Local Area, Metropolitan Area, and Wide Area Networking

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Network Engineering and Telecommunications Section (NETS)

- NETS moves your bits - email, web searches, big data, hangouts, phone calls, etc.
- Manage all NCAR/UCAR networking and phones
- Manage the regional networking for Colorado and Wyoming named the Front Range GigaPoP and Bi-State Optical Network
- 23.8 staff including network engineers, technicians, software engineers, accountants, and administrative staff
Almost all networks today are constructed with fiber optic cable: Fiber optic cable is a high-speed data transmission medium. It contains tiny glass or plastic filaments that carry light beams. Digital data is transmitted through the cable via rapid pulses of light. The receiving end of a fiber optic transmission translates the light pulses into binary values, which can be read by a computer.

Because fiber optic cables transmit data via light waves, they transfer information at the speed of light.
Networking Organizational Structure

- **Local Area Network (LAN)**
  - Within and intra-UCAR campuses
- **Metropolitan Area Network (MAN)**
  - Boulder Research and Administration Network (BRAN)
- **Wide Area Network (WAN)/Regional Optical Networks (RONs)**
  - Front Range GigaPoP (FRGP)
  - Bi-State Optical Network (BiSON)
  - Western Regional Network (WRN)
  - Internet2 (I2)
Boulder Research and Administration Network (BRAN) – January 2000
“Fiber for a Healthy Future”

- [http://www.branfiber.net/](http://www.branfiber.net/)
- Partners a the City of Boulder (the City), the University of Colorado at Boulder (CU), the National Center for Atmospheric Research (NCAR), and the Department of Commerce Laboratories (DOC)
- BRAN provides a significant, local, next-generation, fiber optic infrastructure that gives the partners a competitive advantage in research, higher education, and administrative functions
- The network links greatly improve the ability of each of the partner organizations to conduct their business, as well as enhance their ability to serve the public
- The fiber network is over 15 miles in length
- Expanded fiber via BVSD partnership in 2009
- Enables NEON, UNAVCO, City of Boulder connections to the FRGP
Front Range GigaPoP (FRGP)

- [http://www.frgrp.net](http://www.frgrp.net)
- The FRGP enables advanced scientific research and education, supports experimental and production networks, fosters networking and application research, and facilitates interconnectivity among regional, national, and international high-performance research and education networks
- 17 years of operation
- Started new 5-year agreement cycle 7/1/14
What is the FRGP – Cont’d

- The FRGP is a consortium of Universities, research organizations, non-profit corporations, government agencies, cities, counties, States, and K-12s that cooperate to share wide area networking services including Internet2, intra-FRGP, commodity Internet, caching, and peering connectivity

- UCAR provides the management, engineering, and network operations center support for the FRGP
Why UCAR manages the FRGP

- UCAR has been a leader in regional and national networking since 1986
- Participated in Westnet, NSFnet, vBNS, Big Pipe Consortium, I2, NLR, Quilt, etc.
- Trusted by the community
  - Unbiased
  - Non-competitive
  - Strong engineering skills
FRGP advantages to UCAR

- Significantly faster and more cost effective networking than UCAR could afford alone
- Access to caching and peering resources that UCAR could not garner alone
- Significant local, regional, national recognition
- Extensive local, regional, national technical and managerial collaboration, which is critical to stay current in high tech
- FRGP funds 4.2 NETS staff that share expertise and UCAR workload
- Access to NSF and DOE networking funding
- Strong strategic element for UCAR for the recompete in leadership in IT and WAN services
FRGP Benefits

- FRGP participants, including UCAR, typically enjoy reduced costs, shared expertise, shared services, increased buying power, and economies of scale.

- Aggregated and direct intra-participant network access - “what happens in the FRGP stays in the FRGP”

- Provides connectivity to the Internet2 network
  - Either directly for Internet2 members or qualifying community anchor institution via the US UCAN program
  - 100Gbps to Chicago, 100Gbps to Los Angeles, 100Gbps to Seattle
FRGP Benefits

- Direct peering connections including Comcast, Google, CoreSite Any2, and the Energy Sciences network (ESnet)
- TransitRail (TR)/Commercial Peering Service (CPS) managed by Internet2 - over 80 select entities
  - Internet2 members have commercial traffic needs, too, for traffic that can’t be carried by other services, e.g. email to IBM or SGI via Teliasonera or Level3
  - Offers a low cost path with higher performance goals than commercial alternatives
  - Carries 30-50% of FRGP traffic
- Provides caching services as part of the Akamai and Netflix (carrying ~10Gbps)
FRGP Benefits

• Access to multiple commodity Internet service providers at 10Gbps offering resiliency and diversity
  – TeliaSonera and Level3

• Traffic aggregation and FRGP membership in The Quilt, Inc. provide cost savings for commodity Internet services

• Supported a doubling in traffic growth every 2-3 years since inception

• Currently serves approximately one million users whose organizations participate in the FRGP research and education community in Colorado and Wyoming

• Multiple locations to terminate circuits for redundancy
FRGP participant and service connection overview

- Google (peering)
- CoreSite Any2 (e.g., Apple, Microsoft - peering)
- Bi-State Optical Network (BiSON-North)
- Level3 (commodity)
- Energy Sciences Network (es.net - peering)
- Telia Sonera (commodity)
- BiSON-Golden and BiSON-South
- frgp.net (info/stats)
- NOC (24x7)
- Netflix (caching)
- TransitRail/Commercial Peering Service (TR/CPS - peering)
- Akamai (caching)
- Comcast (peering)
- Internet2 (national R&E)
- Western Regional Network (WRN)

Level3 colocation
910 15th Street

UC-Denver colocation
1200 Larimer Street

Level3 colocation
1850 Pearl Street

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Current FRGP voting participants - 11

- Colorado School of Mines
- Colorado State University - Fort Collins
- National Oceanic and Atmospheric Administration - Boulder
- State of Colorado
- University Corporation for Atmospheric Research (UCAR/NCAR)
- University of Colorado - Boulder
- University of Colorado - Colorado Springs
- University of Colorado - Denver
- University of Denver
- University of Northern Colorado
- University of Wyoming
FRGP participants – non-voting - 20

- Auraria Higher Education Center
- Colorado College
- Colorado Community College System
- City of Boulder
- Colorado Department of Higher Education
- Colorado Mountain College
- Colorado State University - Pueblo
- Colorado Telehealth Network
- Community College of Denver
- Educational Access Gateway Learning Environment Network
- Johnson & Wales University
- Fort Lewis College
- I2-USDA
- JeffcoSD
- Metropolitan State University of Denver
- University Information Systems (CU system)
- NEON
- NREL
- State of Wyoming
- University NAVSTAR Consortium (UNAVCO)
Bi-State Optical Network (BiSON)

- The Bi-State Optical Network, or BiSON, is a collaboration of research and educational institutions in Colorado and Wyoming that utilize long-haul fiber for high performance optical networking.
- BiSON participants receive robust, redundant access to regional and Wide Area Network (WAN) services.
- BiSON agreement part of FRGP agreement.
Western Regional Network (WRN)

- The Western Regional Network is a multi-state partnership to provide advanced, robust high-speed networking for research, education, and related uses. WRN is a collaboration of the Pacific Northwest GigaPoP (PNWGP) in Washington, the Front Range GigaPoP (FRGP) in Colorado, the University of New Mexico on behalf of the State of New Mexico, the Corporation for Education Network Initiatives in California (CENIC), and the University of Hawaii.
- Share Internet2, intra-WRN, and commodity Internet
- Access to Pacific Wave
Internet2 Membership

• **Affiliate - 54 Members**
  – Non-profit research or education organizations
  – UCAR and NOAA here

• **Corporate - 41 Members**
  – For-profit companies

• **Research and Education Network - 32 Members**
  – Network infrastructure providers to R & E community

• **University – 211 Members**
  – United States institutions of higher education
Discussion

✧ Any follow up questions or feedback?
✧ Other items?