A PERSONAL HISTORY OF THE EARLY INTERNET

Dennis Jennings

"I told you this Internet thing would catch on"

THE EARLY INTERNET DAYS -1963-85

- The Computer Networking Conception Phase – 1963 to 1973
- The Birth of the Internet Concept – 1973 – Bob Kahn, Vint Cerf – TCP/IP
- The Internet Research Phase and Pilot Phase – 1973 to 1983
- The Initial Internet Production Phase – 1983 – ARPANET / MILNET adopts TCP/IP - CSnet started. Both were restricted internets – for DARPA research projects, and Computer Science academics, respectively.

A SUMMARY HISTORY TO 2000

The Production Phase – The Open Internet as Infrastructure

- NSFNET – 1985 to 1995 – Open to all US Academic Researcherss
- THE Commercial ISPs – 1989/93; FIXs – 1989; CIXs – 1991;
- The Web – Tim Berners-Lee (CERN) – 1990/1993
- The Web Browser / Server – Mosaic (NCSC, Illinois), January 1983
- The dot.COM Boom and Bust!

NSFNET

Dennis Jennings Background

1981:	IUN Networking Proposal to NBST
1982:	1st HEAnet Proposal
1983:	2nd HEAnet Proposal (Protocols – UK Coloured Books)
	President of the EARN Network
	Technical Adviser to CEC ESPRIT Programme on Networking
1984:	EARN Meetings and Expansion
	Contributor to US NSF's Networking Discussions / Report (TCP/IP)

NSF SUPERCOMPUTER INITIATIVE

Background to the NSF's Supercomputing Initiative and associated Supercomputer Access Network, NSFNET (Originally SCIENCENET).

1982/3:	Complaints by senior US Scientists about Supercomputer Access
1984:	US Congress approves $0.5 billion Superconducting 5-year Initiative and NSF appointed lead agency (10% earmarked for a supercomputer access network)
	NSF'S Office of Advanced Scientific Computing established
	NSF's Supercomputer Centres established
	Search for Program Director for Networking
	– Dennis Jennings appointed.

SCIENCENET/NSFNET MISSION

NSFNET Mission

Provide Access to US Supercomputers for US Academic Researchers

NSFNET – OVERALL STRATEGY

DJ Overall Strategy:

- To build a general-purpose network for all academic research, so that all academic researchers could have access to all networked resources, including the NSF supercomputers, if required.

- For All, not just the Few

NSFNET – OVERALL STRATEGY

DJ Overall Strategy - Why?

- Given my background in research and in Networking in Europe, I believed that research needed national / international networking infrastructure.
- Building Infrastructure is Hard – it's nobody's priority - and special national efforts are required to build infrastructure.
- NSFNET seemed to me to be a wonderful opportunity to get networking infrastructure right for the USA research community.

OVERALL STRATEGY – THE ROAD NOT TAKEN

- Give the funding to each Supercomputer Centre to build individual networks to enable access to their Centre.

- SDSC – MFEnet
- JvNC – DecNet planned (I advised them otherwise)

NSFNET – TECHNICAL POLICY DECISIONS

- Adopt an "open" non proprietary set of internetworking protocols

  I chose the TCP/IP Internet protocol suite, and I mandated that these be used on NSFNET funded networks.

  Because that was the only proven internetworking technology, proven in ARPANET and Csnet

  (the alternative was the ISO/OSI suite of protocols – but they were incomplete and unproven for academic networking requirements).

TCP/IP – THE INTERNET PROTOCOLS

- An Open set of Inter-Networking Protocols
- Standards developed by the Internet Engineering Task Force (the IETF)
- Standards Freely Available
- Standard Unix (Berkeley 4.3) Implementations available for free
- Universal Addressing Scheme, managed centrally (Jon Postel)
- Considerable experience in the US Computer Science community (CSnet)
- Robust technical experience in ARPANET
- BUT – In 1985 – Limited signs of emerging commercial suppliers of hardware and Software, but it was very raw in terms of availability and affordability.

NSFNET – TECHNICAL POLICY DECISIONS - THE ROAD NOT TAKEN

- Leave the technical decisions to the Supercomputer Centres
- This may in the short-term have worked well, but I thought that in the longer term it would not be an optimal strategy - even for supercomputer users.

NSFNET – IMPLEMENTATION DECISIONS

Implementation by the Community

- I expected that the networks would be designed and built by the local research communities, with funding from the NSFNET Programme and from local universities, research institutes, and the local US States.

- Why?
  Because this was what worked in Europe, and because it fostered buy-in and ownership by the local institutions and the built-up of local expertise, and that it would be the most cost effective.

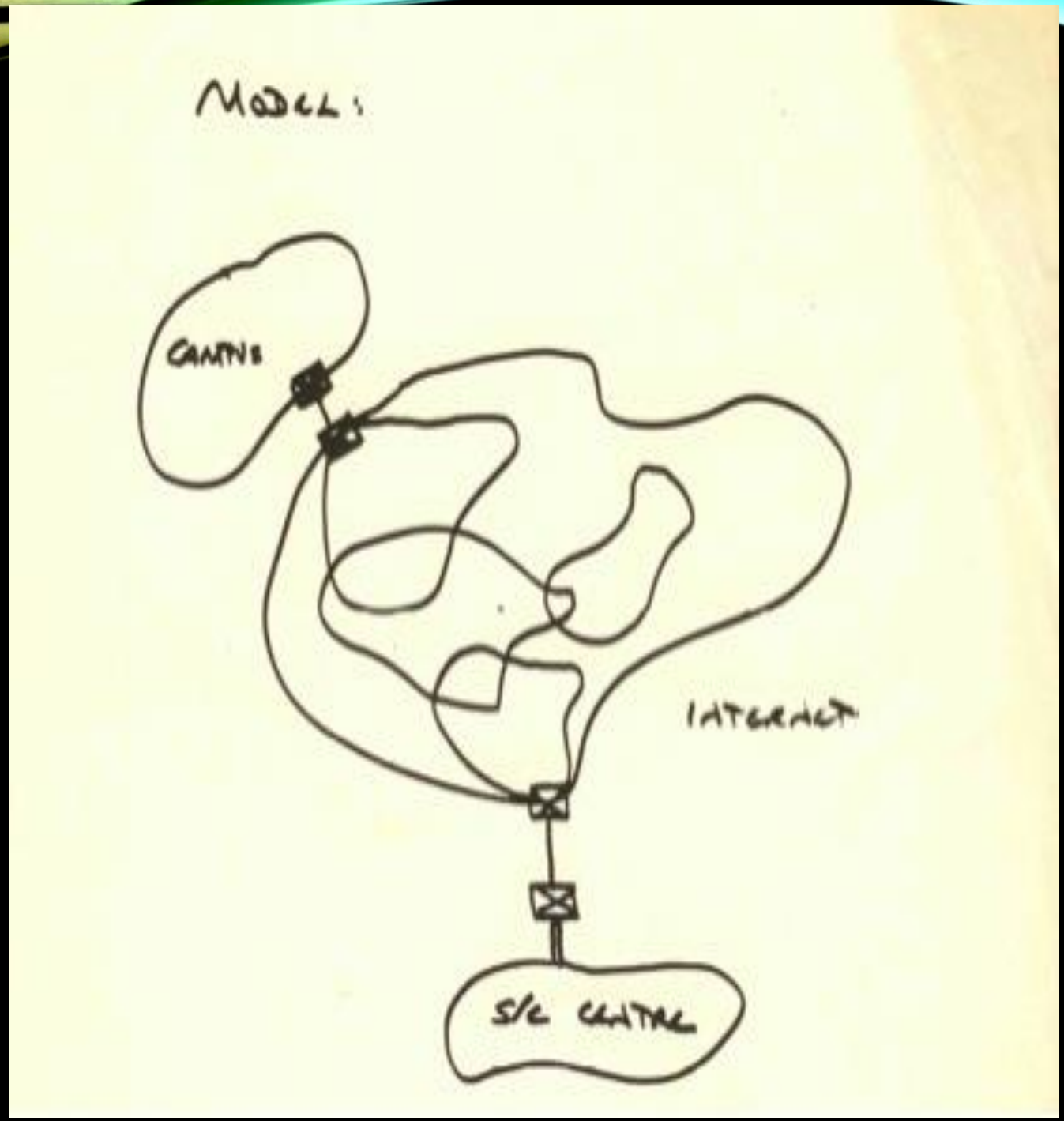
NSFNET – IMPLEMENTATION DECISIONS - THE ROAD NOT TAKEN

Centralised (Lead Contractor) Implementation

- A lead organisation contracting with a specialist firm to design and build a network of networks / internet. There was only one such firm that I was aware of, BBN, and their experience was with ARPANET and US Government funding.

- Why? I thought that this would be difficult, expensive and very slow, and would not encourage local expertise and buy-in, and would not be a stimulus needed to develop the IP suppliers / industry.

1985 – PRESENTATION TO THE NSF SCIENCE BOARD



NSFNET: THE THREE-LAYER MODEL

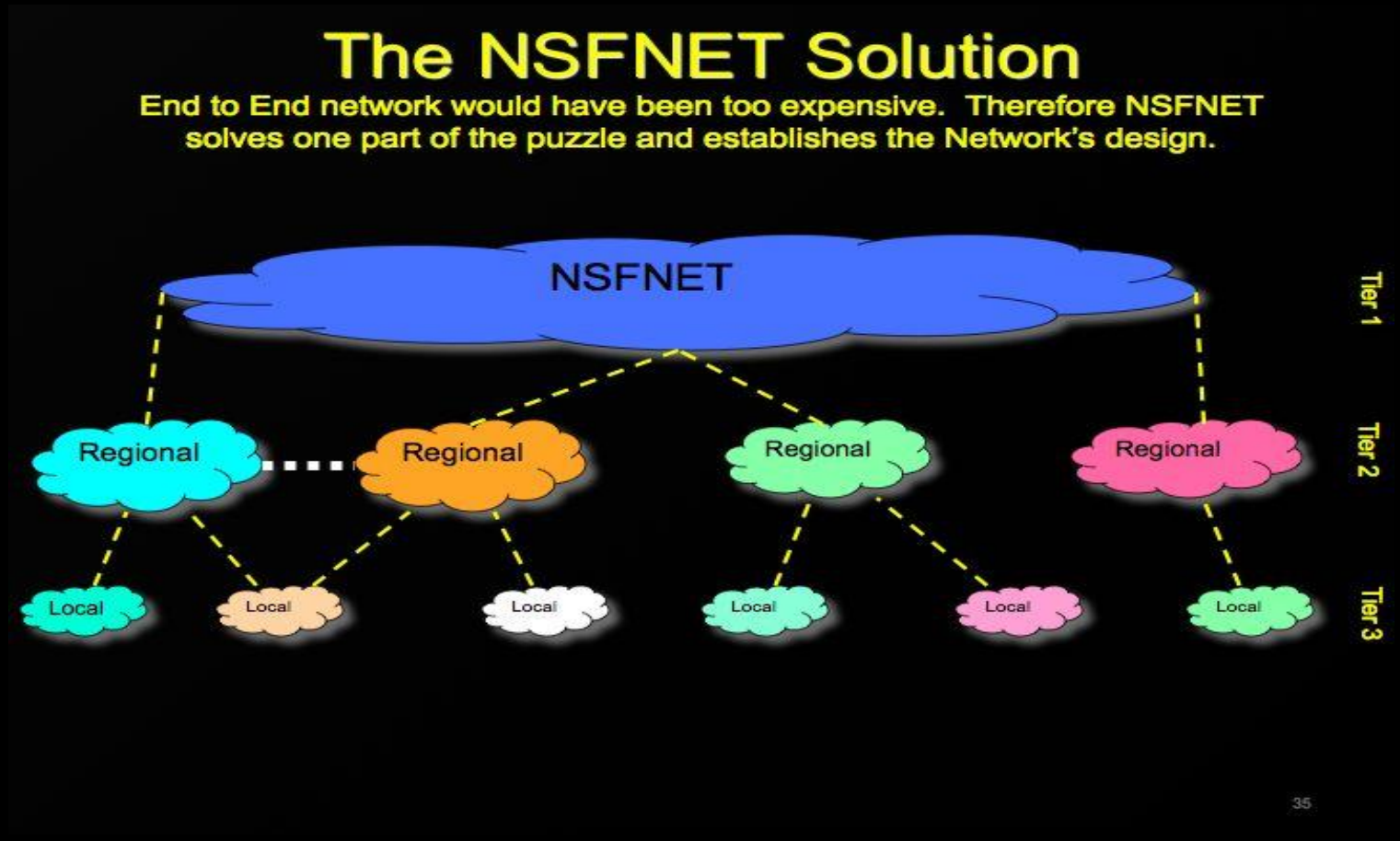
NSFnet Backbone

Mid-Level Networks
(Supercomputer Centre / Regional / State / ARPANET / etc. Networks)

Campus Networks

(All mandated to run Internet Protocols (TCP/IP) and use IP Addressing)

NSFNET NETWORK DESIGN



CAMPUS NETWORKS

- The basic level component of the design was the Campus Network – following the Subsidiarity principle (not that I would have said that in 1985)
- Most US universities in the US had or were developing campus networks using a variety of communications technologies and networking protocols
- Most importantly, the campus networking organisation was asked to take responsibility for connecting researchers to NSFNET, including the supercomputer users. (Individual researchers/research groups would not get individual links to the supercomputers as part of NSFNET).

REGIONAL NETWORKS

- The second level component of the design was the Regional Network
- The definition of “regional” was loose but was designed to encourage campuses to club together with local and regional academic research organizations in their region / State and to build their own shared TCP/IP regional network.
- Most importantly, it was made clear form the outset that the NSFNET Programme would provide some initial funding, but that additional institutional, regional and State funding would be required.
- The NSFNET programme did not exert any control over the Regional Networks, other than to mandate that the TCP/IP protocols be used.

- NSFNET: The Regional Networks

BARRnet; CERFnet; CICNet; JVNCNet,
Merit; MIDnet, NEARNET, NorthWestNet,
NYSERnet, SESQUINET, SURAnet, Westnet

All partially funded by NSFNET, but also funded by States,
Consortiums of Universities, and by commercial companies

OTHER INTERMEDIATE LEVEL NETWORKS

- Other Intermediate level Networks
- The supercomputer Centre networks were also considered to be NSFNET intermediate level networks, and existing ones were requested to transition to TCP/IP protocols as soon as possible.

- (The SDSC supercomputer centre network was, quite reasonably, very reluctant. The JvNC supercomputer network was advised to use TCP/IP rather that DECNET).

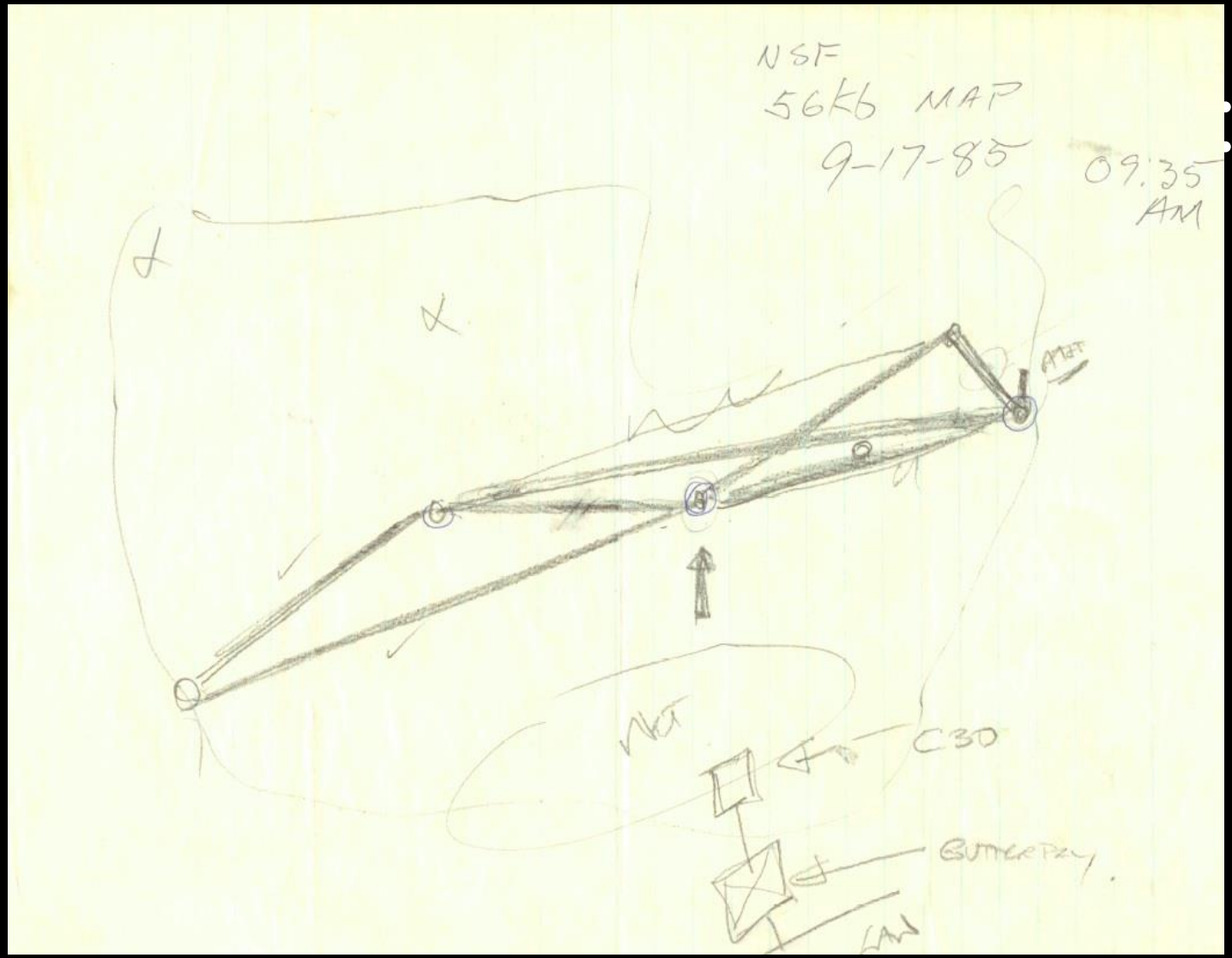
- The ARPANET was also considered a NSFNET intermediate Network (!), and NSFNET funds were transferred to DCA via DARPA for expansion of the ARPANET by up to 20 nodes

THE NSFNET BACKBONE

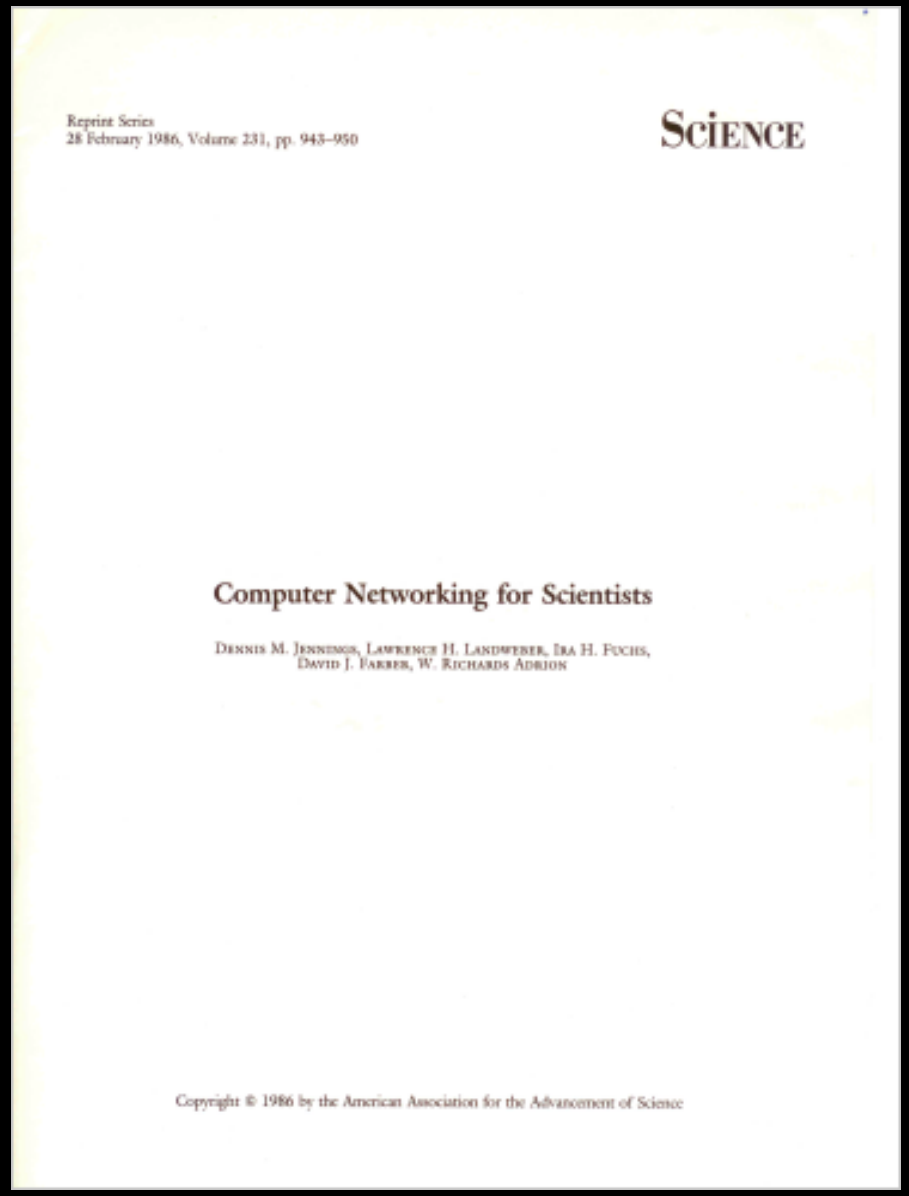
The NSFNET Backbone

- The top-level component of the NSFNET design was the NSFNET Backbone Network, and the initial backbone was to be funded completely by the NSFNET Programme.
- The approach was that the NSF Supercomputer Centres would take responsibility and build the NSFNET backbone as a collaborative project and interconnect at the campus/regional networks.
- The initial approach to the NSF Supercomputer Centre Directors was rebuffed, but after some discussions and explanation, they were enthusiastically behind the project.

- NSFNET:
  The [Interim] Backbone



- NSFNET:
  The SCIENCE Article



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SCIENCE

Computer Networking for Scientists

DENNIS M. JENNINGS, LAWRENCE H. LANDWEBER, IRA H. FUCHS,
DAVID J. FARBER, W. RICHARDS ADRION

- NSFNET: SCIENCE Article - The Vision Statements

"Our vision of this network is of a vast network of networks interconnecting the scientist's local advanced graphics workstation environment to other local and national resources."

"Through … single window … … the scientist may gain access to required computing facilities and databases and communicate with peers, colleagues and scholars throughout the world."

A PERSONAL HISTORY OF THE INTERNET

NSFNET - Consequences

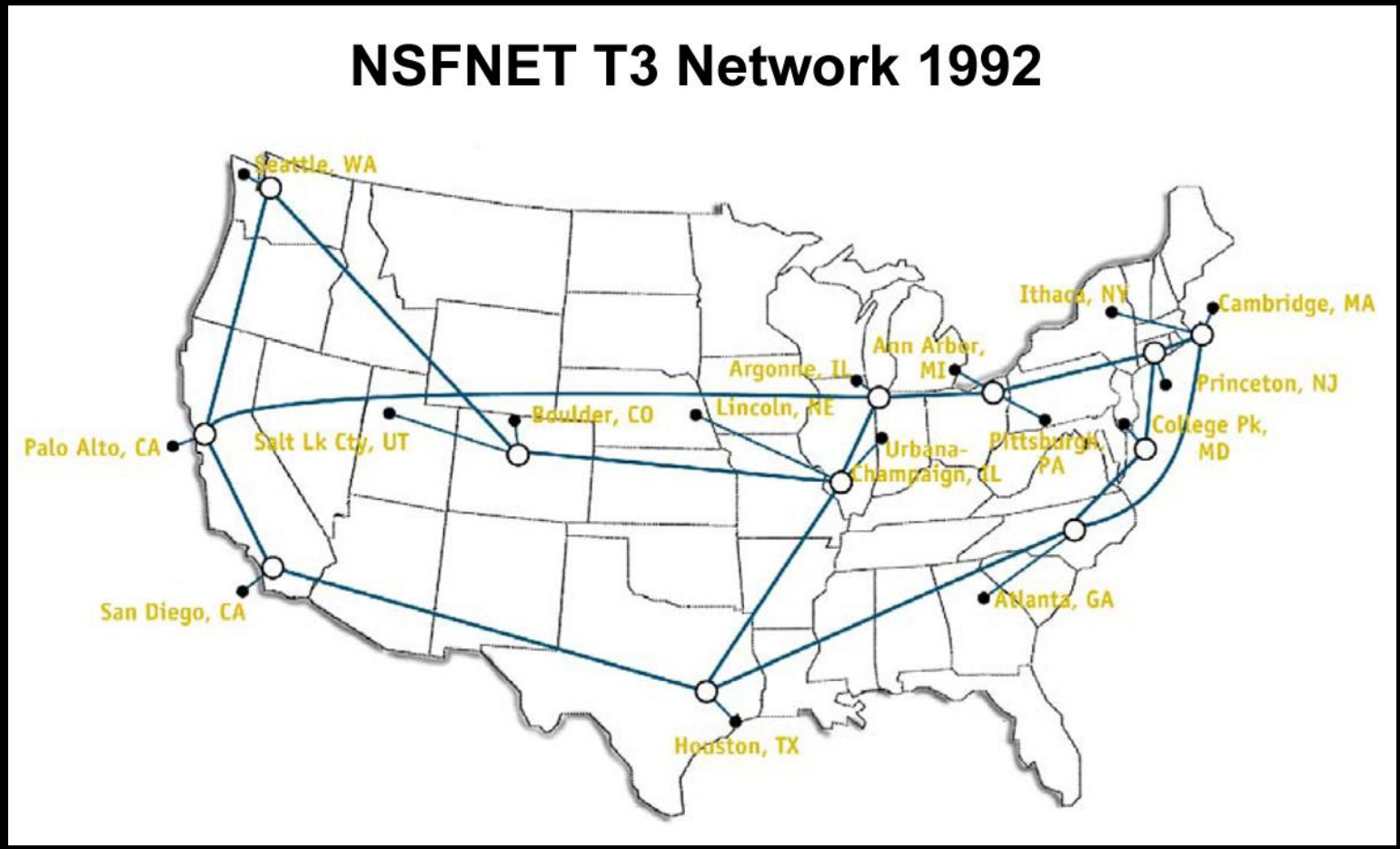
- The NSFNET Backbone – initially 56Kb with planned upgrade to T1. The Backbone became the driver of the development of advanced high-speed networking. The Developments were funded by under an NSF Cooperative Agreement with Merit / IBM / MCI with the NSF
- The Regionals – Only partially funded by the NSF, they Initially took on commercial research customers, and then all customers, and spawned the commercial ISPs
- Campus Networks – developed into the core service for the campus.

A PERSONAL HISTORY OF THE INTERNET

NSFNET

- **The beginning of the open Internet** - designed to serve the US Research Community (and the supercomputer users), and it developed into the Internet we know today…..
- My Role: Based on my European experiences, I went around the USA, explaining the benefits, and encouraging local research communities to build their own local and regional networks and connect to the Internet.
- I spent or committed $17 million while at the NSF

NSFNET T3 Network 1992



A PERSONAL HISTORY OF THE EARLY INTERNET

YES, it's true.

An Irish man started the open Internet.

(with help from many wonderful people at the NSF – especially Steve Wolff who built upon the decisions I made – and the US research community)

Thank You