

# An Integrated Approach to Facilitating Network and Computational Research at the University of Utah

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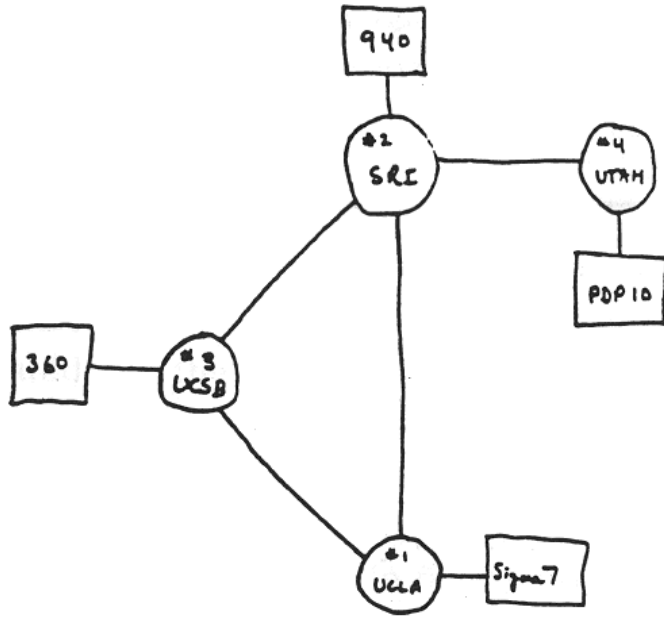
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GEC18 – GENI Engineering Conference

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# Fourth node on the ARPANET – 1969



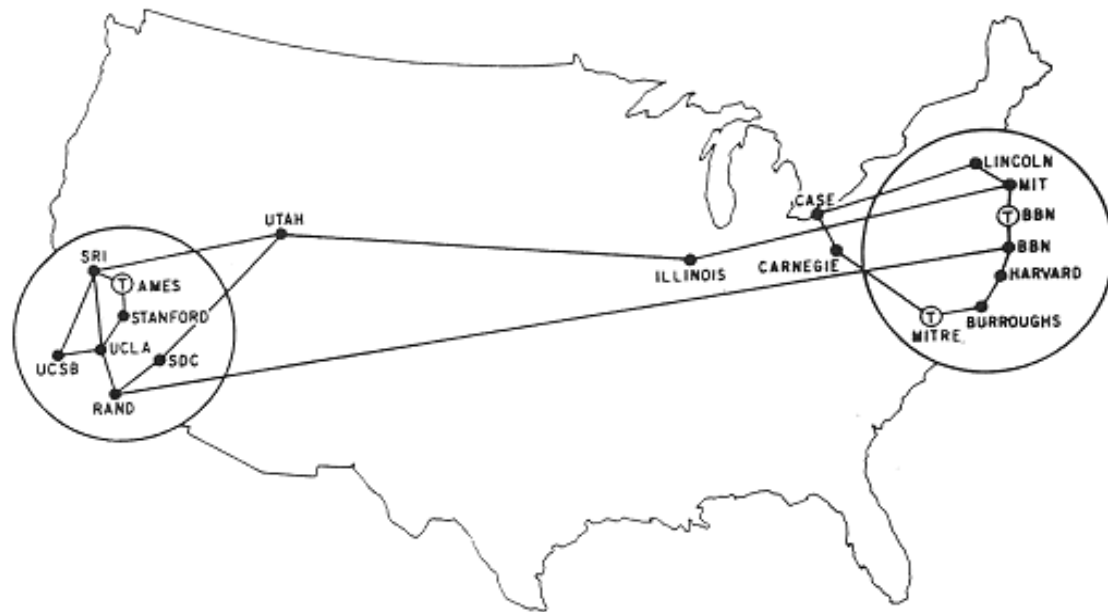
THE ARPA NETWORK

DEC 1969

4 NODES

FIGURE 6.2 Drawing of 4 Node Network (Courtesy of Alex McKenzie)

ARPANET (1969-1980)  
 Univ. of Utah Computer Science Department  
 (now School of Computing)



MAP 4 September 1971

# Network research facilitation leverages highly collaborative environment

- **SoC Flux research group (Ricci, Eide, Van der Merwe)**
- Center for High Performance Computing (Breen)
- University IT
  - CIO Office (VPIT Denna, Corbató),
  - Infrastructure (Elieson)
  - Security (Bowden)
- VP for Research (VPR Parks, Furse)
- Utah Education Network (Stewart, Quire)
- Utah NSF EPSCoR (Teutonico, Crawl, Jones)
- Internet2 (Vietzke, Wolff)

# Research infrastructure development

- Downtown Data Center
- Campus Network Upgrade and Science DMZ
  - **NSF CISE CC-NIE**
- Metro SLC/Northern Utah Optical Network
  - NSF EPSCoR RII Cyber Connectivity
  - NTIA BTOP (UEN)
- **UEN GENI Spiral 3**
- Network research/computational science
  - Apt: NSF MRI Instrument Development (Ricci)

# New off-campus data center

- 74,000+ sq ft<sup>2</sup> former industrial building south of downtown SLC (~4 miles off-campus)
- Designed for both enterprise & HPC (2.4 MW)
- Co-location by research groups & partners
- Low industrial electric power rates in Utah
- Energy efficient design (low PUE)
- In operation since spring 2012



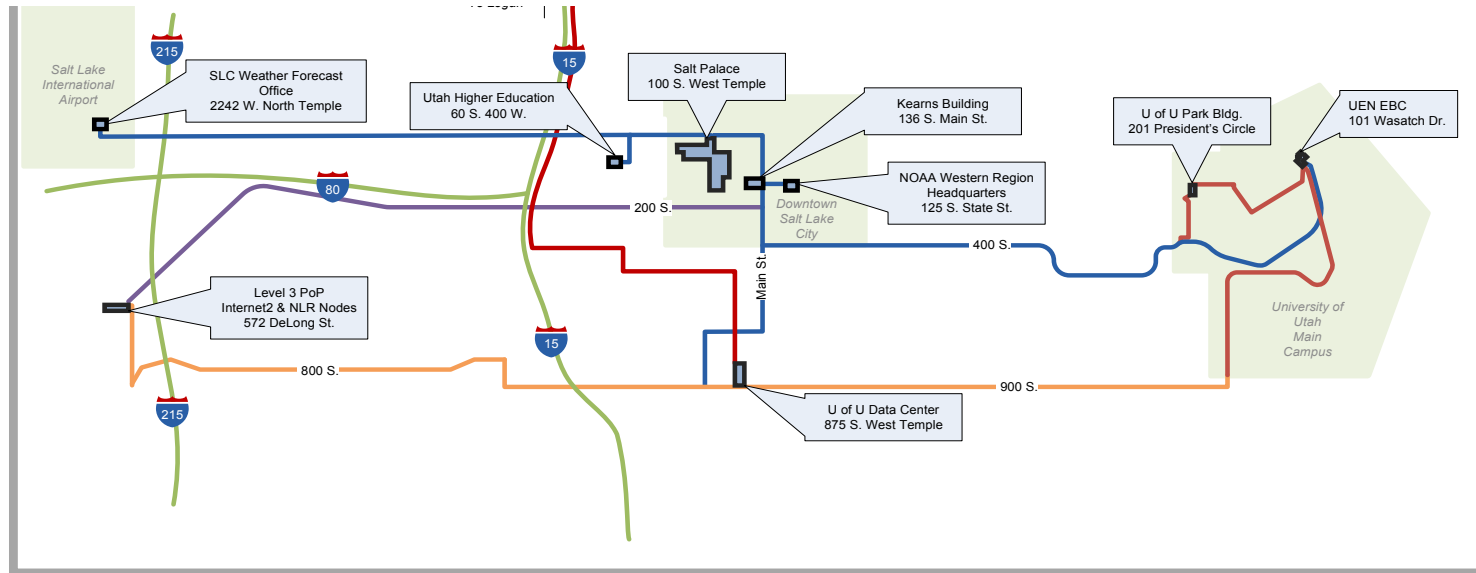


# Regional Optical Network Development in Utah



- Collaboration of Utah Education Network (UEN) and University of Utah
  - Leverage UEN operational capability & statewide reach
- Leverage public sector partner assets (fiber & conduit) wherever possible
  - UDOT (highway RoW)
  - Utah Transit Authority (UTA/TRAX light rail)
- Work with wholesale oriented carriers (Zayo, Syringa)

# SLC metro optical network



**Research@UEN: Salt Lake City Metro Optical Network**

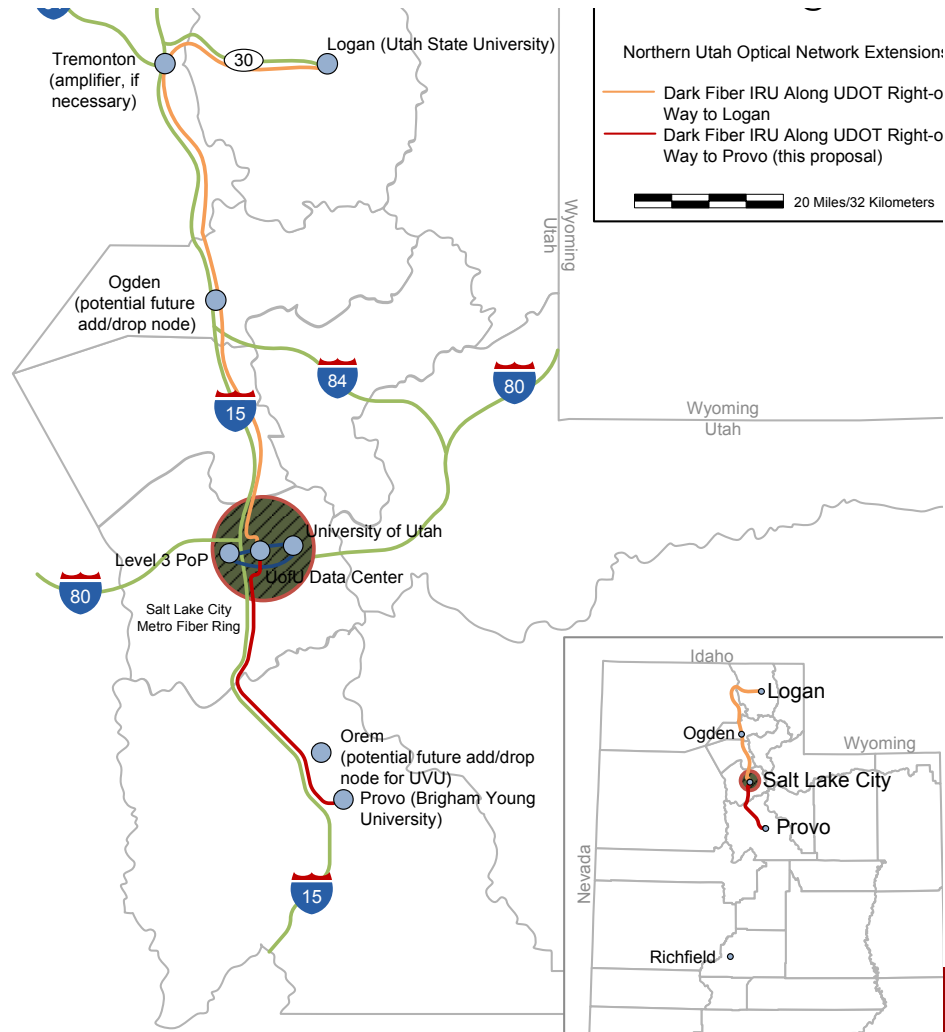
- U of U Campus Fiber
- UTA Light Rail Routes (proposed)
- CENIC/LLC Fiber IRU (through AFS)
- AFS Fiber IRU (proposed)
- Northern Utah Extension (proposed)

1 Mile

Carrier proprietary information included



# Optical network extensions to Logan and Provo for USU, BYU and UVU



# UEN GENI: Yr 1-2 Results

- 3-year award starting September 2011
- Deployed fiber and lambdas between EBC PoP and Level3 PoP
- Deployed Switch in UEN EBC PoP
- Deployed fiber and lambdas between EBC PoP and DDC PoP
- Deployed Switch in UofU Downtown Data Center
- Brought up 34 node InstaGENI rack in DDC with ProtoGENI group

# UEN GENI: GENI S3 Year 3

- Extend GENI capabilities to USU & BYU
- Extend GENI capabilities to a Utah charter high school (Utah County Academy of Sciences)
- Continue GENI collaboration with University of Idaho and IRON

# Utah CC-NIE award

- “Science Slices Converting Network Research Innovation into Enhanced Capability for Computational Science and Engineering at the University of Utah”
- Collaboration of Flux research group & CHPC
- Funded under Network Integration and Applied Innovation track – Oct 2013 start
- Implementing ProtoGENI/GENI research outcomes in production science environment

**“What if we turned things upside down and placed the Science DMZ on top of SDN infrastructure?” – Prof. Rob Ricci, University of Utah**

**Implication: Make the Science DMZ a slice**

**UTAH CC-NIE PROJECT**

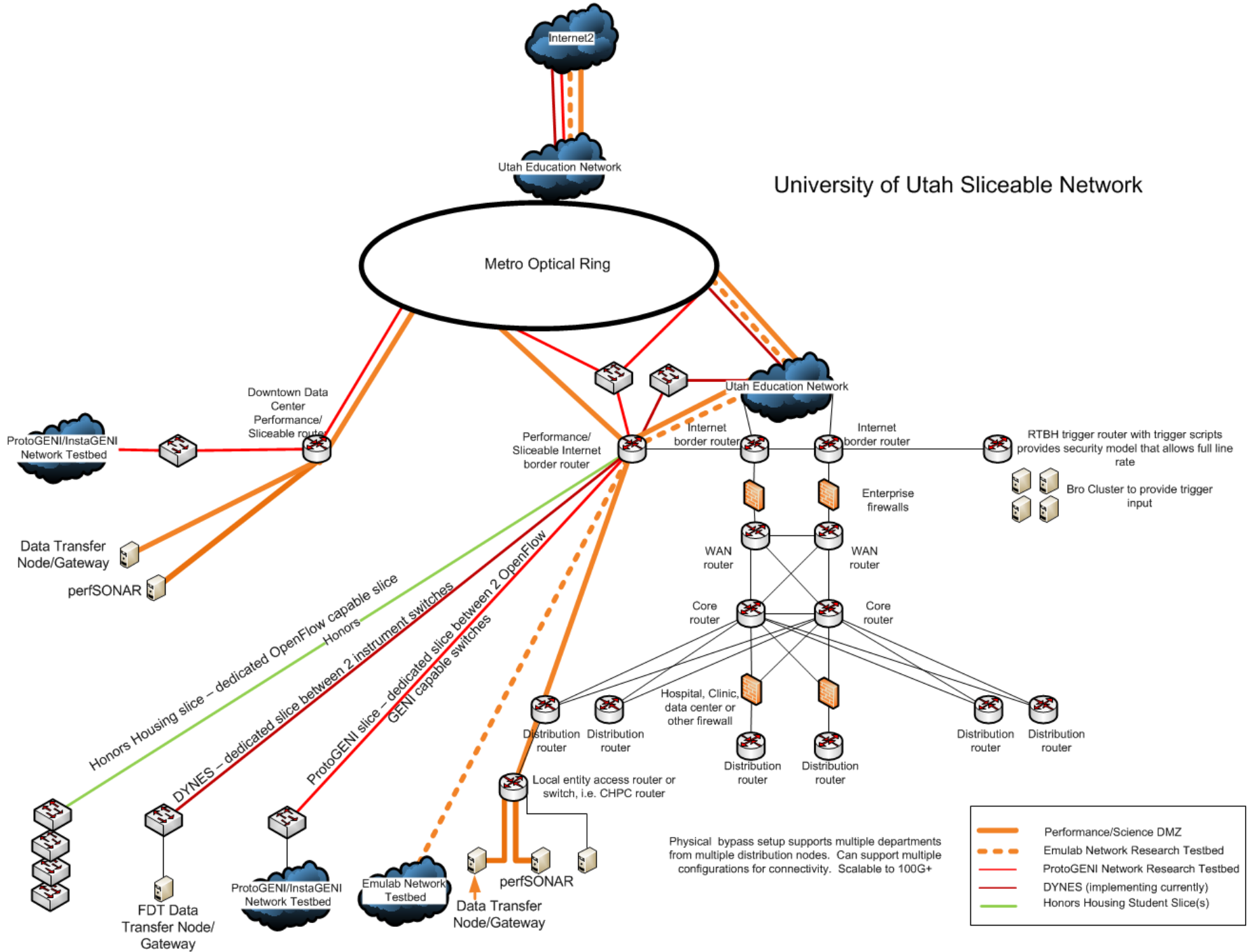
# A perspective

- A “slice” is really a conceptual idea as well as an implementation
  - A virtual overlay network with unique security, performance and other characteristics

# Slices enable flexibility

- Science DMZ as a Slice
- Network Research as a Slice(s)
- Honors Student Housing as a Slice
- Different slices – different contexts

# University of Utah Sliceable Network





# Science DMZ as a slice

- Science DMZ defines a separate egress at the border and a section of the network for a set of known Data Transfer Nodes (see <http://fasterdata.es.net/science-dmz> )
  - Easy to define for HPC resources at data center
  - Easy to define for certain known research groups where we can reach with dedicated fiber.
  - What about ephemeral Data Transfer Nodes?
  - What about individual Research areas in campus connected to instruments that normally have network security constraints (e.g., PHI)?

# Domain Science is not always constrained to the Data Center

- UofU needs deeper and dynamic penetration of the Science DMZ into campus network
  - Example #1: Huntsman Cancer Institute (HCI) genomic sequencers to CHPC computational resources
  - Example #2: Need dedicated path to pathology lab (ARUP) equipment which resides in a different domain on campus

# How to balance these slices?

- Large bandwidth slice with other slices? Do we still egress on dedicated ports on a switch? (Both intra-and inter-campus) Is backbone overprovisioning adequate?
- How to deal with security for sensitive flows?
- How to monitor substrate and individual slices – what information do campus and regional operators need and how to expose?
- What are the best mechanisms to implement security within slice?

# We can't do this without tremendous partners!



- Utah Education Network (UEN)
- Utah State University
- Brigham Young University
- Weber State University
- Utah Valley University
- Utah Transit Authority (UTA)
- Utah Dept. of Transportation (UDOT)
- Utah Dept. of Technical Services (DTS)
- Governor's Office of Economic Development (GOED)
- EDCUtah
- Salt Lake City Corporation.
- Utah EPSCoR – iUTAH and CI-WATER
- USTAR
- Salt Palace Convention Center
- Internet2
- University of Montana
- Idaho Regional Optical Network (IRON)
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