“The Coming of the Grid”

Building a Computational Grid Workshop
Argonne National Laboratory
September 8-10,1997

Dr. Larry Smarr

Director, National Computational Science Alliance and the National Center for Supercomputing Applications

Professor in the Departments of Physics and Astronomy

University of Illinois Urbana-Champaign

Other Infrastructures

- Electrical Power
- Communications
- Petroleum
- Transportation
  - Air
  - Highway
  - Railroad
- Physical Goods
  - Manufacturing
  - Supply Chain
  - Inventory and Warehousing
- Banking System

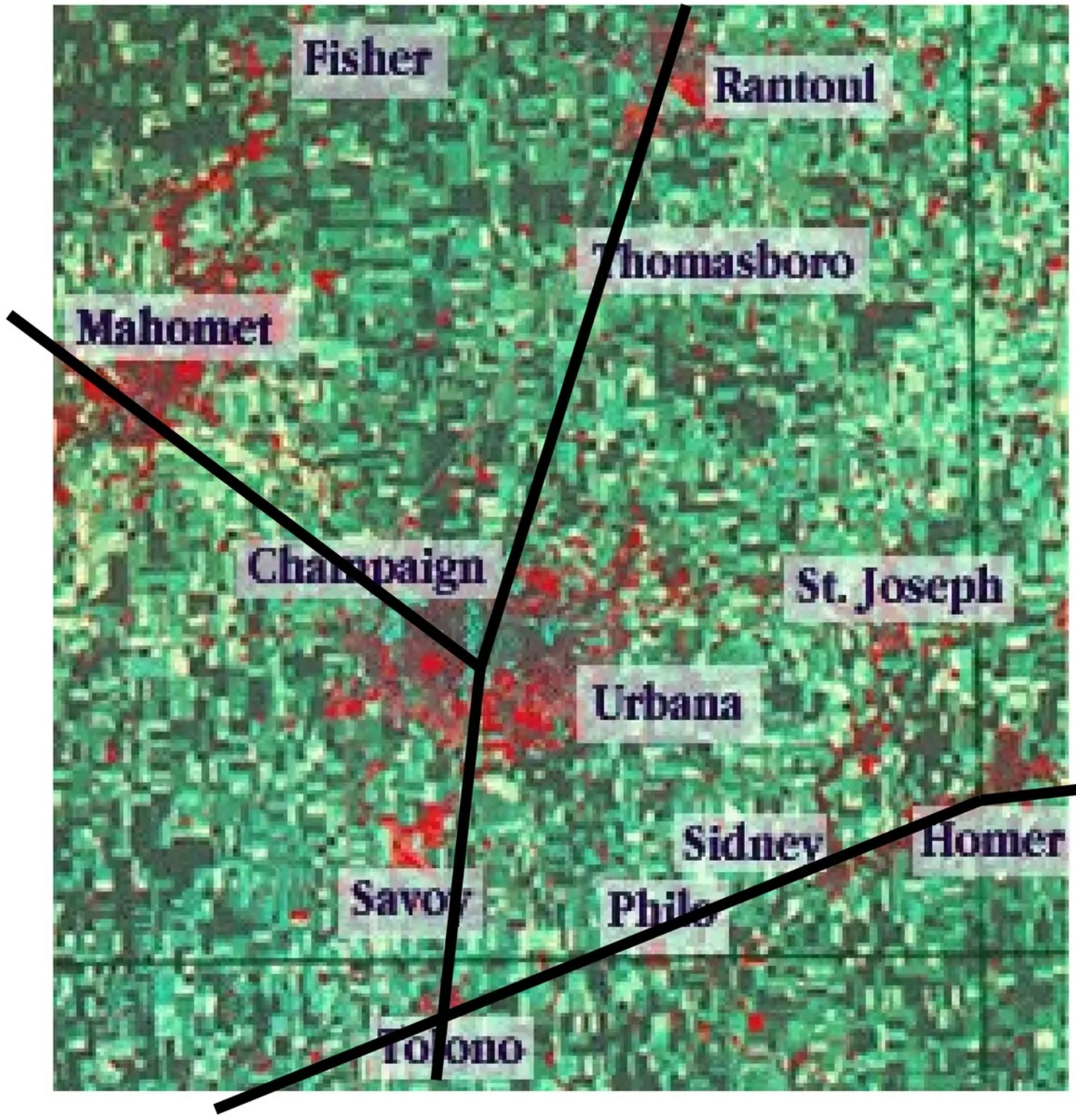
General Properties of Grids

- **Inhomogeneous Node Distribution Function**
  - Supernodes
  - Ubiquitous Smaller Nodes
- **Caching Essential**
- **Variable Speed Pathways**
- **Created by Interactions**
  - Government
  - Industry
  - Invention

Why Is There Chicago? - Supernode on the Transportation Grid

- **Railroad Infrastructure Required Caching**
  - **Grain**
  - **Livestock**
- **Caching Created Financial Markets**
  - **Board of Trade**
- **Retailing Center Emerges**
  - **Manufactured Goods Need Middleware**
  - **Inventory and Redistribution**
- **Today Air Transport, Telecom Supernode**
- Cronon, William. *Nature's Metropolis: Chicago and the Great West*

Infrastructure Leaves its Mark -- a Century Later



Exponential Cascade:
From Leading Edge to Consumer Electronics



1985 Cray X-MP

Cost:$8,000,000

60,000 watts of power

No Built in Graphics

56 kbps NSFnet Backbone

1997 Nintendo 64

Cost: $149

5 watts of power

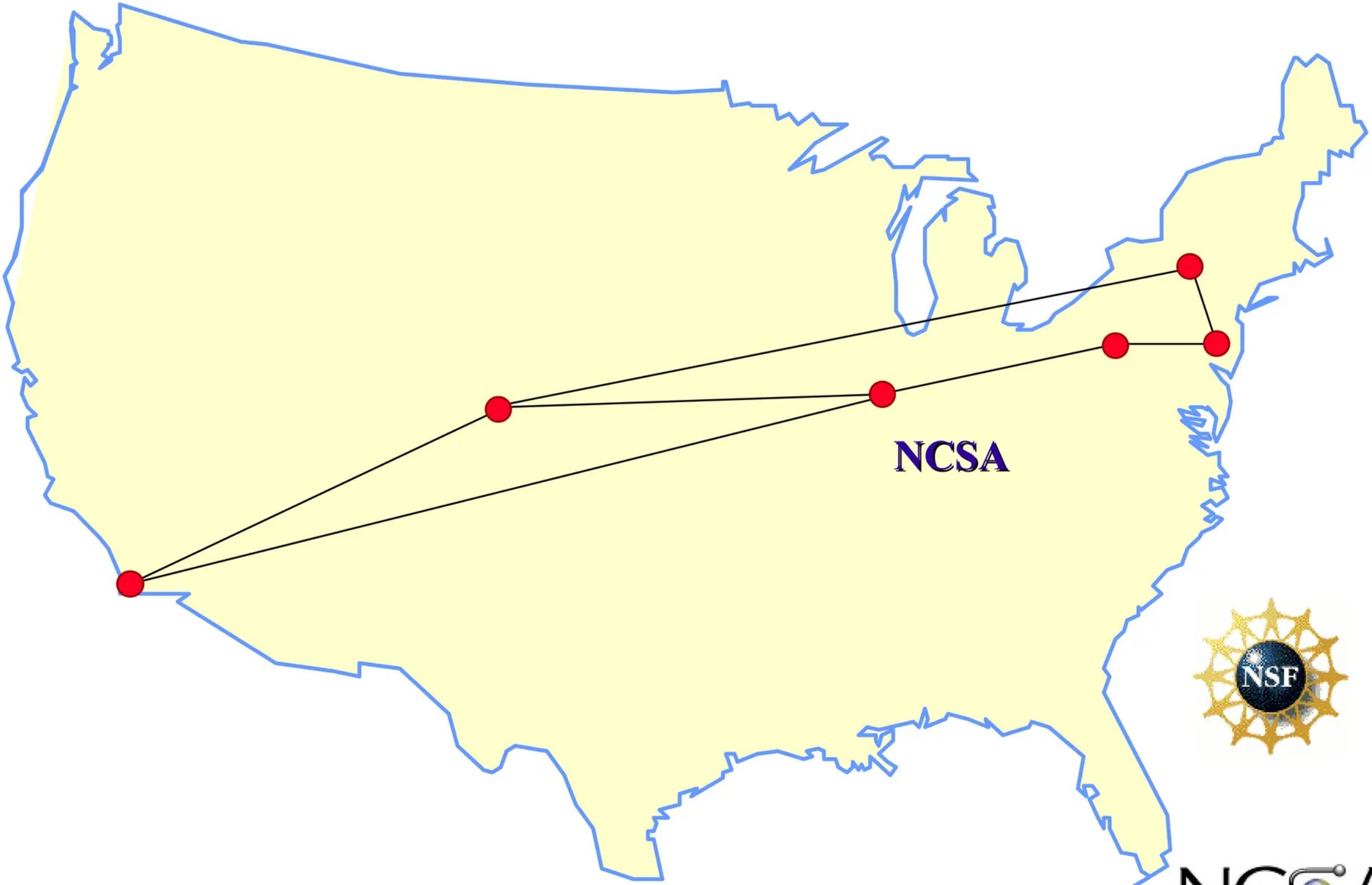
Interactive 3D Graphics

64 kbps ISDN to Home

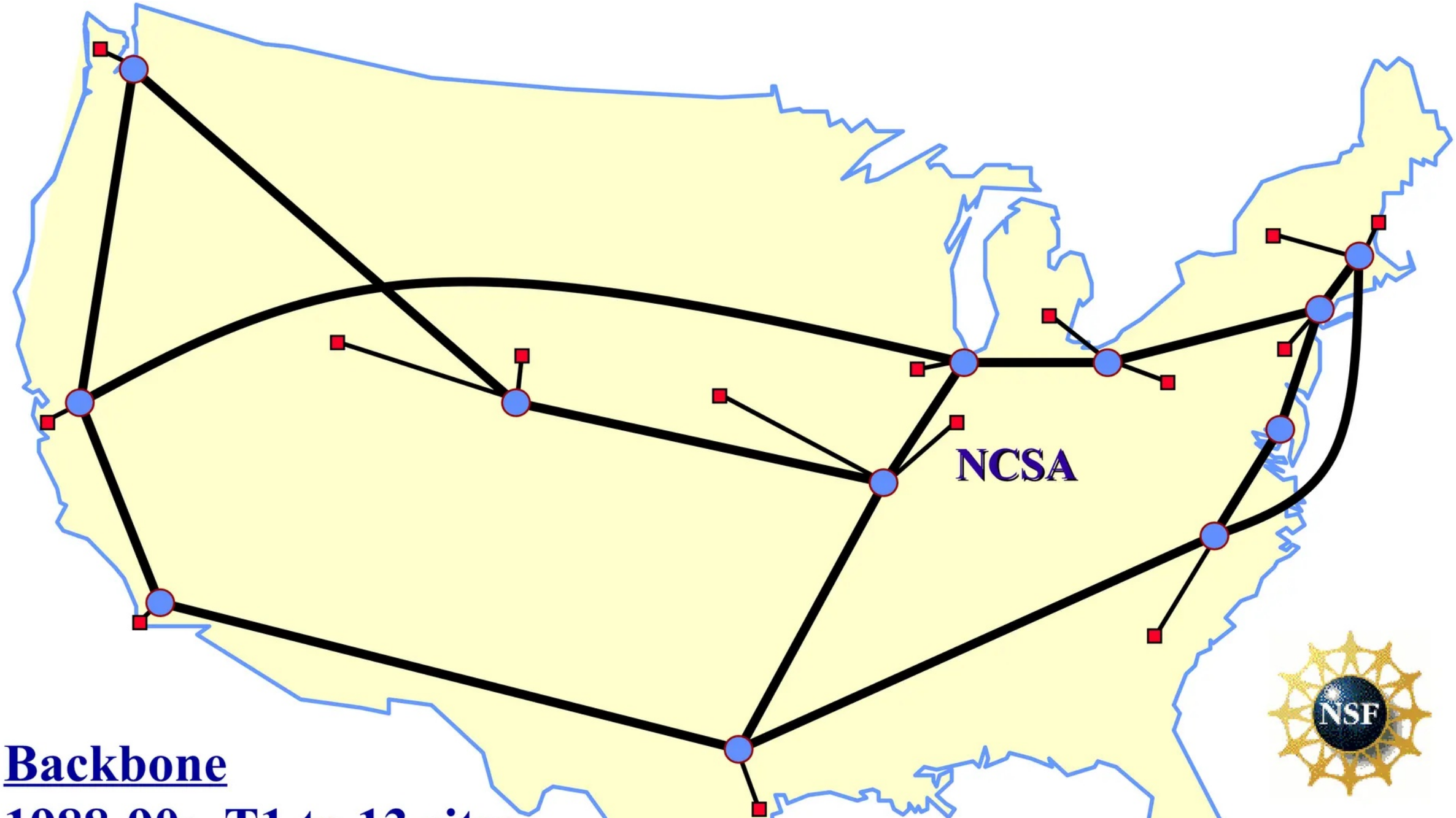


Source: Silicon Graphics, 1997

NSFNET 56 Kb/s Backbone (1986-8)



NSFNET 1.5 -> 45 Mb/s Backbone (1988-94)

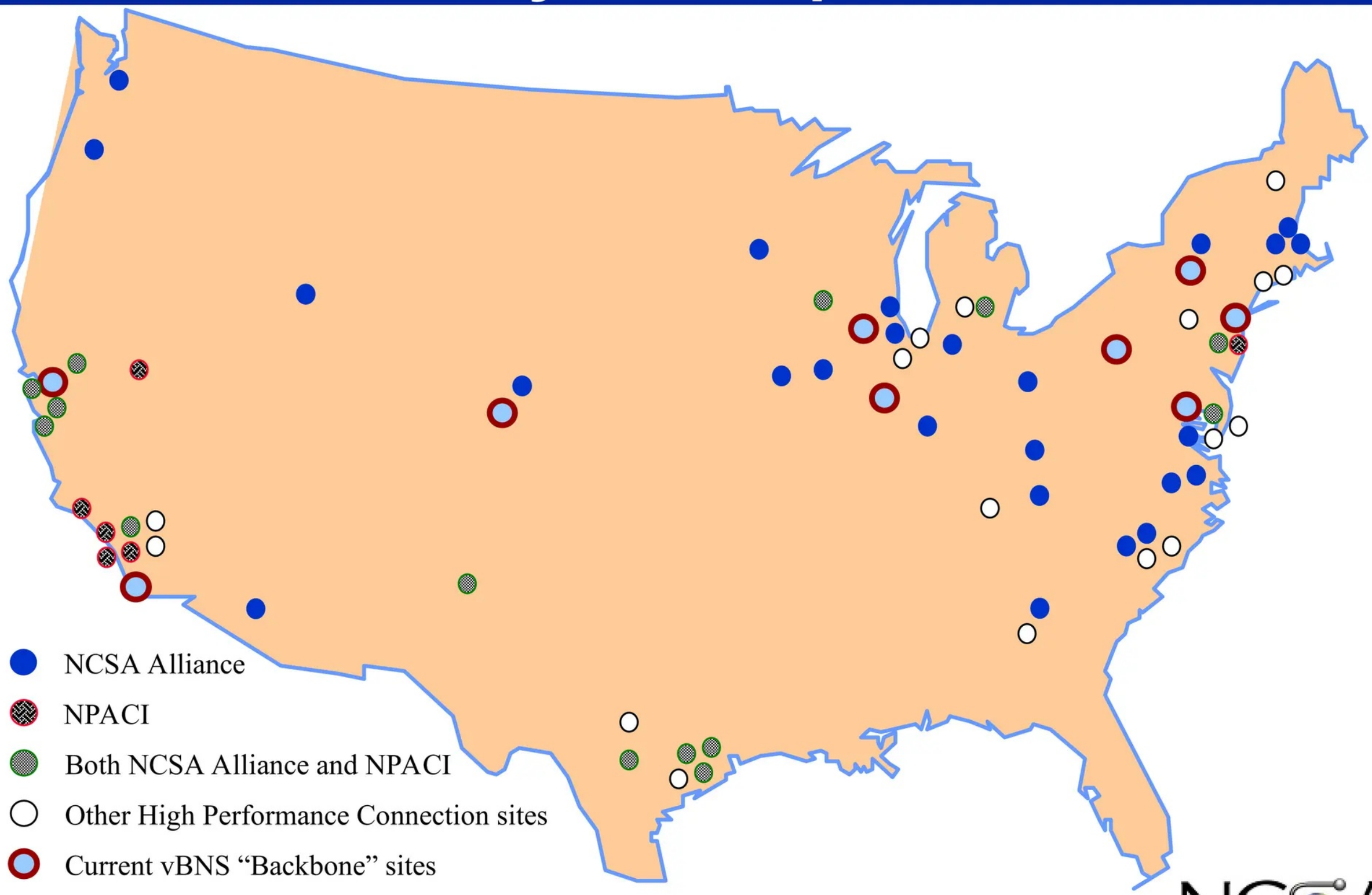


Backbone

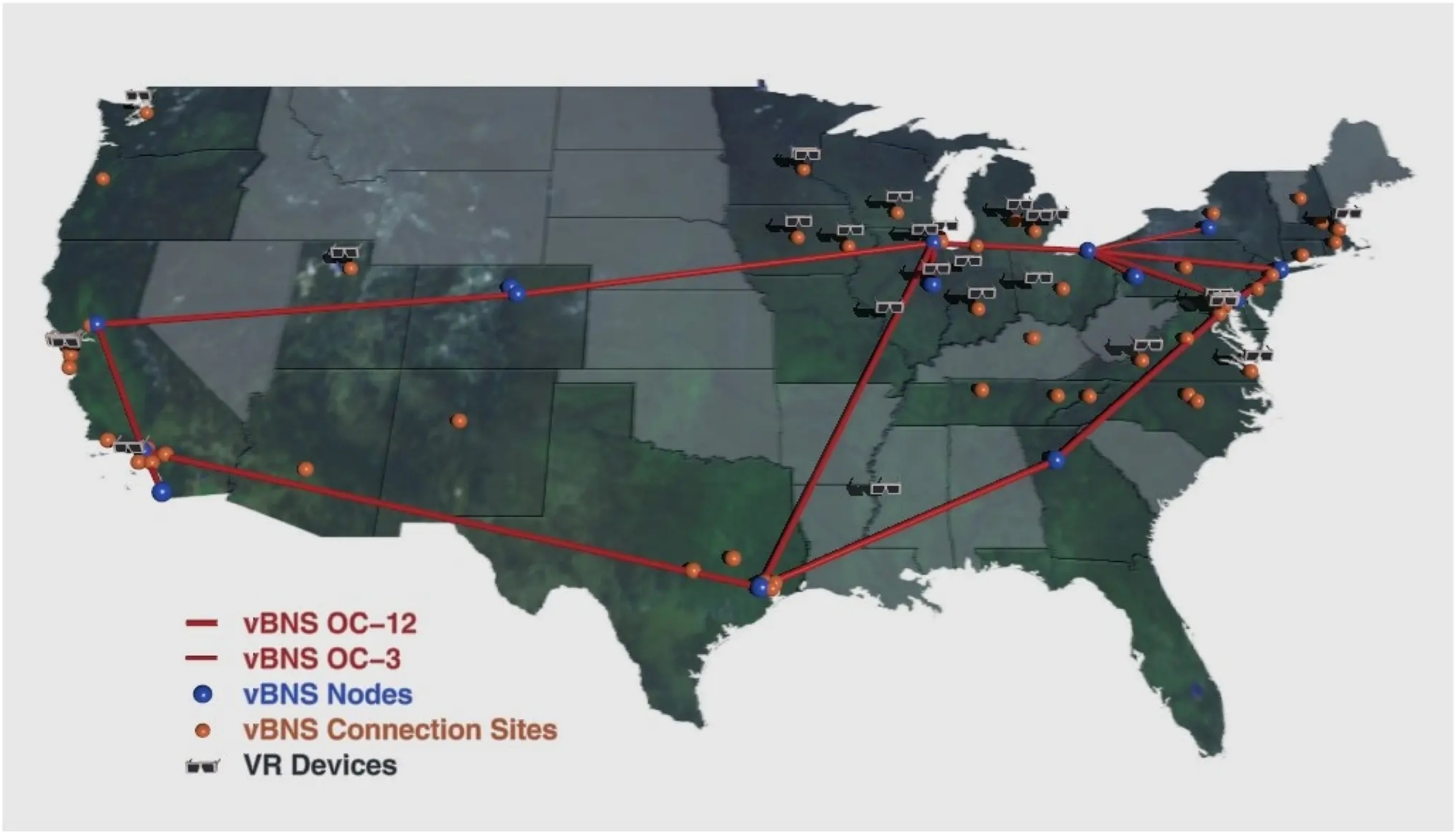
1988-90: T1 to 13 sites

1990-94: T3 to 16 sites

NSF vBNS and PACI - Mutually Interdependent



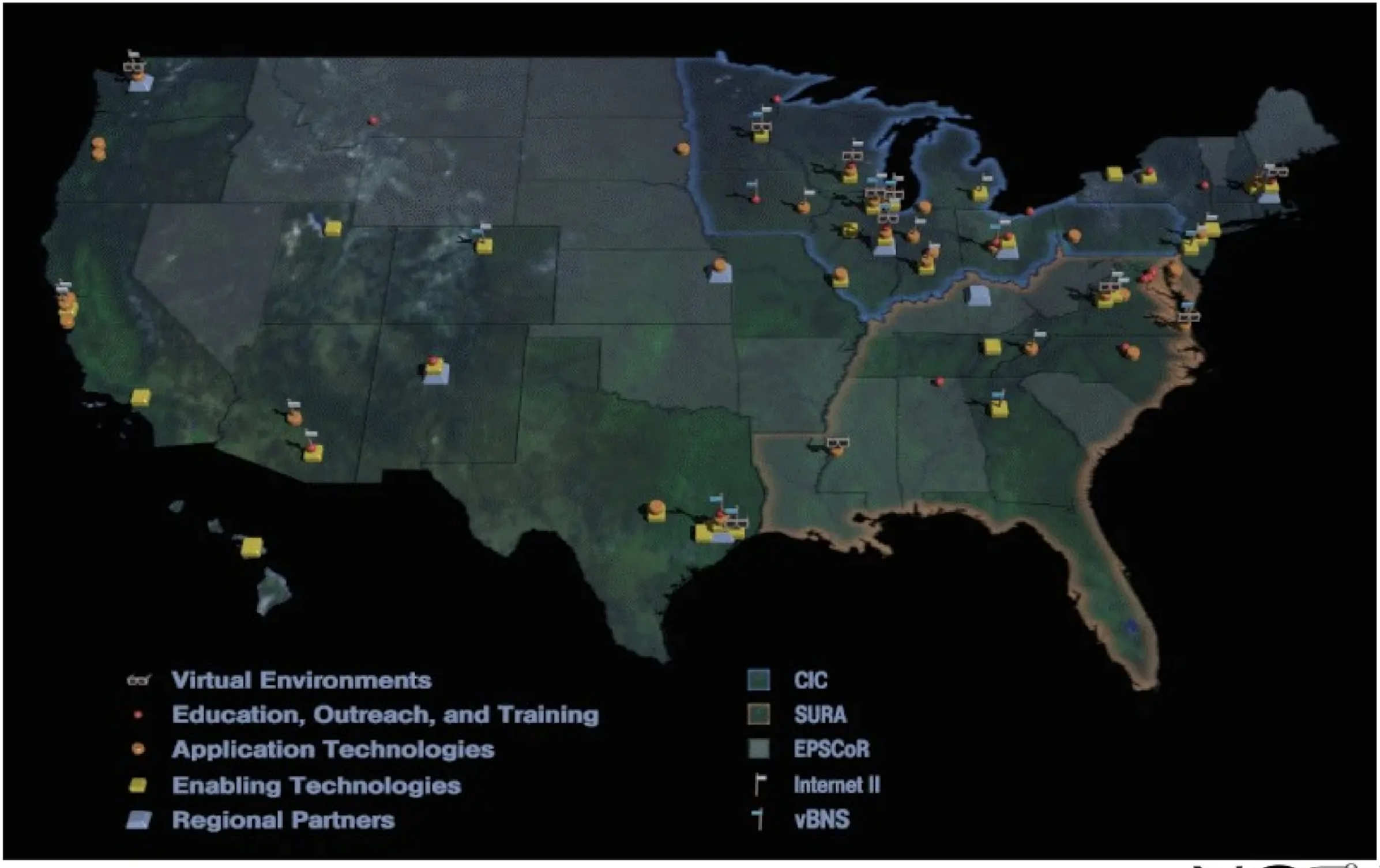
EPSCoR and the State Participation Problem



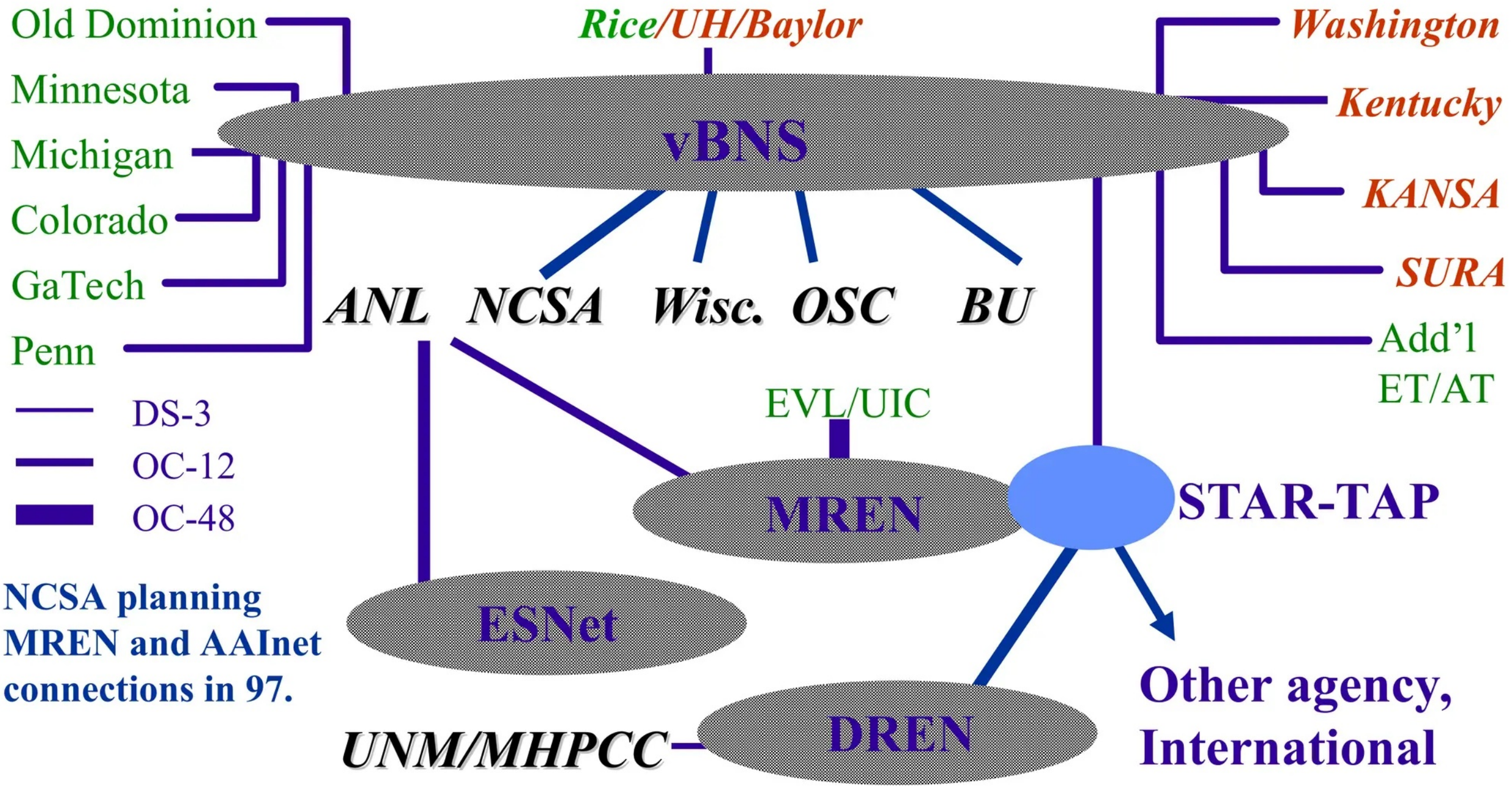
The Alliance is Prototyping the National Technology Grid

- **Leading Edge Centers**
  - Supernodes of the Grid
- **Enabling Technology Teams**
  - Architects of the Grid
- **Applications Technologies Teams**
  - Specifications for the Grid
- **Education, Outreach, and Training Teams**
  - Content for the Grid
- **Partners for Advanced Computational Services**
  - Support for the Grid

The National Technology Grid



Projected NCSA Alliance Interconnection

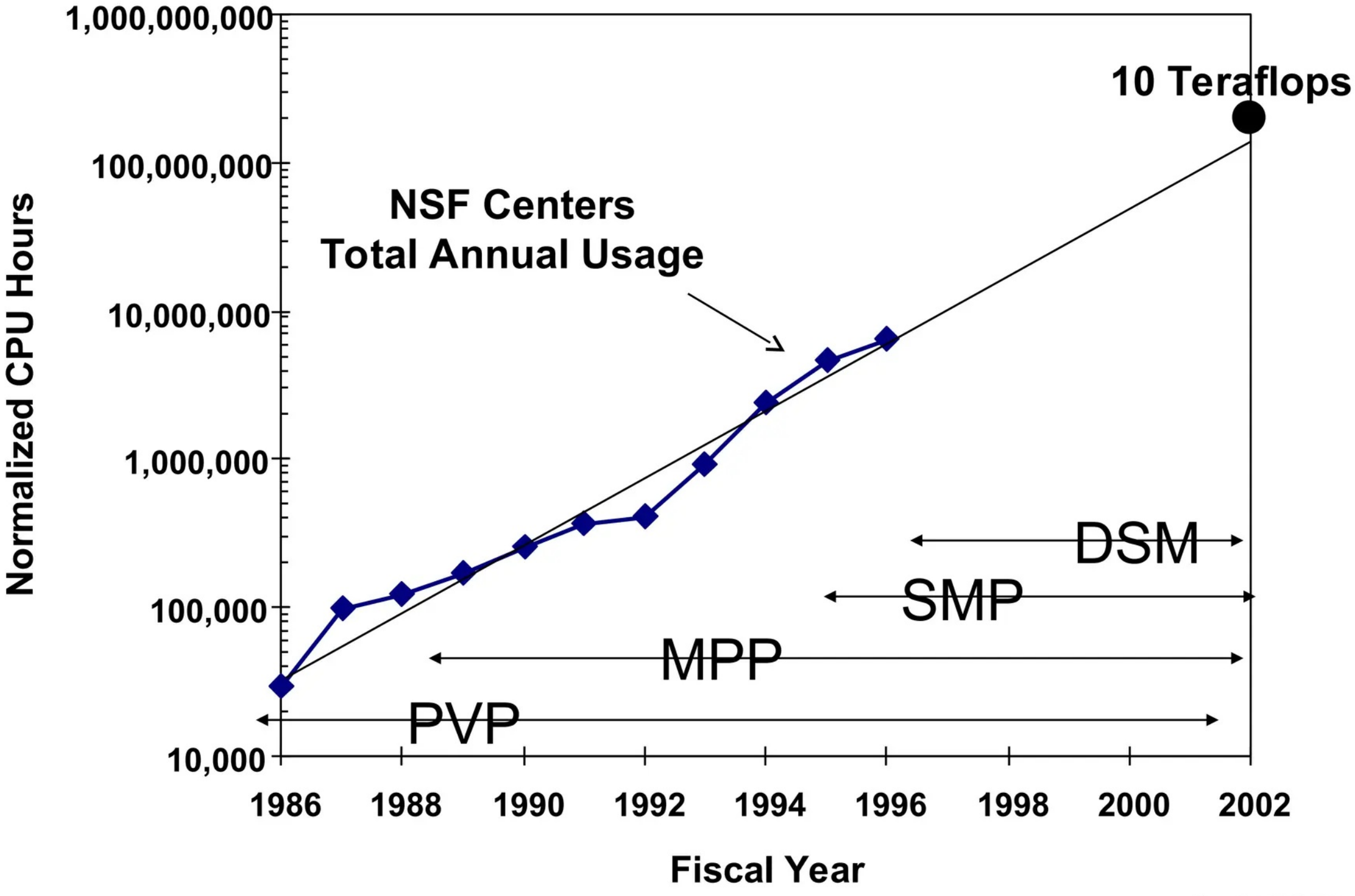


NCSA planning MREN and AAInet connections in 97.

User community primarily Internet-II but spread throughout.

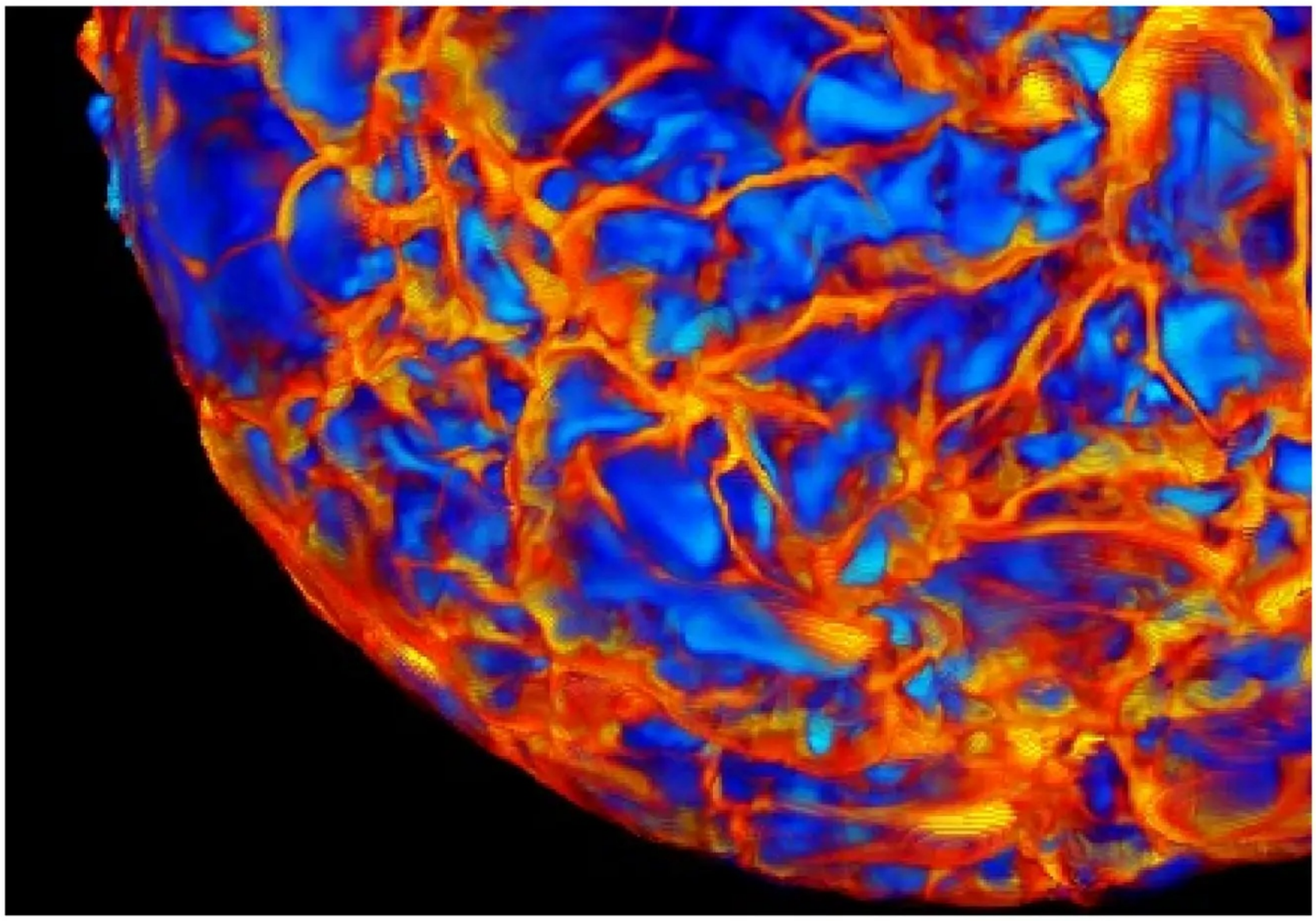
Regional ET/AT *LdgEdge*

Exponential Growth in National User Demand Will Drive Grid Capabilities



Source: Quantum Research Database

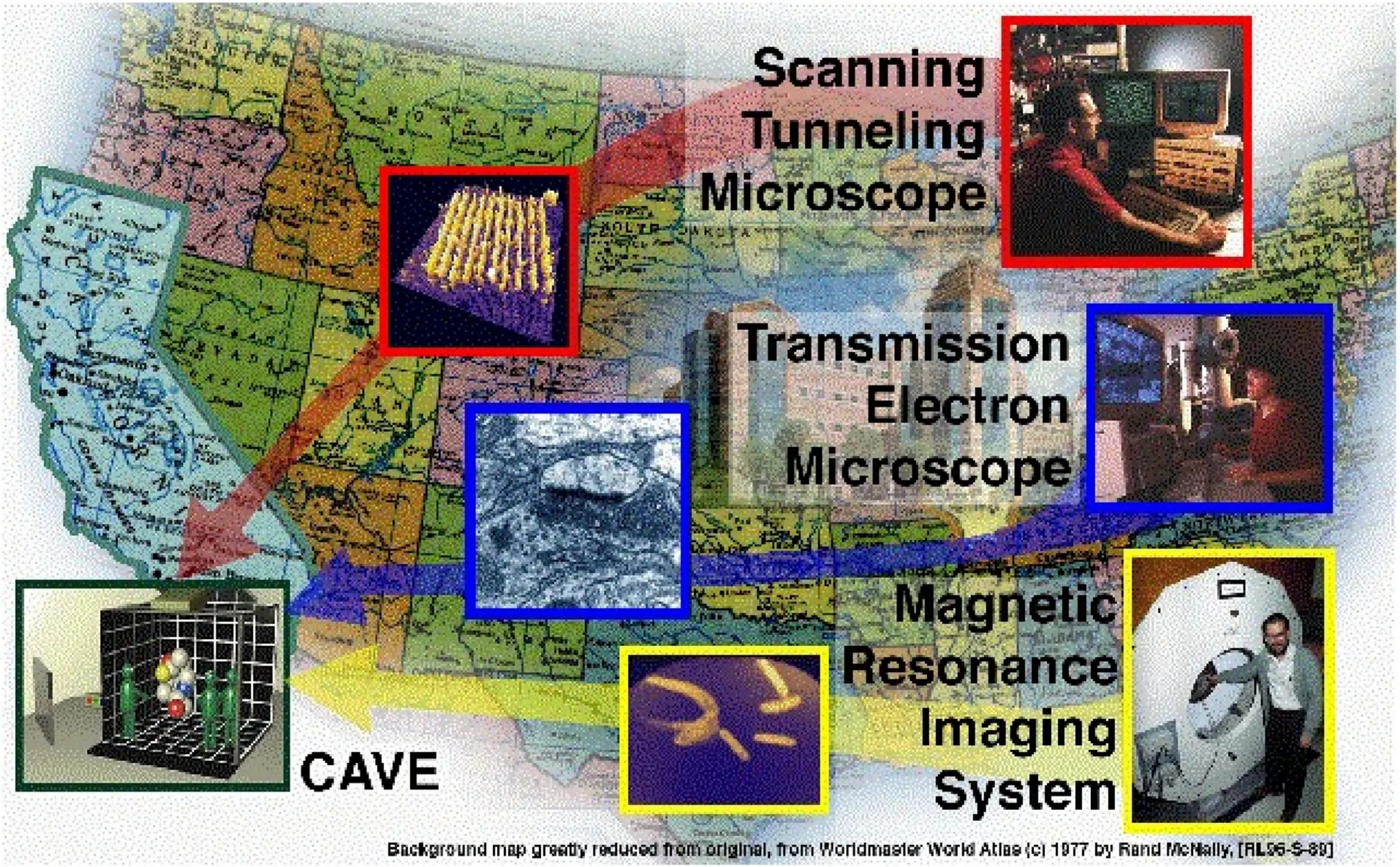
Computational Scientists Need the Grid



- Rotating Turbulent Gas Ball Model of the Sun
- Nine Day Run on NCSA Origin (128-processors)
- Generated 2 Terabytes of Data, LCSE Visualized in 3 Days

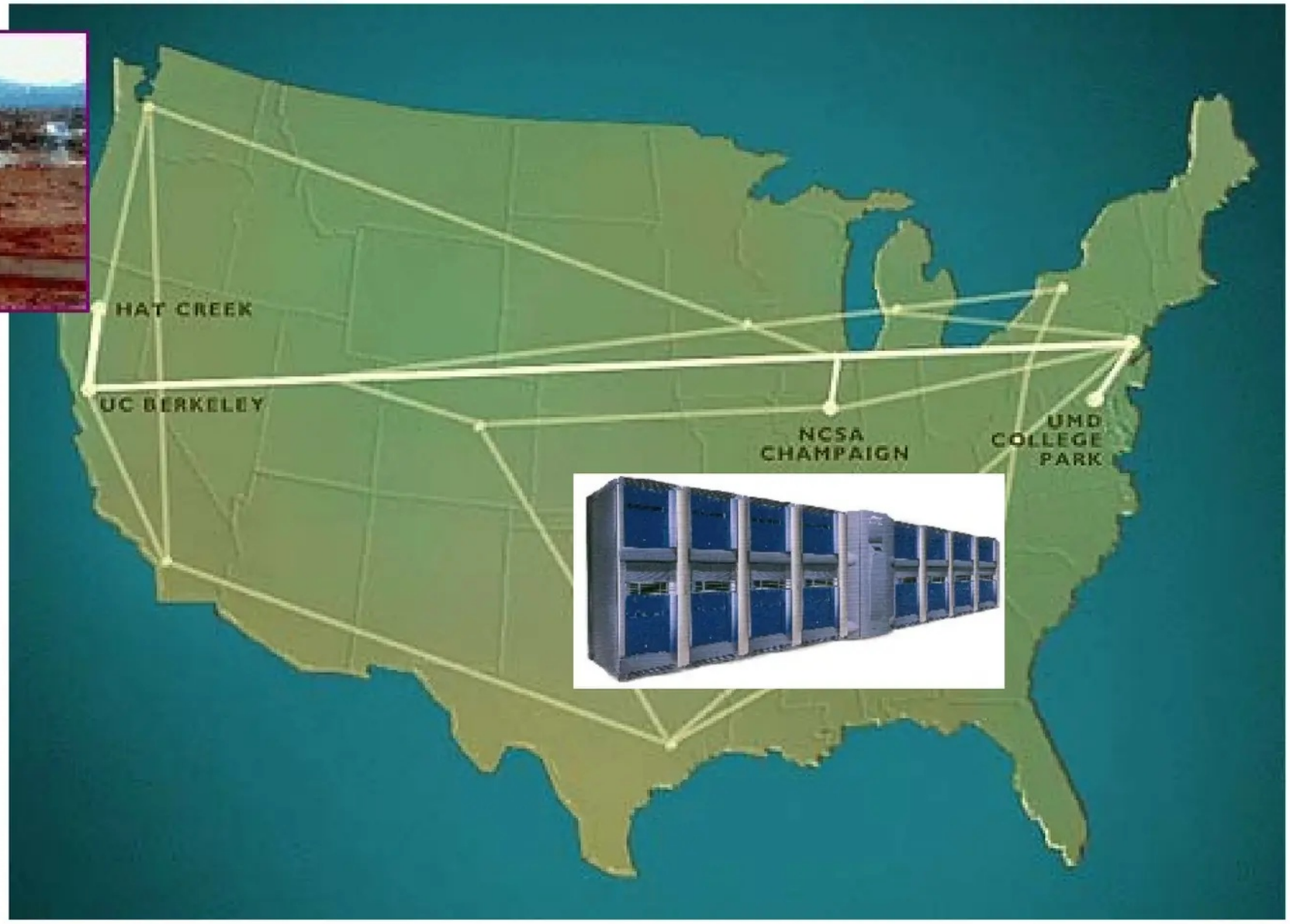
Dave Porter, Paul Woodward, et al., LCSE, Univ of Minnesota, June 1997

Experimental Scientists Need the Grid



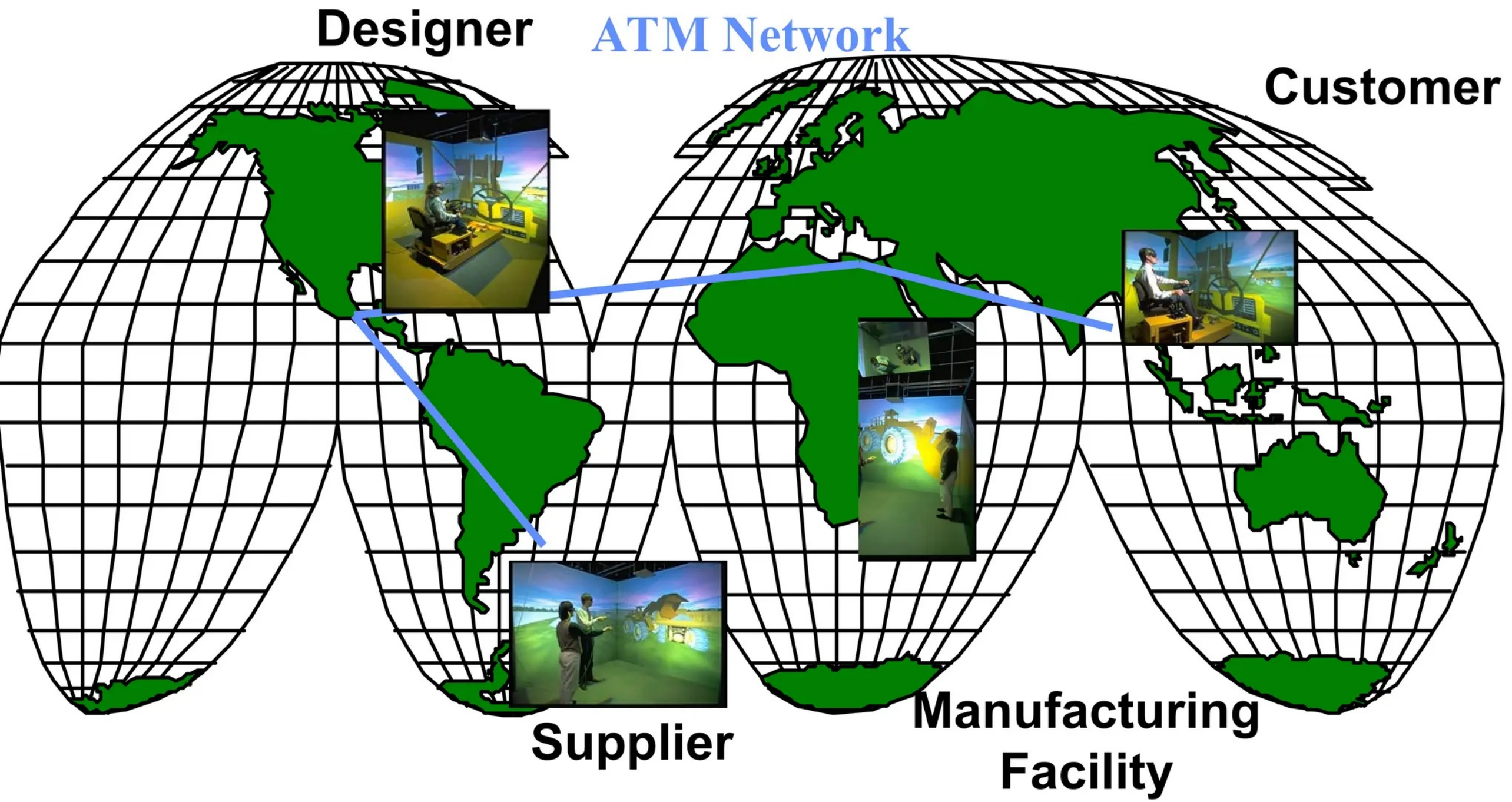
Observational Scientists Need the Grid





BIMA, Courtesy Richard Crutcher, UIUC

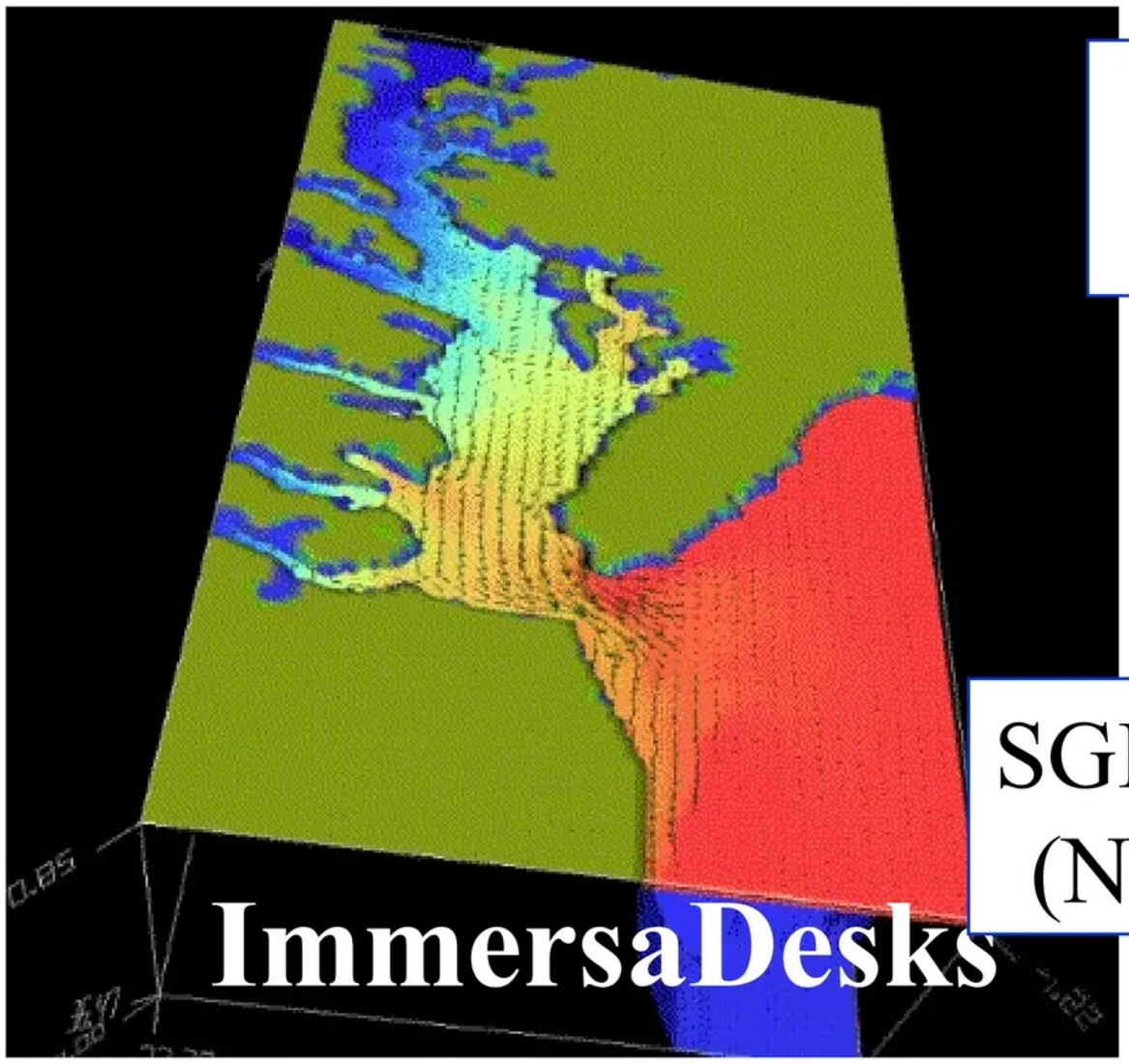
Virtual Manufacturing Needs the Grid

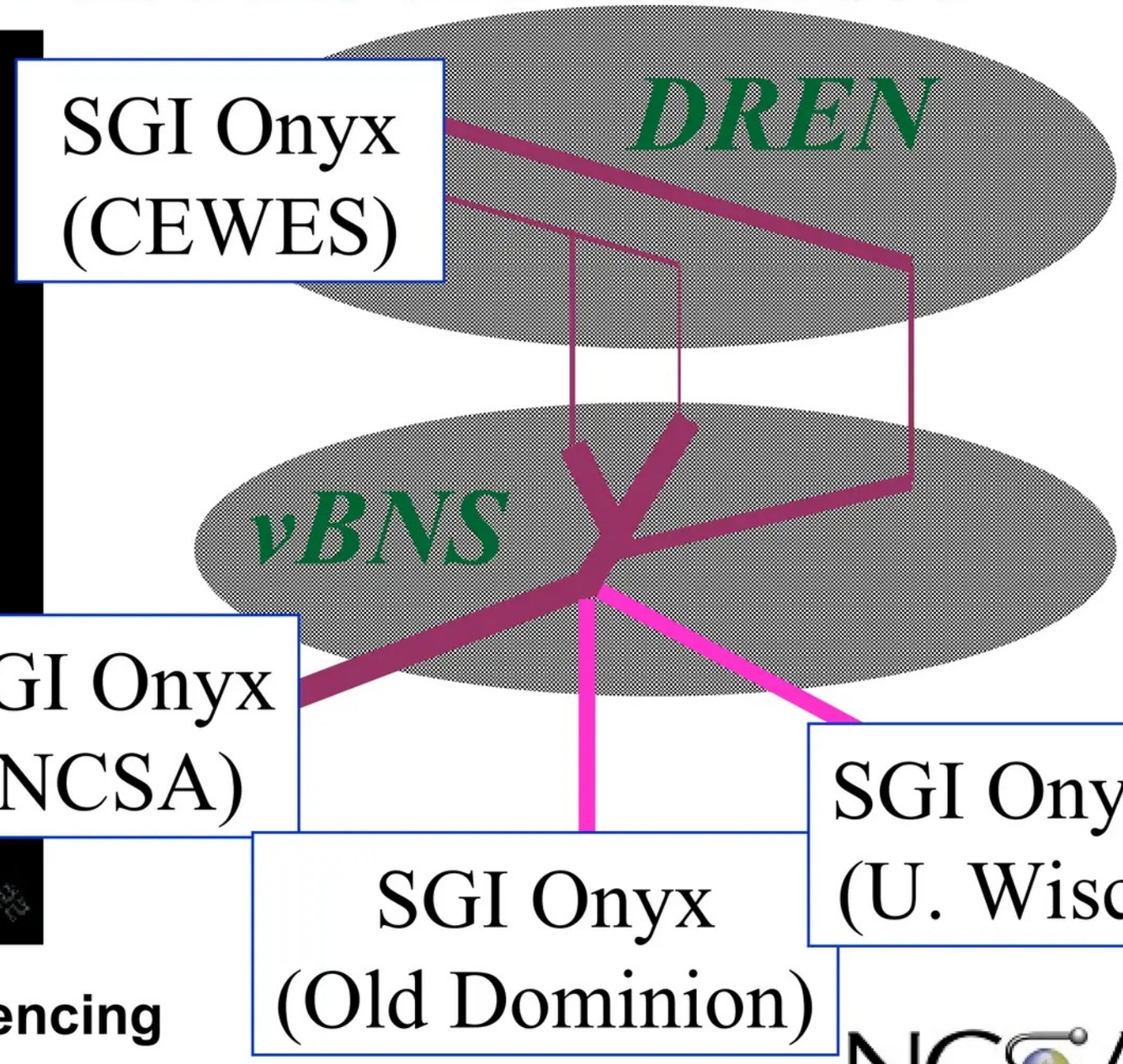


Source: Kem Ahlers, Caterpillar

The Environment Needs the Grid

- **Environmental Modeling in Shared VR-space**
  - **Chesapeake Bay Simulations and Databases**



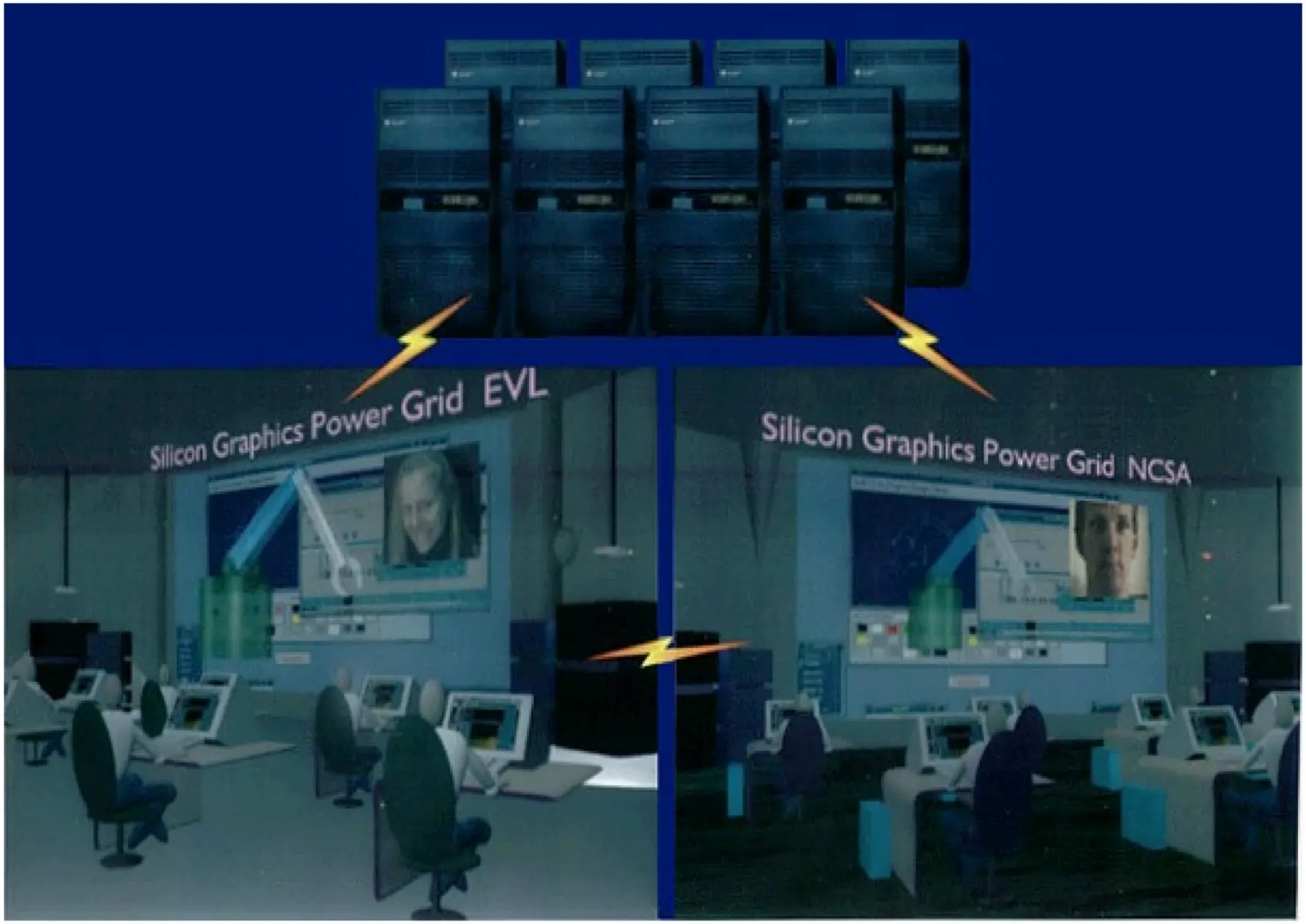


Integrated M-Bone Videoteleconferencing

Data courtesy Old Dominion University
Images produced by John Shalf, NCSA

NCSA™
National Computational Science Alliance

Trainers and Educators Need the Grid



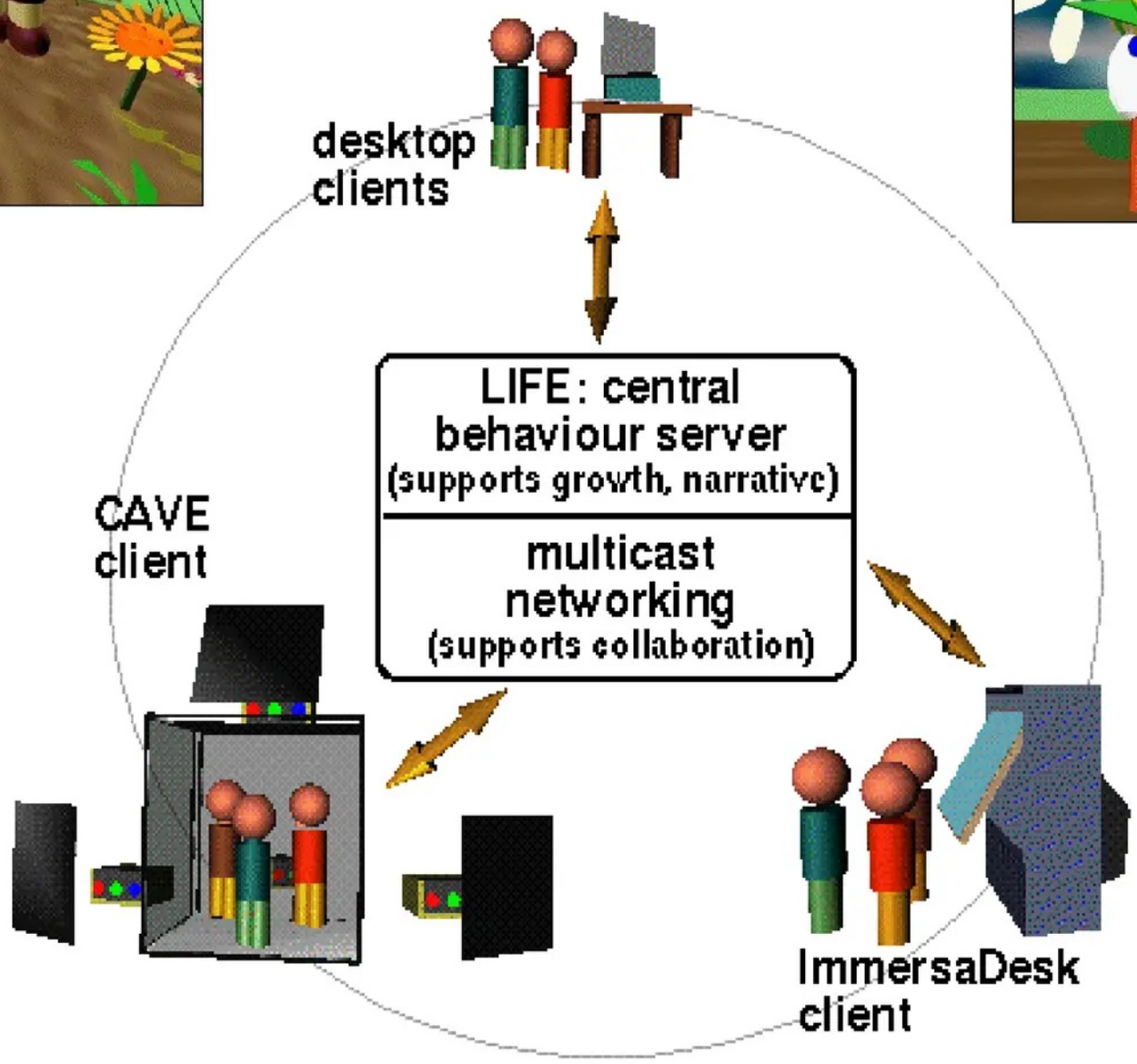
155 Mbps vBNS

Image from EVL

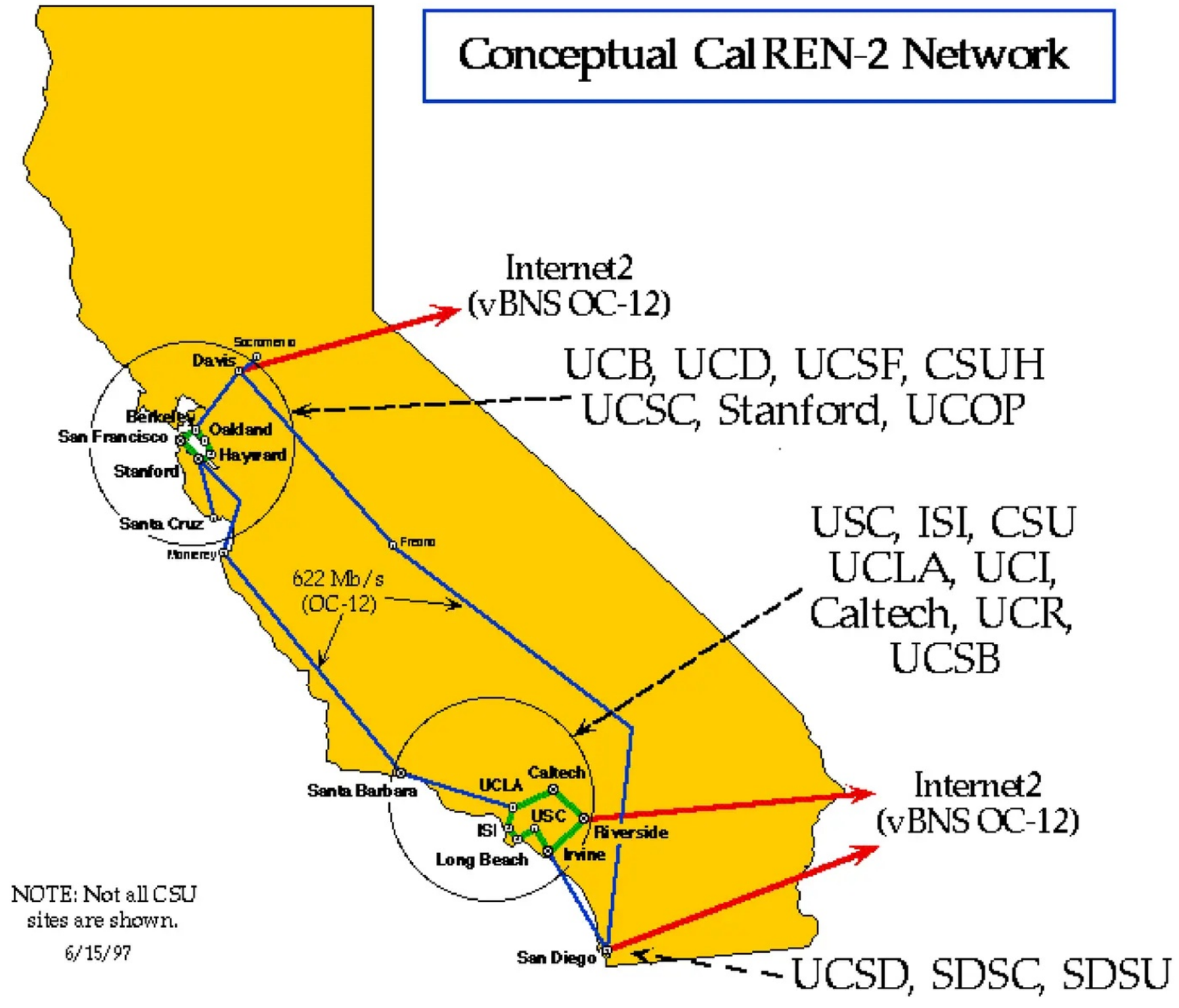
Kids Need the Grid





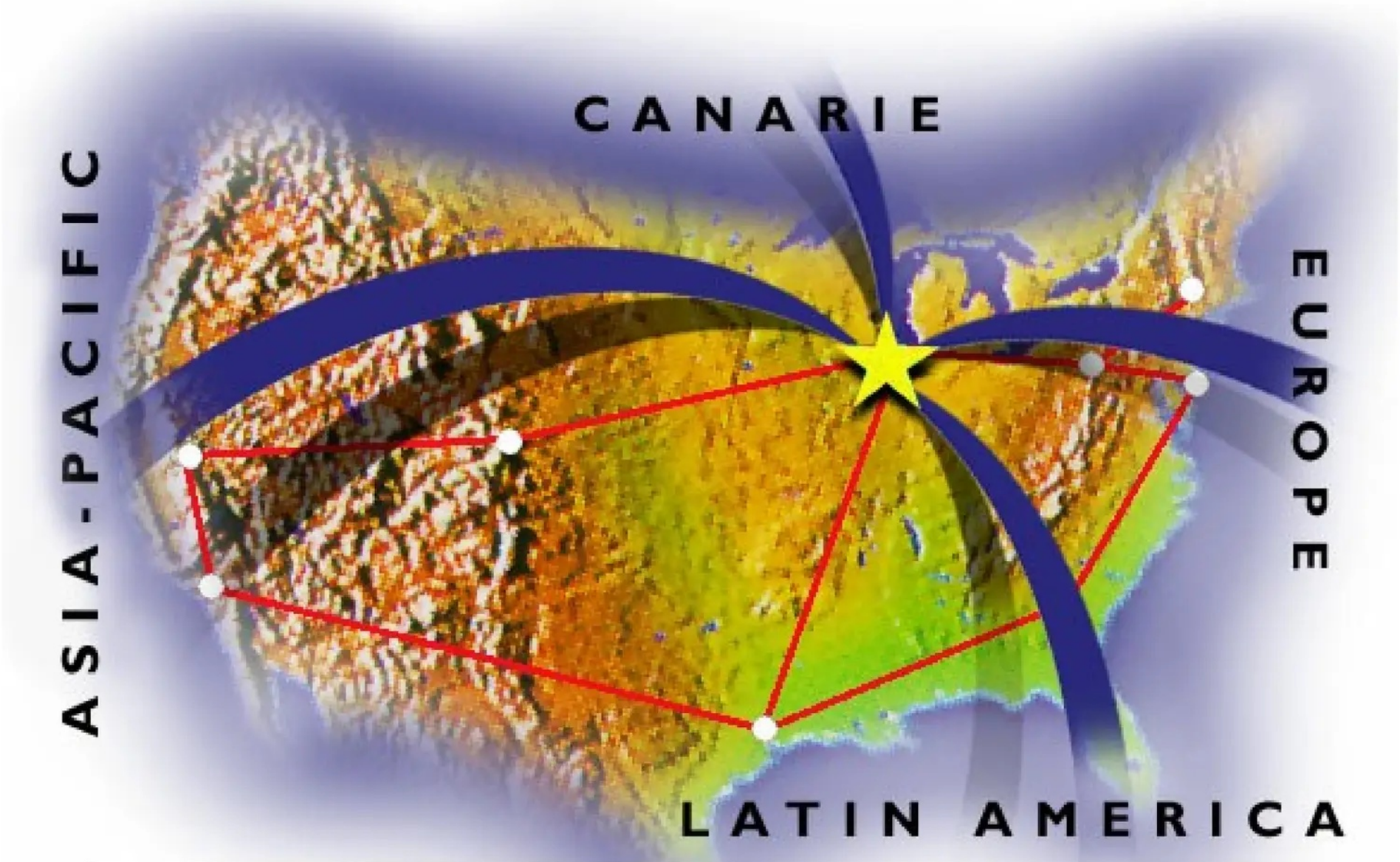


States Need the Grid



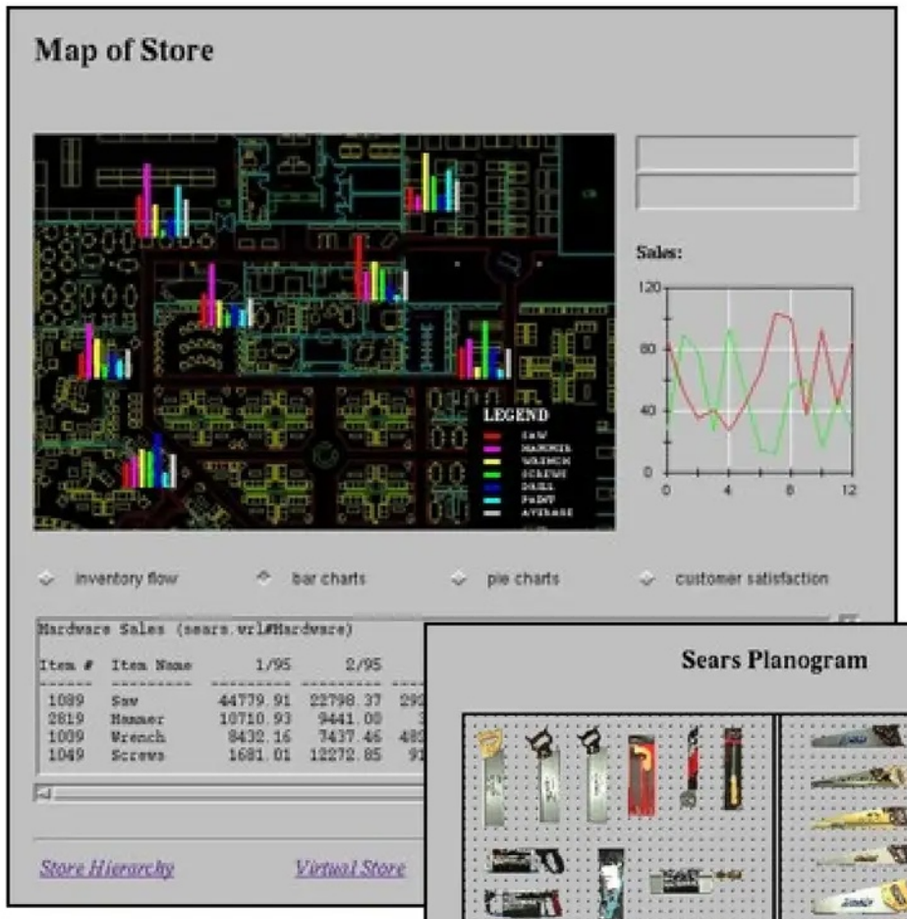
http://www.aldea.com/cenic/calren-2.html

The World Needs the Grid



High-performance networks from across the United States connect with international networks at the STAR TAP access point in Chicago, Illinois

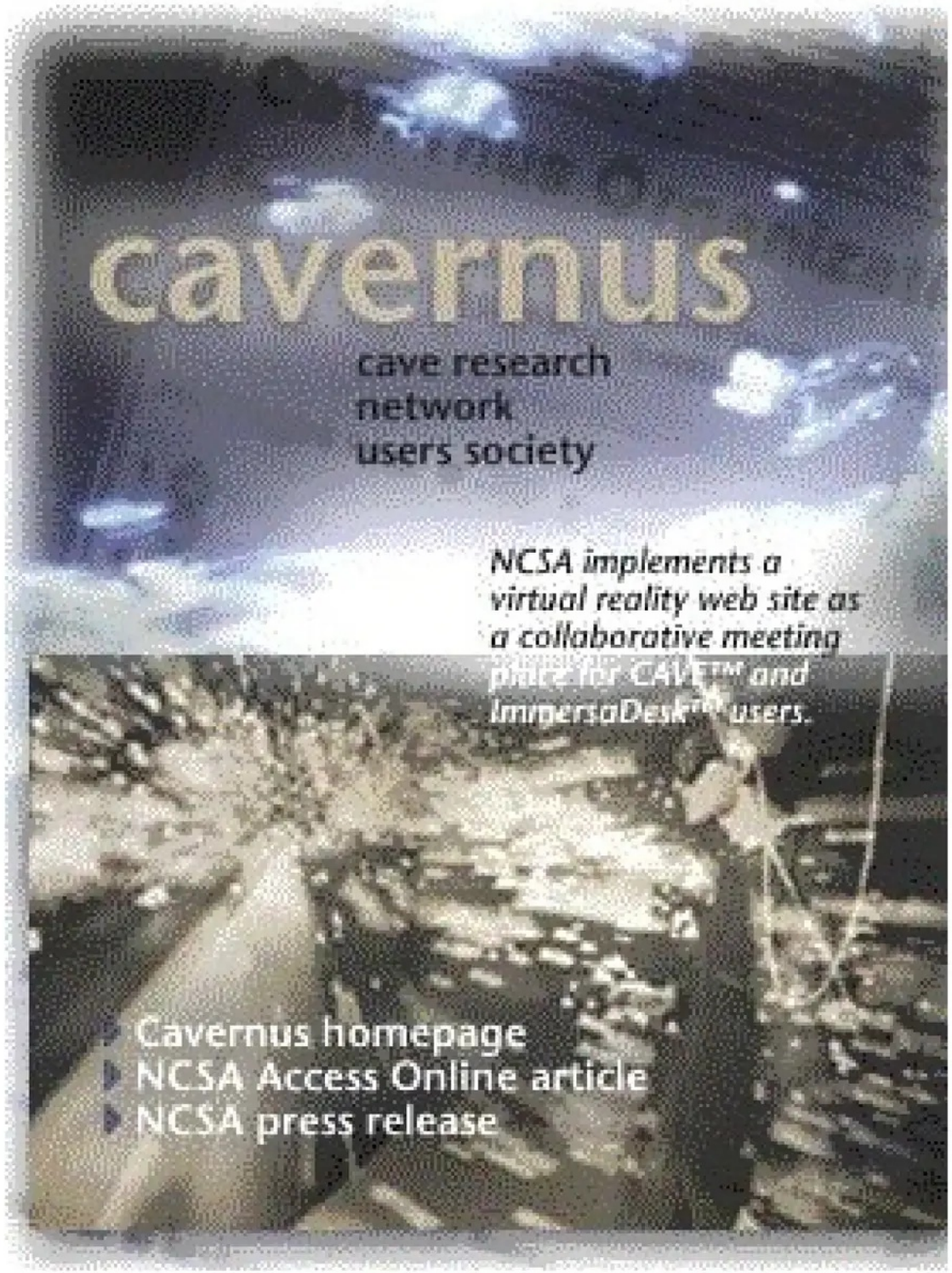
American Consumers Need the Grid







The Grid Needs YOU



- CAVE and ImmersaDesk Systems
- Hypernews Forums
- User Lists
- Application Galleries
- Shared Programs

http://www.ncsa.uiuc.edu/Indices/Spotlight/Features/feature_CAVERNUS.html