpole projects, municipal aggregation projects or schools.
- Higher education institutions also play a large role in aggregating traffic for the MNT, connecting an additional 281 sites, mostly schools (upper columns).



	County Government	Municipal Government	Healthcare	Library	College	School District	School	Other	Grand Total
Higher Ed Sites	2	4	4	11	26	30	197	7	281
MNT Aggregated Site	36	57	15	10	7	20	178	5	328
Direct MNT Site	19	5	15	8	1	15		2	65

Figure 4: Connections to MNT by Political Subdivisions

- Please note, in addition to the sites shown here, roughly half of MNT connections paid directly by state agencies connect to municipal and county public sector entities such as law enforcement, human services, clerk and recorder, etc.
- The additional local, public entity participation documented in Figure 4 greatly expands the scope of the MNT, bringing education, library, and healthcare communities into the network. The MNT "enterprise network," spanning all components of the public sector, will be especially important in the future for high-bandwidth applications such as videoconferencing.

[3] As reported in the MNT Project Completion Report, September 2003, p. 16, not including law enforcement agencies which for this year's report are counted as state circuits and reported under Metric 1. Logan County and Fort Morgan did not provide data for inclusion in Figure 4.

Goal 3 – Enhance Access for Private Sector

METRICS:

Percentage of rural[4] Colorado municipal population with access to fiber-based ATM services. Percentage of county seats with DSL, cable, or wireless broadband access.

The CHSDN (e.g., the "private side" of the MNT) serves as a statewide telecommunications "backbone" that reaches every county seat. In order for businesses in county seats to reach this backbone, there needs to be an affordable "last-mile" broadband connection available, such as DSL, cable or wireless. These last-mile broadband options provide substantially less expensive (often in the range of from $30 to $50 per month) connections than Frame Relay and ATM T1 access. The MNT has served as a trailblazer for last-mile broadband deployments by Qwest and its partners, and by entrepreneurs who have stepped forward to exploit this new resource and offer broadband Internet services to the community.

RESULTS

- The public now has ATM broadband access via the CHSDN made possible through the MNT public-private partnership.
  - 63% of Colorado's rural municipal population has access to ATM.
  - An additional 11% have ANAPs in their community that are, however, at present, only available to the public sector (e.g., governmental entities). Negotiations are underway to expand this access to include the private sector (these communities are shown at the left of Figure 5).

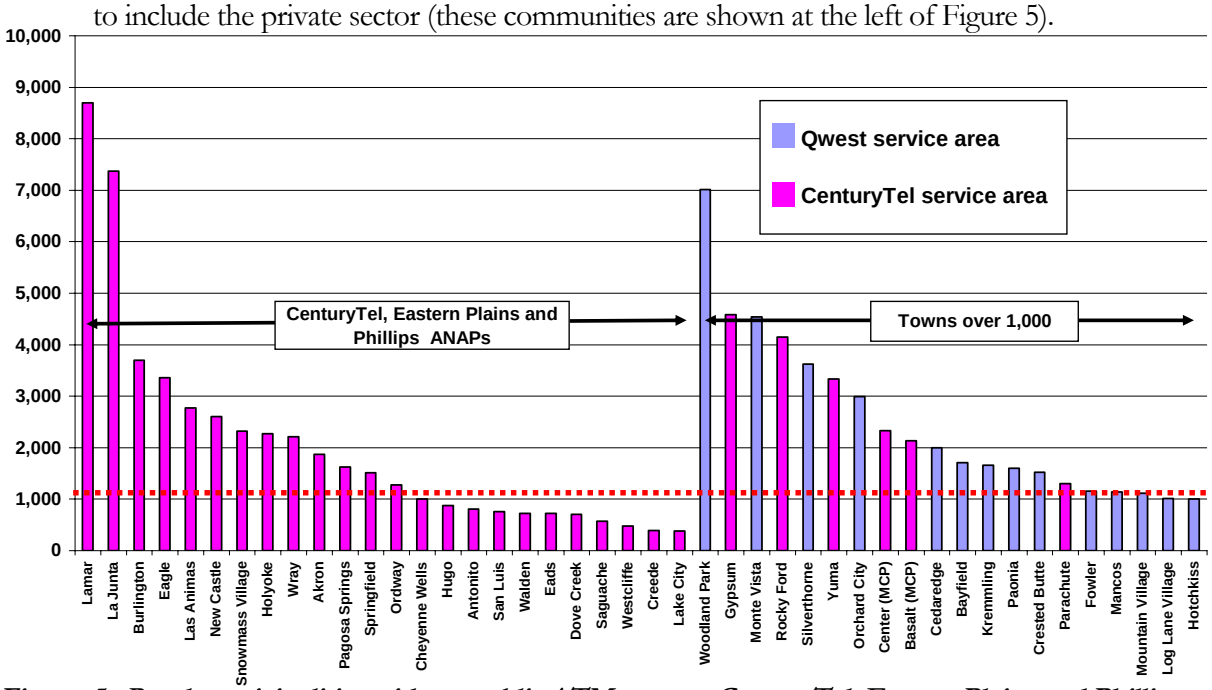


Figure 5: Rural municipalities without public ATM access: CenturyTel, Eastern Plains and Phillips ANAPs (left) and towns over 1,000 population (right).

[4] For the purposes of this report, "rural" is defined at the county level and includes all counties not deemed to be Metropolitan Statistical Areas by the U.S. Census.

- In addition, if the MNT were expanded to include the 20 towns with population over 1,000 that are not currently served by the CHSDN, 91% of Colorado's rural municipal residents would have ATM access. (These communities are shown at the right in Figure 5.)
- While the goal is not to reach every household, but rather to reach major population centers in each county, a low priority challenge remains to reach the 50.2% of Colorado's rural population that live in unincorporated areas (365,187 people, or 8% of Colorado's 4.5 million population). Local entrepreneurship coupled with new broadband wireless technologies may help address this challenge.

- Last-mile broadband availability is, according to a January 2004 survey of county administrators, as follows:

Table 2: Availability of Last-Mile Solutions in ANAP Municipalities

	Average Number of Vendors	At Least One Vendor	All 3 Types of Vendor
Metropolitan Counties (12 of 12 reporting)	3.8	All	75%
Rural Counties (42 of 52 reporting)	3.1	All but 4	40%

- Qwest has deployed DSL at two-thirds of their ANAPs (29 of the 43 ANAPs they operate). State-wide, Qwest has disclosed 96 DSL deployment locations (central offices). Arguably, the MNT has paved the way for wide-scale DSL deployment.

Goal 4 – Promote Rural Economic Development

METRIC:

Gap in percent workforce in high technology, rural vs. metro areas

The United States has benefited from the worldwide, dramatic improvements in productivity over the past decade due to the advent of information and communications systems. This New Economy strengthens existing industry (e.g., tourism, agriculture) and enables entirely new forms of economic activity (e.g., data and information services). Because it is hard to measure New Economy job growth, high technology jobs are used in this report as an indicator of New Economy potential. Access to high speed communications is a prerequisite to New Economy jobs. The deployment of high-speed communications throughout rural Colorado should enable growth in this type of employment.

RESULT

- As of December 2003 (the most recent employment data available as of the writing of this report), there was a 5-fold gap in high tech employment between metro and rural regions of the state.
- While the anticipated growth in rural high tech employment due the MNT is not yet evident, it has, at least, remained flat over the three-year recessionary period from January 2001 to December 2003 (see Figure 6). During this period, metro high tech employment has dropped 25% and overall Colorado employment fell by 3.8%. The metro-rural high tech gap has narrowed, but not due to proportionately faster high tech job growth in the rural area of the state, rather due to a fall in metro high tech jobs.

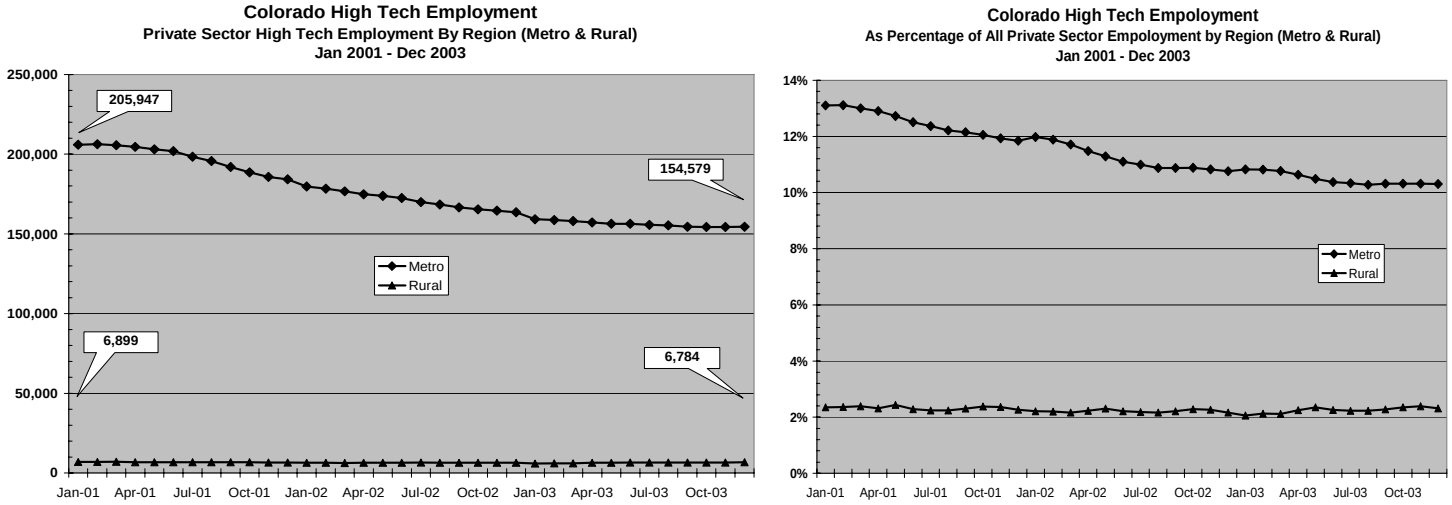


Figure 6: Colorado High Tech Employment, Metropolitan and Rural Regions (left, absolute numbers; right, as percentage all jobs)

One candidate explanation for the lack of recessionary decline in rural high tech employment might be that these are stable, infrastructure-related jobs. However, the high tech employment categories of telecommunications, cable, satellite and Internet combined comprises only a minority (35%) of rural high tech employment.

The balance of high tech employment falls in primary industries that generate wealth for the region, notably engineering services, computer systems design, and software publishing (see Table 3). It should be obvious that access to high speed communications is an absolute prerequisite for growth and competitiveness for these rural high tech employers.

Table 3 Top 10 Rural High Tech Employment Categories

INDUSTRY	RURAL EMPLOYMENT
Engineering services	1435
Other telecommunications	919
Wired telecommunications carriers	767
Computer systems design services	500
Software publishers	487
Physical, engineering and biological research	368
Custom computer programming services	347
Other computer related services	334
Cable and other program distribution	294
Totalizing fluid meters and counting devices	177

Goal 5 – Improve Educational Quality

METRIC:

The percentage of schools participating in the federal E-rate program.

RESULTS

Cumulatively since 1998, Colorado school districts have requested $310 million in federal E-rate funds for Internet access, received federal commitments of $115 million in these funds, utilized (spent) $68 million of the amount made available, and declined to spend $161 million (see Table 4). Reasons for a district to decline available funding include a decision by the district to change Internet provider and an inflexibility of the federal government to reallocate those funds to the new provider; or a dramatic drop in the cost of service (for example, through participation in the MNT, which provides low-cost Internet access).

Table 4: History of E-Rate Funding for Internet for Colorado Schools

Year	Total Requests	Requested Amount	Pending Amount	Committed Amount	Utilized Amount	Rejected Amount	Utilization %
2004	2,756	$47,544,096	$27,128,218	$16,525,595	$536	$3,890,283	0%
2003	2,074	$29,074,746	$5,721,232	$16,753,134	$4,667,397	$6,600,381	28%
2002	2,265	$90,538,878	$0	$23,834,595	$20,019,601	$66,704,282	84%
2001	2,315	$70,143,951	$6,912	$16,714,970	$12,018,761	$53,422,069	72%
2000	2,550	$32,845,313	$0	$14,464,401	$9,448,650	$18,380,912	65%
1999	1,599	$16,261,069	$0	$13,040,474	$10,601,333	$3,220,594	81%
1998	1,969	$24,061,892	$0	$14,316,280	$11,506,150	$9,745,612	80%
Total	15,528	$310,469,944	$32,856,361	$115,649,450	$68,262,428	$161,964,133	

Figure 7 shows the overall context of E-rate Internet access funding and its relationship to MNT subscribership. As seen, 60% of Colorado School districts participated in the E-rate program in 2004. However, only one-sixth of the E-rate schools choose the MNT as Internet provider. This may be because many schools had multi-year contracts in place for Internet connections prior to the availability of the MNT. The MNT Program has an aggressive marketing campaign in place to capture these subscriberships when existing commitments expire.

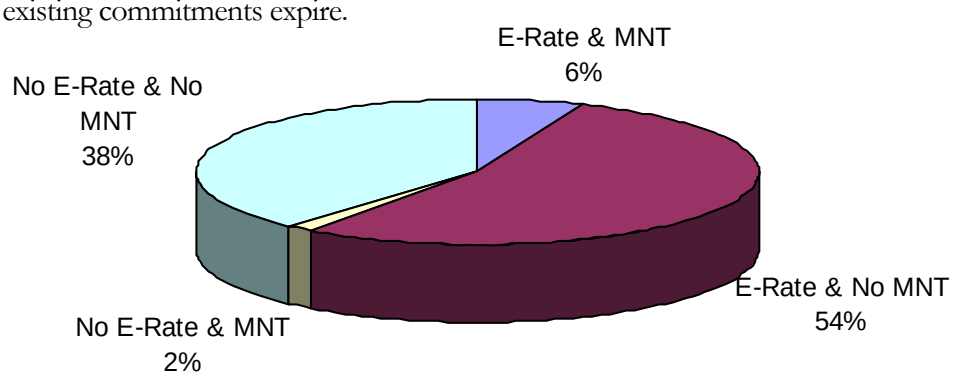


Figure 7: Colorado School District Participation in E-Rate and MNT

Libraries also receive E-rate funding. 43% of the 114 public libraries applied for E-rate in 2004, requesting, to date, $455,890. The 2003 request total was $893,618.

Recommendations

❖ **Private sector access should be available at all ANAPs.**

As described under Metric 3, Qwest's partner telephone companies in the MNT program have not disclosed (i.e., tariffed, offered) public ATM access at the ANAPs they operate. While this is not a requirement of the MNT contract, it defeats the primary goal of the MNT which was for the state to act as the anchor tenant for ATM services, not the sole tenant. The MNT Task Force recommends that appropriate strategies be developed and implemented to rectify this situation.

❖ **Oversight of statewide networking needs and programs should be continued beyond the sunset of the MNT Task Force.**

The MNT Task Force will sunset at the end of December 2005. It is recommended that a successor body be formed by Executive Order or legislation prior to December 2005 and before the next gubernatorial election. The successor body should continue to have broad representation across state agencies, higher education, K12 education, and local government. The mission of the new body should not be the oversight of the MNT per se, which is now an operational program under the management of the Division of Information Technologies. Rather, the new body should address issues that go beyond the mission and scope of the Division of Information Technologies, and indeed, beyond the mission and scope of any department or agency.

The charter of a successor organization to the MNT Task Force should include:

- Infrastructure. Build out the physical network to reach as much of Colorado's population as is feasible. A national goal has been established by the Bush Administration to reach 95% of the population by 2007.

  The infrastructure must be redundant and reliable. Redundancy means service outages at any one node or link do not affect other nodes or links, and that traffic may be re-routed around broken nodes or links, i.e., the network should be self-healing. Reliability means that the network is up and available. The industry standard is "5 nines," meaning 99.999% of the time.
- Aggregation. Aggregate connections coming from certain sites, in particular, county courthouses. This aggregation is most easily achieved at the connection layer (e.g., "Layer-2"). While more difficult to aggregate at the packet layer (e.g., "Layer-3"), due to security and reliability issues, this may be preferable in the long-term as this layer of aggregation provides the support infrastructure for IP voice and video services.
- Services. Expand the type of services available over the network to fully capitalize on its nature as a multi-use network to carry voice, data, and video. The successor group should explore how voice and video may be employed statewide by our public institutions in a seamless manner. Consideration should be given to circuit/system performance metrics and the impact of additional workload on the existing infrastructure.
- Applications. Assess and recommend areas for expansion in applications available over the MNT, recognizing that these applications originate from mission-driven agencies and political subdivisions. However, there is a need for a broad perspective of the totality of e-government, e-education, and e-health services, their nature and their integration.

Appendix – Data Collection Methodology

In order that multi-year trends of the quantitative metrics provided in this report may be observed, the metrics must be computed in a consistent manner each year. The following information is provided to specify exactly how the numerical values of each metric were obtained.

METRIC 1

A spreadsheet was compiled by the Communications Service branch of the Division of Information Technologies. The spreadsheet listed all connections billed to the MNT program. For each connection, the following data elements were provided: Dept, Agency - Org Key, State Circuit, Qwest Circuit, DLCI VPIVCI, Service Type, Circuit Quality, MNTPAths_Bandwith of Path_K, MNTPAths_Nbr Increments, Nbr Paths, Bandwidth Cost, Max Burst Cost, Backhaul Cost, DoIT Link/Port Cost, Monthly Path Cost, USF Charge, CDEF Charge, Final Total Path Cost, Port/Link Bandwidth, Site ID, City Name, Post Code, County Name, PathMegs. Cross-tabs were prepared for Dept by Service and Service by Path-Megs. The demographics of the MNT was obtained by comparing 2002 Colorado census data (for rural municipalities) against the published ATM disclosures of telecommunications carriers.

METRIC 2

The Communications Service branch of the Division of Information Technologies maintains a database documenting all "non-state agency" (NSA) connections to the MNT. This includes not only NSA direct customers, but also the first tier of entities behind customers serving as "aggregators" for others (e.g., Beanpole aggregators, county points of presence, municipal LANs, etc.). Also included are all entities served by higher education institutions. Note, higher education institutions interconnect with the MNT at the major meet-point for public sector Internet traffic in the state, the Front Range GigaPoP.

METRIC 3

The Division of Information Technologies surveyed county administrators and IT directors in January 2003. All 12 MSA (metro) counties responded, and 52 of the 58 non-MSA (rural) counties responded. This survey methodology is repeatable from year to year. The survey asked for administrator or director's opinion as to the number of DSL, cable, and wireless vendors in their county seat.

METRIC 4

ES-202 data was obtained from the Colorado Department of Labor and Employment Labor Market Information Division in a file titled, NAICS Macro Thru 4Q2003. This file was filtered to include only the NAICS codes included in the American Electronics Association's definition of high tech. Pivot tables and charts included with the DOLE table were used to produce employment totals for MSA and non-MSA regions of the state. These totals were divided by total employment figures for each region. The data were plotted monthly for the three-year span covered by the DOLE file (January 2001, December 2003).

METRIC 5

E-Rate data was compiled from the following primary data sources: Funding Request Data Retrieval Tool (http://www.sl.universalservice.org/funding/OpenDataSearch/Search1.asp) and Colorado Department of Education list of school districts (http://www.cde.state.co.us/edulibdir/directory_15.pdf), and MNT User Base Data Report, extract of all school districts on MNT. The process followed was: pull E-Rate data file from USAC site, covert it to an Excel spreadsheet, delete all duplicate FRN/471 requests, use

directory15 file for master school district list, cut and paste the .pdf file into a new excel file with select table feature in Adobe, sort the individual files by school district names, cut and paste the files into one sheet by matching the school district names to the applicant name as primary keys. Note, a match was not made for all school districts since some did not submit E-Rate applications (also, some may not match their names and discrepancies were resolved). Continuing, in the new worksheet was added an "on E-rate" column, filtering on applicant name. Found blanks were marked as "no" in the "on-E-rate" column. After clearing the filter, MNT users from the MNT list were found and designated as Yes-MNT and No-MNT depending if they are on E-Rate or not. All the rest of the blanks that are on E-Rate were marked as "yes" using the filter to do entry. A pie chart function was then run on the E-rate data.