

# ***NSFNET: The Community***

29 November 2007

Moderator: Doug Gale

Panelists: J. Mark Pullen, Sidney Karin,  
Richard Mandelbaum, Doug Gale, Glenn  
Ricart, Jim Williams, Henry E. Schaffer

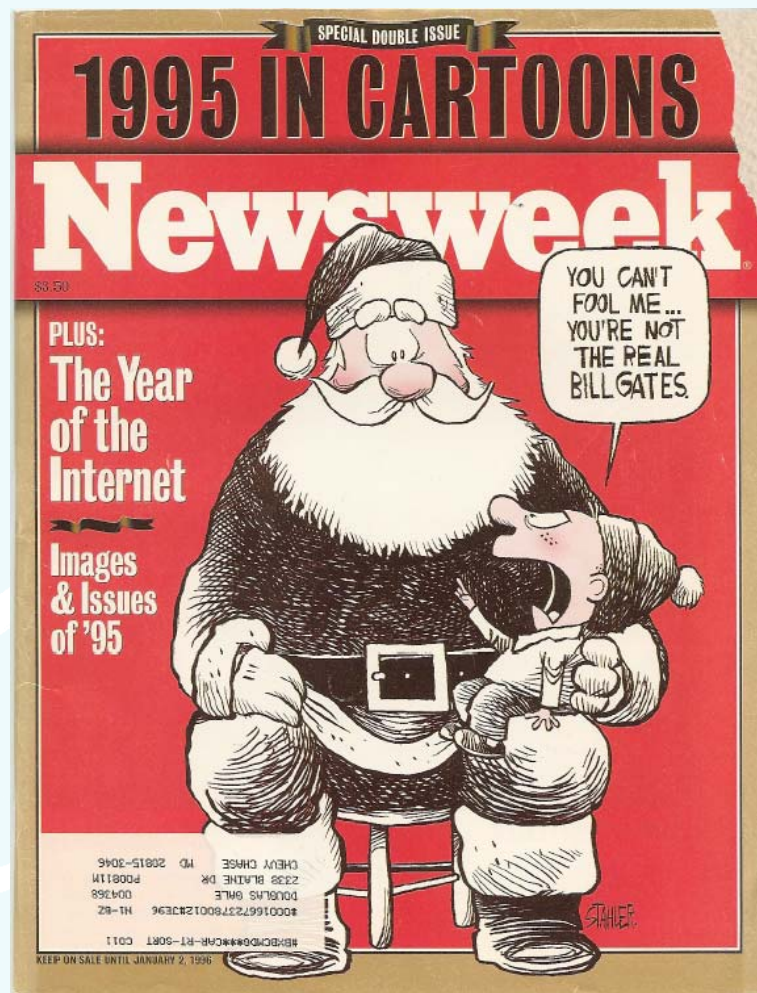


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# How Did We Get From

- 213 hosts in 1981  
to
- between 700,000 and 3.2 million hosts connecting somewhere between 2.5 to 32 million people in 1994?  
or stated differently
- How did we get on the cover of Newsweek?



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*How phasing out ARPANET  
helped NSFNET spawn the  
commercial Internet*

Dr. Mark Pullen  
Director, GMU C<sup>4</sup>I Center  
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# ARPANET Came First

- ARPANET was the first large-scale packet network
  - Existence proof for packet networking advantages
  - Over the years it came to support DARPA's stable of world-class academic and industry researchers
- DARPA Internet project used ARPANET as its core
  - Showed scalable network of networks to be feasible
  - Deployed and validated TCP/IP
  - Interconnected with DoD MILNET, NASA and DoE scientific computing networks
  - Adding NSFNET enabled extension to many early-adopter universities



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# Victim of Its Own Success

- Pullen took over management of ARPANET/Internet projects 1987
  - Had become infrastructure for DARPA research community
  - Cost was consuming the research budget
- Management challenge - what to do ???
- Good time for a brash Army officer to make a “command decision”
  - Shut down ARPANET (!)
  - Transition the sites to NSFNET regional networks
  - Which seeded the commercial Internet



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# Transition Brought Much Success

- DARPA got its network research budget back
  - Pullen got some great experience
- Having the premier research players onboard stimulated growth of NSFNET
- DARPA, NSF, NASA and DOE found common cause encouraging growth
  - Federal Research Internet Coordinating Committee
  - Early growth of worldwide Internet



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# *NYSERNet: 1985-89*

Nov 29, 2007

Richard Mandelbaum



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# NYSERNet: The Concept

- Q1 1985                      Results of NSF Supercomputer Solicitation Announced
  - 4 New York State institutions are members of winning consortia
- Q2 1985                      Joint Government-Industry-Academe NYS Networking Conference decides to form NYSERNet
- 1986                          NYS S & T Foundation, NSF, NYTel, and Rochester Tel, fund NYSERnet



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# NYSERNet: The Network

- Q1 1987 Initial segment of NYSERNet goes live
- Q3 1987 Full T1 network connecting all 15 founding institutions goes live
- 1988 NYTEL decides to stop funding NYSERNet and donates Routers
- 1989 First (of 3) commercial providers established by NYSERNet founders



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# NYSERNet: Some Lessons

1. Industry-Government-Academe Cooperation
2. Advances in Technology – SNMP
3. Advances in Policy – NYSERNet AUP
4. Cooperating at a National Level
5. Lessons not Learned: The NYTel experience



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# *MIDnet*

Doug Gale

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# What Were We Talking About in 1985?

- Supercomputer Access
  - Phase One Centers
  - Phase Two Centers
    - JVNC
    - SDSC
    - NCSA
    - Cornell Theory Center
    - PSC
- Arpanet
- USAN
- BITNET
- NSFNET
- Regional Networks
  - MIDnet, unsolicited proposal late 1985

## NSF Initiatives to Support Supercomputing

### Phase One Supercomputer Sites

### Phase Two Supercomputer Sites

### Expand ARPANET

- Now 20-25 Universities Connected
- Expand to top 40 research universities
- Upgrade existing links

### Experiments with satellite links

- Vitalink
- Ku Band
- About 50K per station
- Bridge between Ethernets
- USAN

### BITNET Migration Project

- Ira Fuchs (Princeton)
- Lawrence Landweber (Wisconsin)
- David Farber (Delaware)
- Connect three universities with WISNET
- Implementation of TCP/IP for RSCS machines
- Connect major BITNET hubs by 56 kbs
  - √ CUNY
  - √ Wisconsin
  - √ Ohio State
  - √ Maryland
  - √ Cornell
  - √ Boston University
  - √ Pennsylvania
  - √ TUCC

### NSFnet

- 56 kbs
- TCP/IP
- Six Hubs
  - √ San Diego
  - √ NCAR
  - √ Illinois
  - √ Pittsburgh
  - √ Princeton
  - √ Cornell
- Internet

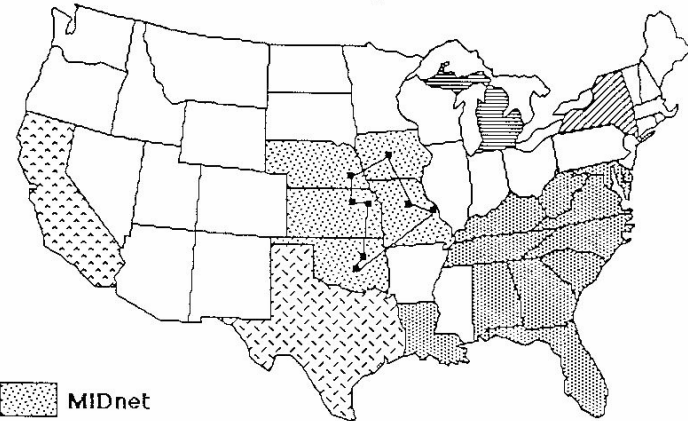
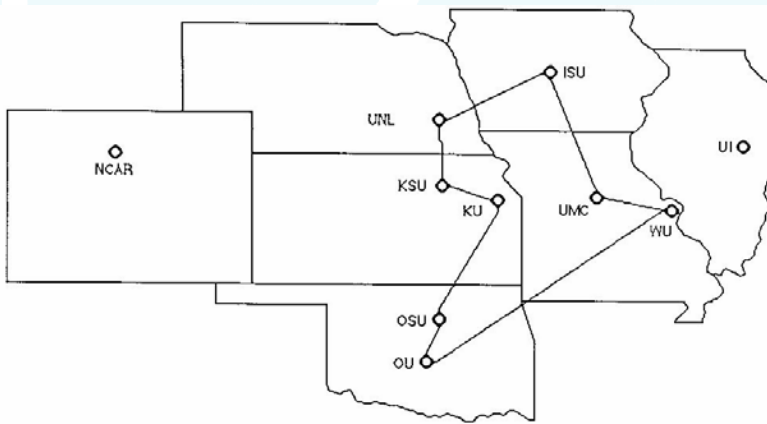


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# What Were We Talking About in 1986

- NSF funded proposals from MIDnet, SURAnet, and NYSErnet
- Followed by funding for BARRnet, SESQUInet, and MERIT
- Lines on a map



**MIDnet**

- Iowa State Un. (Ames)
- Kansas State Un. (Manhattan)
- Oklahoma State Un. (Stillwater)
- U. of Kansas (Lawrence)
- U. of Missouri-Columbia (Columbia)
- U. of Nebraska-Lincoln (Lincoln)
- U. of Oklahoma (Norman)
- Washington U. (St. Louis)

**SURAnet**

- U. of Alabama (Birmingham)
- U. of Delaware (Newark)
- George Washington Un. (D of C)
- Florida State Un (Tallahassee)
- U. of Georgia (Athens)
- Georgia Tech. (Atlanta)
- U. of Kentucky (Lexington)
- Louisiana State Un. (Baton Rouge)
- U. of Maryland (College Park)
- Duke Un. (Durham)
- U. of North Carolina (Chapel Hill)
- North Carolina State (Raleigh)
- Clemson Un. (Clemson)
- U. of Tennessee (Knoxville)
- Virginia Tech (Blacksburg)
- U. of West Virginia (Morgantown)
- National Science Foundation (D. of C.)

**NYSErnet**

- Brookhaven Natl. Lab
- City Un. of New York
- Clarkson Un.
- Columbia Un.
- Rockefeller Un.
- Syracuse Un.
- Polytechnic Inst. of NY
- U. of Rochester
- SUNY at Albany
- SUNY at Binghamton
- SUNY at Buffalo
- SUNY at Stony Brook
- New York Un.

**BARRnet**

- U. of Calif. - Berkely
- U. of Calif. - San Francisco
- U. of Calif. - Davis
- U. of Calif. - Santa Cruz
- Stanford Un.
- NASA-Ames

**SESQUInet**

- U. of Houston
- Rice Un.
- Baylor College of Medicine

**MERIT**

- Michigan State Un.
- Wayne State Un.
- U. of Michigan
- Oakland Un.
- Western Michigan Un.

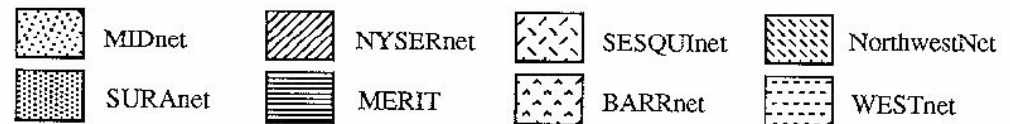
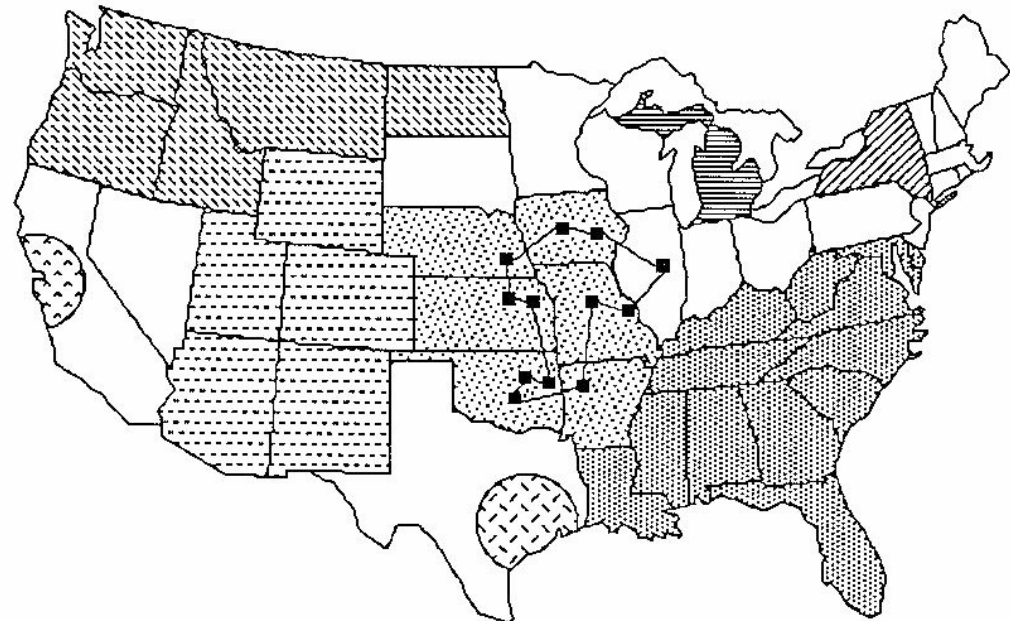


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# What Were We Talking About in 1987

- T1 Backbone Solicitation
- Original regionals operational
- Expansion everywhere
- New regionals forming
- T1 backbone goes live
- Things really work!



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# What Were We Talking About in 1988

- How great it is!
- Cost becomes a consideration
- What was considered “unaffordable”

## Realistic Costs For An Internet Connection

> T1            \$100 K  
  T1            \$ 30 K  
  256 K        \$ 22 K  
  56 K         \$ 15 K  
  Slip            3 K  
  Terminal      \$ 0.3 K

Cost Per Institution for a Typical Regional Network

|                        | Current Configuration |           |           | Expanded Configuration |           |           |
|------------------------|-----------------------|-----------|-----------|------------------------|-----------|-----------|
|                        | Tele. K\$             | Oper. K\$ | Total K\$ | Tele. K\$              | Oper. K\$ | Total K\$ |
| Survival Funding Level | 27                    | 5         | 32        | 21                     | 4         | 25        |
| Marginal Funding Level | 27                    | 9         | 36        | 21                     | 6         | 27        |
| Adequate Funding Level | 27                    | 14        | 41        | 21                     | 9         | 30        |
| Good Funding Level     | 27                    | 19        | 46        | 21                     | 13        | 34        |

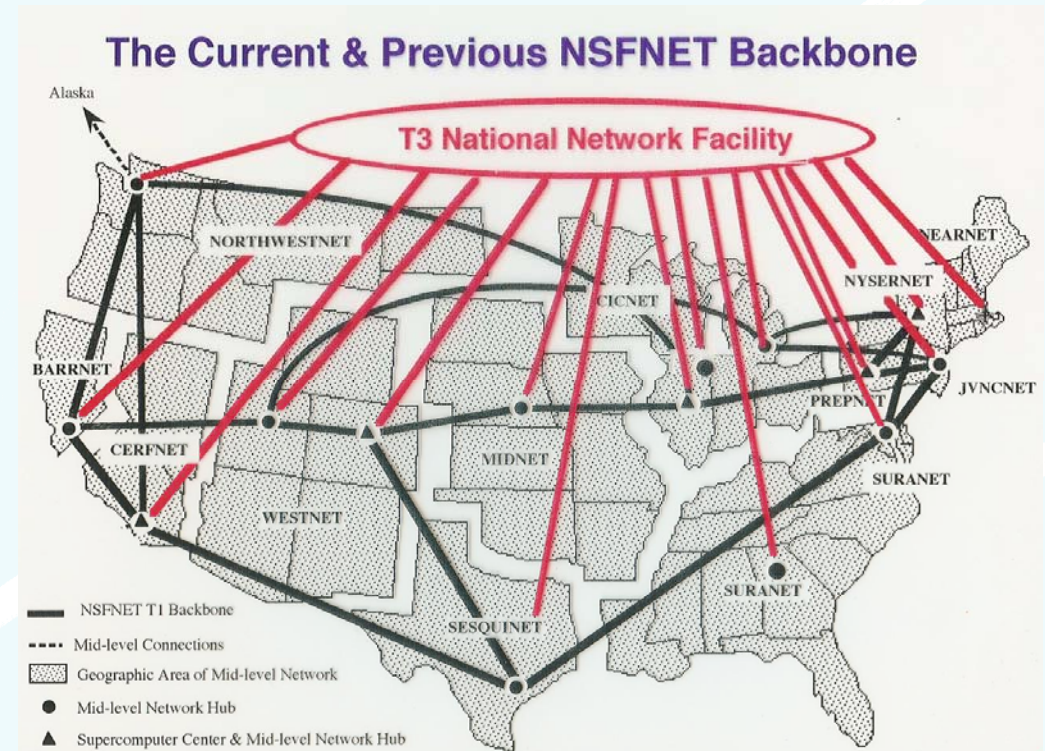


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# What Were the Mid-levels Like in 1993

- T3 Backbone
- T1 to many campuses
- Over 1.4 million attached computers
- 10 - 15 million users
- Reached 100 nations
- Basic Services: Interactive connections, file transfer, electronic



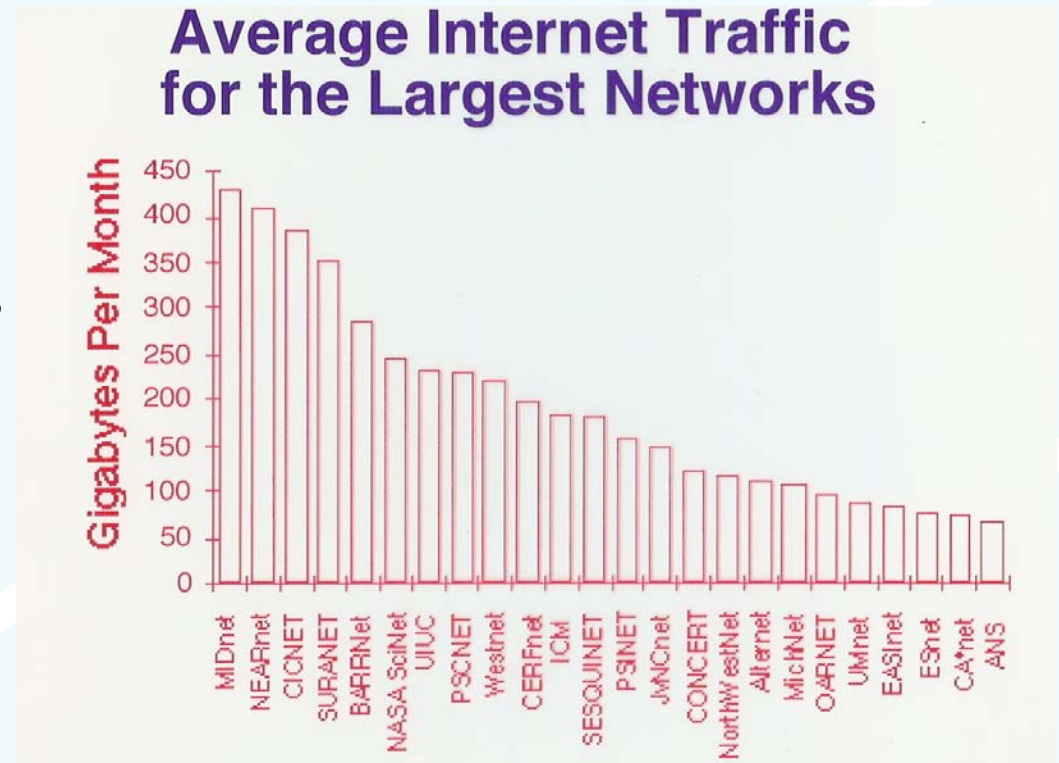
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# What Were We Talking About in 1993

- T1 Regional Connectivity
- Midnet Incorporated as a 501(c)3
- Almost 100 institutions in MIDnet
- “For Profit” members
- Alternative backbone connections
- Partnerships with IXC’s



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*SURAnet*

Glenn Ricart

NSFnet 20<sup>th</sup> Anniversary



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**February 1982**

## **Ricart: New Academic CIO of U. Maryland**

### **Problem:**

- Mainframe**
- Departmental mini-computers**

### **Solution:**

- TCP/IP for the campus**
- From the IRCN report,  
Walt Gilbert, author**



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October 1983

## SURA “Computer Committee”

### Problem:

- Getting a supercomputer for southeast
- Can't get agreement on a single proposal

### Solution:

- At least get a network; SURANet
- Idea was from

**Jesse Poore:**

- Ricart & Schaffer  
go forth



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**June 3, 1984**

## **Ricart makes an informal proposal for SURANet to the NSF Networking Subcommittee**

### **Problem:**

- They want a national ScienceNet**
- SURA is proposing only the southeast**

### **Solution:**

- A 3-tier networking structure**

**NSF Networking Subcommittee of the NSF Advisory Committee for Advanced Scientific Computing**



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**June 22, 1984**

## **SURANet people meet with Harris Communications**

### **Problem:**

- **Can't buy 56Kbps data links to some  
southeastern higher ed institutions**

### **Solution:**

- **A 15-node satellite network  
(like SDSCnet and USAN)**



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**March 12, 1985**

**SURA Submits: “Plan and Experiment for a Demonstration Supercomputer Network“ (NSF 85-12870).**

**Problem:**

- **Proposal is unsolicited**
- **NSF doesn't know how to handle**

**Solution:**

- **Glenn visits NSF**
- **Proposal reviewed but eventually superseded by NSFnet solicitation**



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**March 13, 1986**

# **SURA Submits: “SURANet Phase I” to the NSF**



**Glenn Ricart**



**Henry Schaffer**



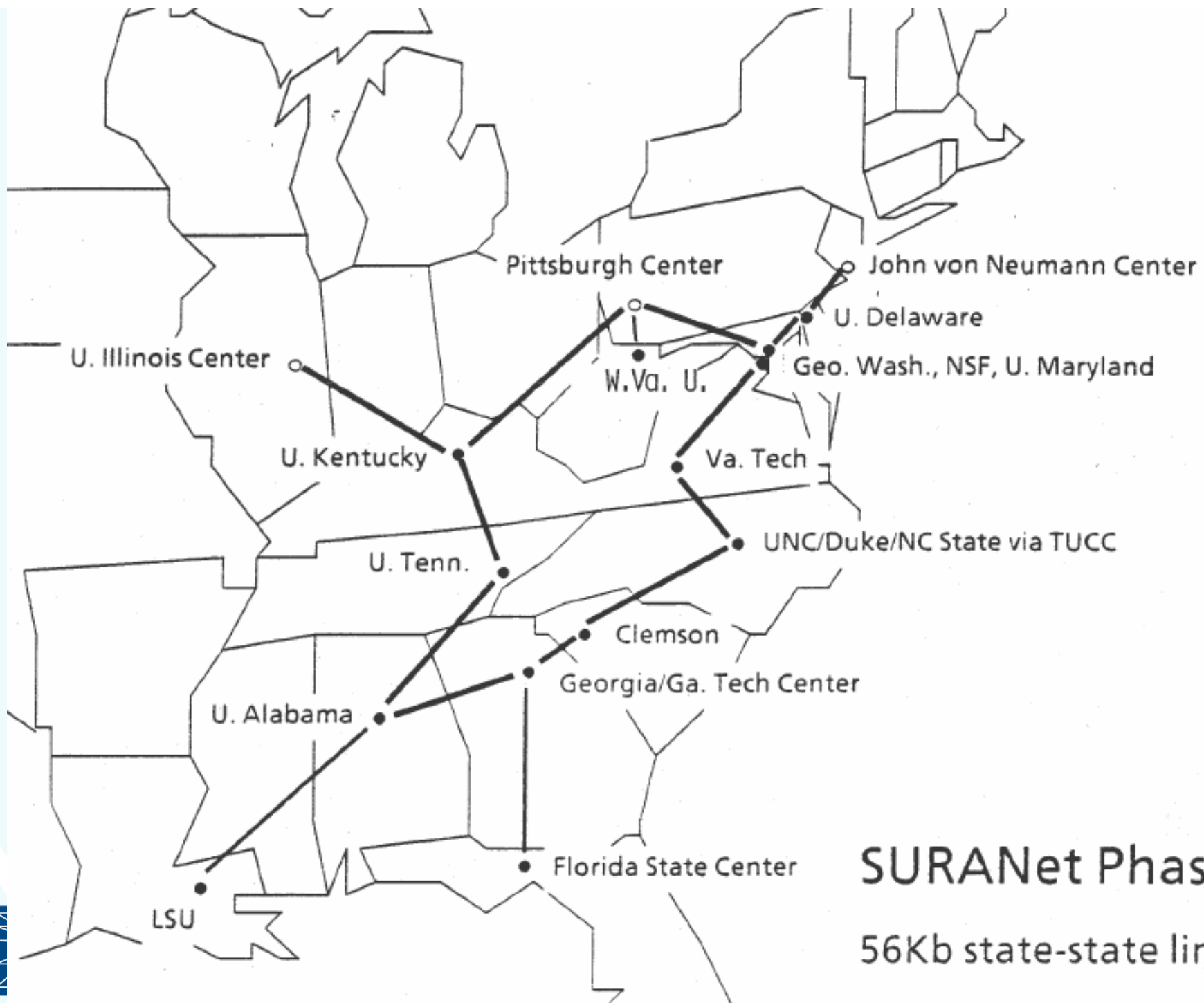
**Morty Taragin**



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## SURANet Phase I

56Kb state-state links

**January, 1987**

**SURAnet becomes first NSFnet Regional to establish operations**

**George Washington University to U. Maryland  
Proteon Routers**

**Jack Hahn managed SURAnet at the time**

**February 10<sup>th</sup>: SURA distributes press kit for each state to use to announce SURAnet as it reaches them**



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# Other dates

- 1989 – SURAnet moves out of the U. Maryland;  
Training workshop for HBCUs;  
Upgrade to T1
- 1990 approx. – FIX established
- 1991 – Backbone moves to DS3
- 1992 – New, upgraded FIX becomes FIX-East
- 1994 – SURAnet sold to BBN; becomes biggest part of BBN's backbone



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# *On becoming a regional*

November 29, 2007

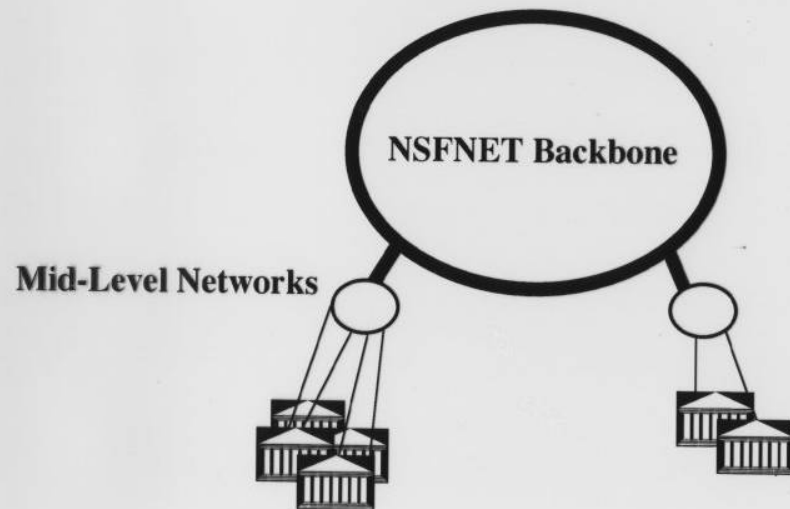
Jim Williams



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# The NSF 3 level architecture



jimw@farnet.org

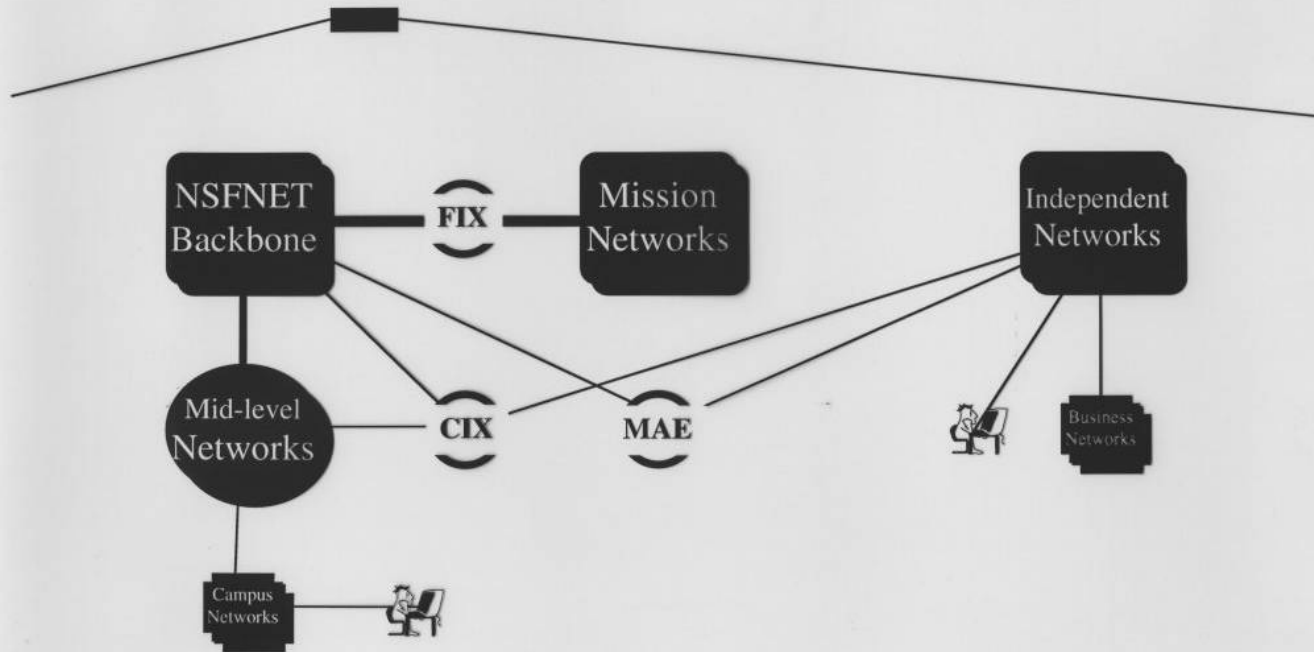
CNI 11/29/94



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# US. Configuration < 4/95



Sao Paulo June 13, 1995



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## How to become a mid-level network

- Believe in the TCP/IP gospel
- Act like you know what your doing
- Get to know Jane Caviness
- Build some sort of network
- Join FARNET
  - Go to 3 meetings, kick in \$1k
- Get Karen Roubicek to put your dots on her map
- Get to know Jane Caviness (better)



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# FARNET

- **Founded in 1986 by the leaders of state and regional computer networks linked to NSFNET**
- **Includes others supporting the FARNET mission such as**
  - **network service providers**
  - **equipment manufacturers**
  - **local and long-distance providers**
- **Governed by a Board elected by the membership**
- **Not-for-profit 501C-3 corporation**
- **Members provide direct access to the majority of universities, research institutions, schools, businesses and other public organizations in the U.S.**

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FARNET 4/26/95



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## The FARNET Mission

The mission of FARNET is **national advocacy** for Internetworking with a primary focus on the education, research and related communities.

FARNET is an **executive forum** for the exchange of information about the Internet and its applications and services, and acts as a catalyst for the transfer of leading edge information infrastructure technology.

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FARNET 4/26/95



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## Our Members

**Ameritech - ANS - Apex - ASPIN - A.T. & T. -  
BBN Planet - Bellcore - CERFnet - CICNet - Cisco  
- Colorado SuperNet - Cornell University -  
CREN - CSUnet - IREN MCI - MERIT - Midnet -  
MOREnet - MRNet - NC-REN NETCOM -  
netILLINOIS - NevadaNet - NorthWestNet  
NYSERNet - OARnet - PREPnet - PSCnet -  
PSInet Sesquinet - Sprint SURAnet - VERnet -  
Westnet**

FARNET 4/26/95



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## This years challenges for mid-level networks



- **Survive the (technical) transition to the new architecture**
- **Adjust to diminished direct NSF funding**
- **Compete with a growing plethora of big and little NSPs**
- **Evaluate and respond to the VC frenzy**
- **Expand the enterprise to serve the traditional community**
- **Provide for the high-bandwidth requirements of the R&E community**



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## Overview of changes

|                              | < 1987   | 1987 - 1995  | >1995                         |
|------------------------------|--|--|-------------------------------|
| <b>Vision</b>                | U.S. Government Agencies (DoD)                 | U.S. Administration, Congress, Agencies, Academia, Industry        | ?                             |
| <b>1<sup>o</sup> Purpose</b> | Defense Researchers                            | Education/Research Community                                       | Commodity                     |
| <b>Authority</b>             | U.S. Government Agencies (DoD)                 | U.S. Government Agencies (NSF, DoD)                                | none?                         |
| <b>Technical Leadership</b>  | U.S. Government Agencies (DoD)                 | U.S. Government Agencies (NSF, DoD, DoE, NASA), Academia, Industry | Telecommunications Industry ? |
| <b>Acceptable Use</b>        | Restricted to defense related research users   | Initially restricted to research and education (including defense) | Commodity                     |
| <b>Backbone funding</b>      | U.S. Government Agencies                       | U.S. Government agencies (e.g. NSF, DoE, DoD, NASA)                | Commodity                     |
| <b>Distribution funding</b>  | U.S. Government Agencies (e.g. DoE, DoD, NASA) | U.S. Government Agencies (e.g. DoE, DoD, NASA)                     | Commodity                     |

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## Challenge: Internet administration

- By design, no one is in charge
- Issues
  - Address space allocation
  - Routing coordination
  - There is **no end to end coordination**

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# FARNET 1991



# The Quilt 2007 (FARNET2)



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Thanks for your attention

for further information:

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