

BRAN Technical Information

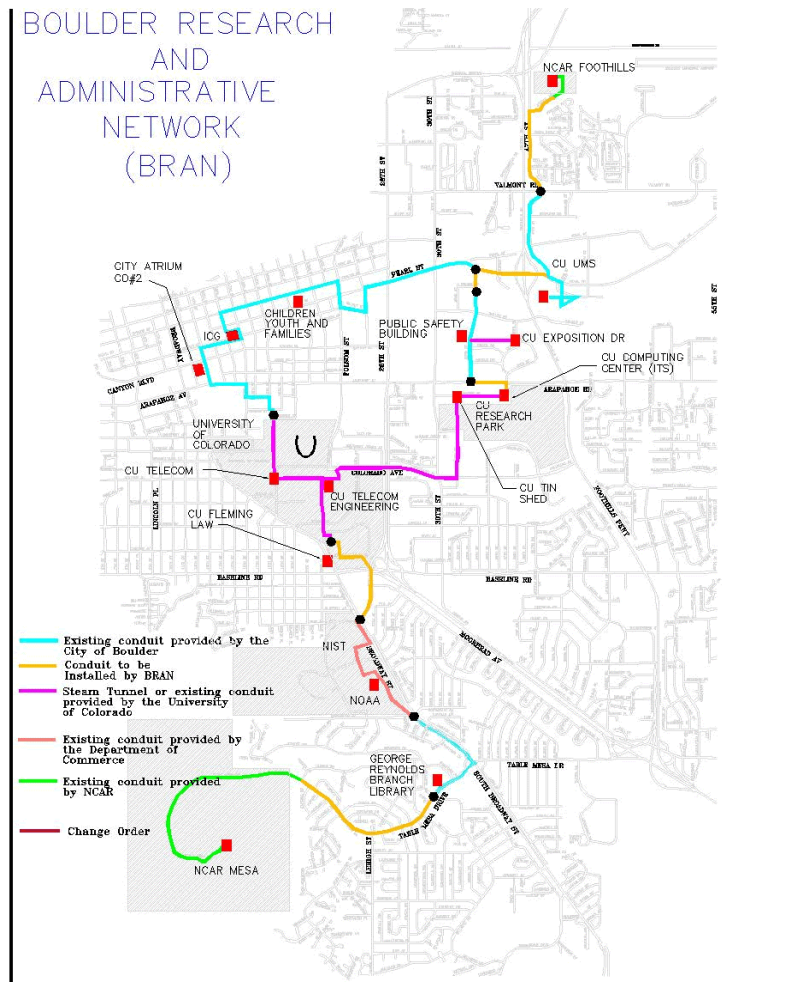
Document Version 1.0 - by Jim Van Dyke - May 2004

Introduction

The Boulder Research and Administration Network (BRAN) was founded by the City of Boulder, University of Colorado at Boulder, NOAA/NIST Boulder Government Labs, and National Center for Atmospheric Research (NCAR)/University Corporation for Atmospheric Research (UCAR) to consolidate and promote intercommunications between their own and the member organizations. It was constructed in 1999 for a cost of over \$1,200,000.00. The BRAN consists of 96 single mode strands of optical fiber which extend to many parts of the city. Since the fiber cable is organized into 12 fiber bundles or tubes, the split of fiber between the members is the following:

- Blue Tube - 12 fibers: City of Boulder
- Orange and Green Tubes - 24 fibers: University of Colorado at Boulder (CU-Boulder)
- Brown and Slate Tubes - 24 fibers: NOAA/NIST
- White and Red Tubes - 24 fibers: NCAR/UCAR
- Black Tube - 12 fibers: Common Tube - Split between: CU, NOAA/NIST, NCAR/UCAR - 2 pairs each

The BRAN has a web site where all documentation for the project may be obtained including: CAD Drawings, construction notes, and meeting minutes. The site is: www.branfiber.net.



Member Cooperation and Guiding Principles

Since this project involves the cooperation of many partners, the management committee developed a set of philosophies that should be observed as the project moves forward into the future. Both the "BRAN Member Cooperation Memo" and the "BRAN Context and Guiding Principles" documents may be found in Appendix A.

Physical BRAN Characteristics

The BRAN fiber cable is installed in 1 1/4" conduit throughout the entire network. A hand hold or pull point is installed about every 100-200' of installed conduit. There are approximately four major manholes where the BRAN cable is racked and mounted. At each pull location, approximately 20-80' of service loops are installed. A list of manhole/handholds can be found at: www.branfiber.net.

The BRAN fiber cable has the following characteristics.

Lucent Singlemode, general purpose OSP cable, Lightpack core, LXE dielectric sheath - DNX
D-LUX Coating

Two color-coded binders for easy identification of each bundle

Technical Specifications:

Part No.: 105 929 749

Attenuation: 0.40 dB/km @ 1310 nm, 0.30 dB/km @ 1550 nm

Cladding: Depressed Clad

Core Size: 8.3 nm

Tensile Load Rating: 600lb. (2,669 N)

Minimum Bend Radius:

10 times cable diameter under no load

20 times cable diameter under load

Outer Diameter:

50-96 fibers: 0.61 in. (15.5 mm)

Weight:

50-96 fibers: 115 lbm/kft (171 kg/km)

Operating Temperature Range: -40F to 158F (-40C to 70C)

The BRAN is terminated in the following manner. Each end of the raw cable enters a splice box where it is spliced to "pigtail" connectors. The pigtail connectors are about 5' in length and are terminated into a patch panel with ST type connectors.

Each patch panel is split up according to tube color and the connector panels are colored as such. Not all fibers are terminated at all locations. However the black fiber tube is terminated at all locations. Each group chose which fibers to terminate at each location, however the order is constant throughout the system. At End locations all fibers are terminated as well as at the CU Engineering building location where the three main branch cables are terminated.

The CU Engineering location has the following setup:

Slack storage shelf / cable breakout point

72 port patch panel / splice shelf - City of Boulder

72 port patch panel / splice shelf - CU

72 port patch panel / splice shelf - NOAA / NIST

72 port patch panel / splice shelf - NCAR / UCAR

72 port patch panel / splice shelf - Common Fiber Bundles



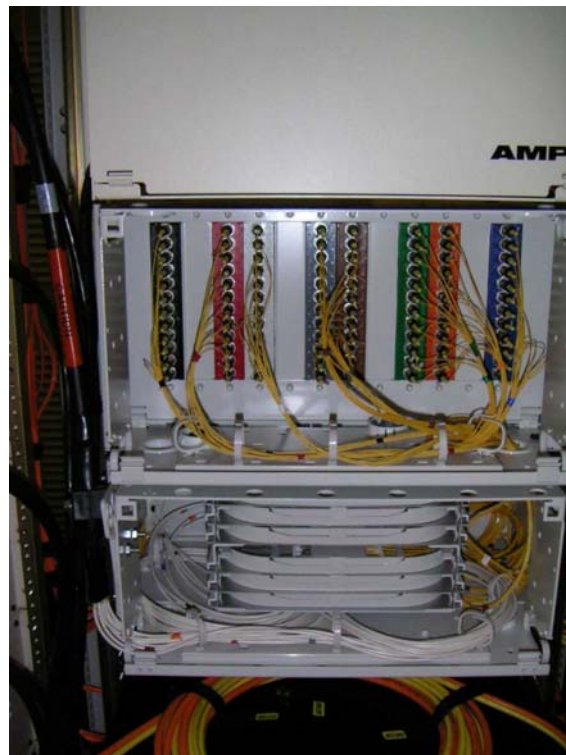
The layout of each panel is:

Cable #1	Blank Panel	Cable #2	Blank Panel	Cable #3
To NOAA/ NIST South Branch		To CU Telecom West Branch		To CU Computing East Branch

The components used at the CU Engineering location are the following:

	Lucent Part Numbers:	
Storage Shelf Part	LSJ1RP-30/7	106 587 694
Fiber Optic Shelf Combination	LSC1U-072/12	105 335 822
Clamp	12A2	106 230 337
Panel for Six ST Couplings	1000ST	105 392 005
Blank Panel	1000BX	106 924 483
Singlemode ST Coupling	C3000A-2	105 271 142
Splice Organizer	LT1A-F/F	105 339 899
Eight-Unit Splitter	D-181683	105 277 792
Lock Set	LGX	106 386 857
Door	11A	104 436 878
8.3 nm Singlemode 5' Pigtail Cable	1STA-5	105 380 703
FIS Fusion Splice	F1-1002	Fiber Instrument Sales

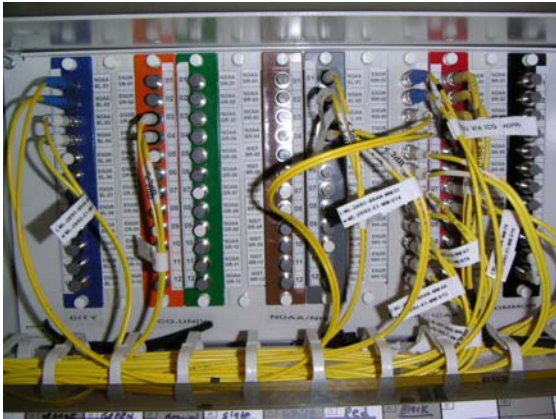
At each node along the cable path, the BRAN splice and connector patch panels are in the order of
 Incoming Connector Patch Panel
 Incoming Splice Box
 Outgoing Splice Box
 Outgoing Connector Patch Panel



The components used at all other locations are the following:

	Lucent Part Numbers:	
Fiber Optic Shelf Termination	LST1U-144/9	107 535 569

Panel for twelve ST Couplings	1200ST1-12	107 599 649
Blank Panel	1200BK	108 308 248
Singlemode ST Coupling	A3000	106 733 553
Fiber Optic Shelf Splice	LSS1U-144/7	105 335 772
Splice Organizer	LT1A-F/F	105 339 899
Eight-Unit Splitter	D-181683	105 277 792
Clamp	12A2	106 230 337
8.3 nm Singlemode 5' Pigtail Cable	ISTA-5	105 380 703
FIS Fusion Splice	F1-1002	Fiber Instrument Sales



The incoming fiber is always the fiber going towards the NCAR/UCAR Mesa lab site. The outgoing fiber is the cable going towards the NCAR/UCAR Foothills lab site. **However there is an exception at the CU Telecom location where the top panel goes to the City Atrium building and the bottom panel goes to CU Engineering.**

The installed conduits where new path shad to be installed for BRAN were installed in either four or eight conduit bundles throughout the BRAN system. A concrete slurry mixture was poured over the conduits in most path as they were being installed.

The conduit installed to house the fiber cable is the following:
Wesflex Pipe Manufacturing
1 1/4" Schedule 40 Conduit
Part No.: FC-47040H06

Meets Requirements of ASTM D 2447
Material: High Density Polyethylene per P34 of ASTM D 1248

Outside Diameter: 1.660 +/- 0.012 inches
Wall Thickness: 0.140 to 0.160 inches

All portions of the BRAN installation are labeled. The patch panels and splice boxes have a yellow tag with black lettering with the words BRAN on them. Manholes and major handhold locations have a BRAN cable label installed in them on each of the BRAN cables.

Part Note: NCAR recently ordered new pigtailed for the expansion of the NCAR fibers into CU Telecom and had problems purchasing them. The 5' pigtail is now from Avaya with a Prod ID: FPCWEPUC11-RF005, FPC Teraspeed ST UC 0.9mm pigtail RI, SER Feet 005.

Installation Standards

The BRAN fiber has been installed with longevity in mind. This cable plant is anticipated to last at least 20 years from the year it was installed, 1999. Therefore high quality has been chosen as the normal installation method.

All cables are/shall be spliced with an average loss of 0.1dBm. All connectors should have a maximum loss of 0.5 dBm. No connector imperfections are allowed. The fiber cladding/core termination on connector faces shall have no imperfections as shown in the picture to the right.



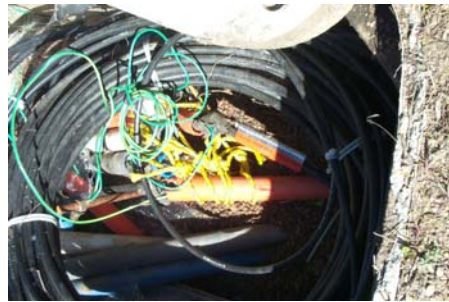
The following pictures display the proper setup for checking a splice box in a manhole.:



Below are pictures of the manholes/handholes which have splice boxes in them. The locations are: Renolds Library, City Center, and



Pearl & 33rd, Pearl & 47th.



Attachment of Patch Cables to BRAN

The BRAN fiber system uses ST style connectors and therefore requires much attention when a patch cable is connected to it. Single mode fiber is extremely sensitive to any obstructions or damage in the 9.0 um core of the fiber.

Always clean the patch cable fiber ends before insertion into the BRAN ST coupler bushing. The connector face should be clear of all dust and contaminants and have distinctive outlines. Use the pictures below as examples.



Check each connector face with at least a 200x power view scope to confirm that no imperfections are found.

Even if a connector is unplugged and then plugged right back in, dust and other contaminants can reduce performance. It is always a good idea to check the connector face before it is reinserted.

Modifications to BRAN

The BRAN technical and management committees have identified characteristics that should be observed whenever any modifications are performed.

Below are the requirements:

- Any new components shall be at least the same or higher quality
- If a spur is installed, all black fibers shall go in and out of the spur
- If a splice box is installed, it shall be water-tight with an over-closure if necessary

Appendix A

BRAN Member Cooperation Memo: April 1998

MEMO

TO: **The Boulder Research and Administrative Network (BRAN) Executive Group**

David Rhodes, City of Boulder Acting City Manager
John Buechner, President, University of Colorado
Richard Byyny, Chancellor, University of Colorado at Boulder
Kent, Goninger, Director, NOAA Boulder Labs
David Norcross, Director, Boulder NIST Labs
_____, UCAR

FROM: **Boulder Research and Administrative Network Working Group**

Britt Basset	--	NOAA
David Bickford	--	City of Boulder
Paul Franchois	--	NIST
Kent Groninger	--	NOAA
Bob Harberg	--	City of Boulder
Jerry Janssen--		NOAA
Caren Litvanyi	--	CU
Marla Meehl	--	NCAR
Bob Rhinesmith	--	City of Boulder
Darren Smith--		NTIA
Jim Van Dyke	--	NCAR
Richard Varnes	--	City of Boulder
David Wood	--	CU

DATE: **FOURTH DRAFT rsv4.2.98 (based on 3-11-98 BB draft)**

RE: **Joint Fiber Optic Project; "Fiber for a Healthy Future"**

I. SUMMARY

Representatives from the City of Boulder, The University of Colorado, and the Department of Commerce Laboratories have completed a series of initial meetings to determine and define the feasibility of an important fiber optic build extending from the NCAR Foothills site to the NCAR Mesa laboratories, with "stops" along the way that will provide key linkages, including:

- improved connectivity between City of Boulder facilities
- important connections between "off-campus" CU facilities and the main CU campus
- connectivity between CU and the new NOAA/NIST site
- connectivity between the new NOAA/NIST site and the NCAR Mesa lab

The Boulder Research and Administrative Network (BRAN) working group is extremely pleased to report that a high degree of cooperative effort between all the

institutions involved has resulted in a preliminary determination that the project is desirable, feasible and affordable -- if we all continue to work together.

The purpose of this memo is to:

1. Advise the Executive Group concerning the status of the project, including a project map and description (ATTACHMENT A) and preliminary cost/cost allocation estimates (ATTACHMENT B).
2. Request Executive Group assistance in identifying potential unaddressed issues regarding the project.
3. Request Executive Group approval of putting the project out to bid (including preparation of bid documents).
4. Look toward final Executive Group approval of project implementation (pending receipt of actual construction bids, necessary intergovernmental O&M agreements and a final cost allocation).

We hope you agree that the proposed joint effort offers an unprecedented “win-win” project for our individual organizations and the citizens we serve.

II. BOULDER RESEARCH AND ADMINISTRATIVE NETWORK MEMBERS

The current members of the BRAN consortium are:

- The City of Boulder (The City)
- The University of Colorado (CU)
- The National Center for Atmospheric Research (NCAR)
- The Department of Commerce (DOC) Boulder Laboratories:
 - National Oceanic and Atmospheric Administration (NOAA)
 - National Institute of Standards and Technology (NIST)
 - National Telecommunications and Information Administration (NTIA)

III. THE VISION

The Boulder Research and Administrative Network (BRAN) is a project to provide a significant, local, next-generation, fiber optic, networked infrastructure that will give the public service institutions in Boulder, Colorado a competitive advantage in research, higher education, and administrative functions.

IV. THE GOAL

The BRAN project is a cooperative effort by public service institutions in Boulder to improve the network infrastructure among their locations.

The goal of the project is to build a fiber optic infrastructure that will be used to establish network links between the various sites of each organization, and among the organizations. This task is difficult, if not impossible, to accomplish by any of these entities acting alone, but can be completed through a cooperative effort.

The network links will result in an enhanced ability for each of the organizations to conduct their business, as well as an enhanced ability for these institutions to serve the public.

The completion of the BRAN project is an important step toward making Boulder a visible, nationwide example of a community with an excellent network infrastructure.

V. THE PROJECT

The BRAN working group has arrived at the following tentative project description:

The build will extend along a north-south corridor with the NCAR Foothills lab as the northern terminus and the NCAR Mesa lab as the southern terminus.

From north to south, the fiber will extend from NCAR Foothills past the City's Pearl Street Maintenance Facility and CU's main computing center, through the CU campus and south to the new NOAA/NIST building and on to south Boulder and the NCAR Mesa lab. The basic construction method will consist of installation of two conduits: one a "research community conduit" that will extend the entire length of the route and the other a "city conduit" that will duplicate much, but not all of the trunk route -- the northern terminus being the City Yards and the southern terminus being (at this time) the Reynolds Branch Library.

VI. BACKGROUND

Today the exchange of information over computer networks has become one of the primary tools for an organization to conduct its business. Networks have allowed for an enormous increase in functionality over stand-alone computers and include such applications as distributed computing, client/server computing, electronic communication, remote system access, real-time project collaborations, enhanced information retrieval and delivery, real-time data visualization, and, of course, the Internet and the World Wide Web.

If the network shuts down, the business shuts down. Whether the business is primarily research, administration, or commerce, computer networks are essential. While the evolution of networking as a way of doing business is still underway, it is clear that networks will increase in importance, and future applications will require even more reliable and high-speed networks than are operational today.

Although Boulder is a relatively small community, it has several national research centers, a major research university, a City government interested in enhanced productivity through technology, and general support of "high tech" businesses among its citizens. These combined assets provide a community in which the BRAN project will have significant benefits for modest effort and cost.

Preparing the network infrastructure of the Boulder community to meet the challenges of the 21st Century is an important task that is gaining attention in all levels of government. From the introduction of the Federal Next Generation Internet Initiative:

The Internet is the biggest change in human communications since the printing press. Every day, this rapidly growing global network touches the lives of millions of Americans. Students log in to the Library of Congress or take virtual field trips to the Mayan ruins. Entrepreneurs get the information they need to start a new business and sell their products in overseas markets. Caregivers for people with Alzheimer's Disease participate in an "extended family" on the Cleveland FreeNet. Citizens keep tabs on the voting records and accomplishments of their elected representatives.

We must invest today to create the foundation for the networks of the 21st Century. Today's Internet is an outgrowth of decades of federal investment in research networks such as the ARPANET and the NSFNET. A small amount of federal seed money stimulated much greater investment by industry and academia, and helped create a large and rapidly growing market. Similarly, creative investments today will set the stage for the networks of tomorrow that are even more powerful and versatile than the current Internet. This initiative will foster partnerships among academia, industry and government that will keep the U.S. at the cutting-edge of information and communications technologies. It will also accelerate the introduction of new multimedia services available in our homes, schools, and businesses.

VII. BENEFITS OF THE PROPOSED PROJECT

- Advanced networks among the research organizations will improve collaborations, allow research that cannot currently be done on the networks in operation today, reduce the time needed to obtain results, as well as help in obtaining research grants.
- A City government with all of its facilities network connected will provide better service to its constituents.
- An established fiber optic network infrastructure will help attract funding from, and connections to, important national network programs such as the Next Generation Internet (NGI), NASA Internet (NI), and Internet2.
- An established fiber optic network infrastructure provides the flexibility to quickly support new projects and to quickly modify network functionality as needed.
- An enhanced and strengthened research community means a continued ability to retain high quality jobs that benefit the city economy.
- Increased capability for telecommuting and video conferencing will result in a reduction in the number of driving trips between sites.
- In addition to immediate benefits, the BRAN project provides a good opportunity for inter-governmental cooperation that can be built on when future cooperative opportunities arise.

VIII. NEXT STEPS

If, as the chief administrative officers of each participant organization, you agree that the joint effort offers an important opportunity to better serve the public by advancing our individual and collective communications resources, we request that you, the "Executive Group", direct the BRAN working group to:

- 1) put the project out for competitive bid
- 2) present the project to the Executive Group for final approval, pending construction bids that meet the agreed upon budget, and the successful conclusion of intergovernmental agreements on operation and maintenance and cost allocation.

We recommend prompt action on this opportunity by the Executive Group in order to meet the desired completion date of 12-31-98 for connection of the new DOC south Broadway lab complex to the BRAN network.

BRAN

Context and Guiding Principles

Context

- The project, associated network, and managing entity will be called “BRAN,” for Boulder Research and Administrative Network.
- There will be four Parties initially—all non-profit, public service organizations:
 - local government (City of Boulder);
 - state government (University of Colorado in Boulder);
 - federal government (Department of Commerce Boulder Laboratories); and
 - federally-sponsored (UCAR/NCAR).
- There is a strong mutual interest among the Parties for an interconnecting, advanced, network.
- The network infrastructure will consist of a multi-strand, fiber optic cable in a single, underground conduit that will be either in a trench or a steam tunnel.
- When new trenches for the BRAN network are being dug, whenever feasible and desirable, extra, empty, conduit will be placed by the Parties for future unspecified usage.
- The initial network, which is about 11 miles in length, will run exclusively through rights-of-way controlled by the Parties within the limits of the City of Boulder.
- The initial network will take advantage of significant infrastructure already in place.

Guiding Principles

1. BRAN shall exist as an unincorporated managing entity for the purposes of constructing, managing, and maintaining the BRAN network. BRAN is not a public utility.
2. BRAN will be used by the Parties for voice, data, and video transmissions (including connections to third parties) in support of their respective missions, consistent with federal and state laws.
3. A Management Committee, consisting of a representative of each of the Parties, will govern BRAN.
4. An Executive Committee, consisting of the senior decision-making executive of each of the Parties, will provide policy direction to the Management Committee for BRAN.
5. There shall be no City franchise fees for a Party’s use of the BRAN network that is consistent with the Party’s respective mission.

6. The Parties shall not be liable to the other Parties for any physical damages to the BRAN network, except to the extent caused by gross negligence or willful misconduct.
7. BRAN will not own anything—ownership of all capital resources will be fully divided among the Parties.
8. BRAN will have initially a minimum of 96 fibers on all network segments—divided initially as 12 fibers to the City and 28 fibers to each of the other three Parties.
9. All new conduit installed by BRAN in a Party's right-of-way will be owned and controlled by the respective Party. The conduit containing the BRAN fiber cable will be managed by the BRAN Management Committee.
10. Contractors working within a Party's right-of-way shall be subject to the respective Party's advance approval.
11. Construction work shall be performed in a timely manner to minimize inconvenience to the BRAN members.
12. All construction work is subject to inspection by the Parties.
13. The City will maintain a repository of as-built drawings of the BRAN network infrastructure.
14. BRAN network construction costs will be shared equitably among the Parties.
15. Based on current cost estimates, the City's share of the initial construction cost will be provided via the contribution of its large, existing, infrastructure and the free use of its rights-of-way for the BRAN network.
16. Maintenance expenses will be shared based on the proportional number of fibers owned by each Party.
17. "Extensions" to the BRAN network may be added by unanimous approval of the Parties and become part of the BRAN network.
18. "Spurs" may be added to the BRAN network by any Party or Parties, but do not become part of the BRAN network. All Parties agree to cooperate as appropriate on the development of future spurs. For example, CU and the City intend to collaborate on future spurs *to CU properties through City rights-of-way*.

19. Developers of spurs must:
 - obtain appropriate right-of-way permits;
 - pay construction and maintenance costs; and
 - accept responsibility for any damages to the BRAN network caused by the addition of a spur.
20. The City shall grant use of its rights-of-way for existing CU spurs.
21. A Party wishing to sell one or more of its fibers must first offer the fiber(s) to the other Parties. In the event of a sale to a third party, that party then becomes a BRAN member and a Party to the BRAN agreement.
22. Fiber ownership exchanges between Parties will be transacted at a unit price not to exceed the original construction cost per fiber (including the City's in-kind contributions), plus adjustments made for inflation (e.g., CPI).
23. Parties may connect their fibers to third parties and may charge for such connections as long as the use is consistent with the respective Party's organizational mission.
24. Terms and conditions of the sale or lease of "dark fiber(s)" (i.e., fiber that is unconnected to a BRAN Party) to a third party must be unanimously approved by the Management Committee and must be consistent with the terms and conditions of the BRAN agreement.
25. At all times there will be a "Lead Party," which shall act as agent of the other Parties by maintaining, repairing, and replacing the network and for keeping the Parties informed of the status of these activities.
26. The Lead Party shall ensure that all contractors have adequate insurance, consistent with the requirements of the BRAN property and right-of-way owners.
27. The Lead Party shall maintain membership in the Utility Notification Center of Colorado.
28. All BRAN costs incurred by the Lead Party in performing its duties shall be actual and verifiable and shall be paid by the Parties through a maintenance fee proportional to the number of fibers owned.
29. The BRAN books and records maintained by the Lead Party shall be open to audit.
30. The Lead Party may be changed at any time by a majority vote of the Management Committee.
31. The Management Committee may suspend or terminate the agreement with the Lead Party based on the Lead Party's non-performance. Notice of termination for default must be given in writing with the opportunity to cure.

32. The City will serve as the initial Lead Party, and in addition to the general responsibilities identified above, will oversee the design, bidding, procurement, and construction of the initial network.
33. A Party wanting to relocate any portion of the network shall give the Lead Party 120 days notice and pay the full costs thereof.
34. Any Party may leave BRAN by abandoning its rights, title, and interest in its BRAN fibers and by giving them back to the remaining Parties.
35. Disagreement regarding interpretations of provisions of the agreement shall be resolved by the Management Committee within 30 days. If still unresolved after 30 days, the disagreement will be presented in writing to the BRAN Executive Committee for resolution.
36. All legal disputes will be resolved according to the laws, practices, and statutes of the State of Colorado.

Appendix B - Modifications to BRAN

George Renolds Branch Library - Spur

Date: 1999 - 4 blue Fibers and all black fibers installed

ICG Boulder Point Of Presence - Extension

Date: 2002 - All Fibers terminated and patched

Any group can now purchase ICG services with incurring a "local loop" charge

CU 1770 Exposition - Spur

Date: ?

Specific fibers pulled out of bundle?

CU Telecom Building

Date: 2/7/04

City Blue fiber 1-4 pigtailed to ST connectors

NCAR Red Fiber bundle pigtailed to ST connectors

Note: Patch panel order is reversed. City Atrium is on top and CU Engineering on bottom

Others?

Appendix C - Work performed on BRAN

Activation of Network

Date: 1999 - BRAN is operational

Hand holes checked

Date: ?

Manholes checked

Date: ?

Web site Updated

Date: December 2003

Route diagram updated.