THE STRATEGIC FUTURE OF THE MID-LEVEL NETWORKS

Richard Mandelbaum	Vice Provost for Computing University of Rochester President, NYSERNet
Paulette A. Mandelbaum	Director, Special Projects Utilicom Inc.

"There is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage than the creation of a new order of things" (Machiavelli, The Prince, 1513)

CONTENTS

Executive Summary 1

I. The Evolution of the Networks : A Review 2

A. A Historical perspective 2

1.Technical Awareness 8

2. Interlude - The Early Players, 1985-1988 11

3. Market and Service Awareness 11

4. A New Age 15

B. Network Evolution – A Conceptual Model 20

II The Networking Challenge 26

A. The Issues 26

1. Increased Connectivity 26

2. Equitable Access 26

3. Simplicity of Use 28

4. Information Resource Provision 28

5. Standards and Interoperability 29

6. Technical Development 29

B. The Business of the Regionals 30

1. Offerings - The Products and Service 30

2. Nature of the Marketplace and Responsiveness to the Market 32

3. Geography and Funding – The Place and the Price 36

4. The Internal Business Structure 37

III. Models for Regional Networks: A Critical Assessment 39

A. The Regionals Today - A Summary 39

B. The Limited Network Model 40

C. The Low Cost Operator 41

D. The Challenge of the Full Service Providers 42

1. The Full Service Not-For-Profit Provider (FSP) Analyzed 42

2. The For-Profit Full Service Provider Analyzed 43

IV. The Regional Network as Market Maker: A New Model 45

A. The Contemporary Landscape 45

1. The Role of the Regionals in Operations Is Challenged 45

2. The Academic and Research Communities As Potential Losers 45

B. The Marketmaker Model Exploits the Regionals' Key Strengths 46

1. The Marketmaker Model Applied 46

2. Stimulating Competitive Sources of Supply 46

3. Maintaining Competitive Pricing 47

4. Protecting the Interests of the Research and Academic Communities: Serving As A General Contractor 47

5. Stimulating New Demand and Increasing Existing Demand 48

6. Engaging in Secondary Functions - Good Business 49

7. Engaging in Secondary Functions - Good Citizenship 52

C. The Viability of the Market Maker 53

1. One or Many? 53

2. Funding Mechanisms, Organization and Viability 54

3. Contribution of the State Networks 55

4. Relations With the Regional Bell Operating Companies 55

Prognosis 57

Executive Summary

Three-Tier Model De-Bunked

We analyze the three tiers of the NSFNET in terms of existing models of the U.S. high-speed telecommunications entities. Analysis leads to the conclusion that the 3-tier model currently in vogue is both artificial and inadequate. It is artificial because there are no inherent reasons for limiting the activities of a particular tier, or assigning specific network activities to a particular tier. Networks in any tier may reorganize themselves to take on the functions of another tier, or of all three tiers, or to divest themselves of functions and create new tiers. The model is inadequate because it fails to differentiate among the various types of services and organizational modes adopted by existing networks. Because of these flaws, the 3-tier model does not provide insight into the future evolution of the regional networks.

Adopting a New Model with Categories Defined by Types of Services

We propose a new model for analyzing the strategic future of the regionals. The model currently has four types, The Limited Network,the Low Cost Operator, the For-Profit Full Service Provider (FSP), and the Not-For-Profit Full Service Provider. There is also beginning of a trend to evolve towards a fifth type, which we call the Marketmaker.

Analysis of Regional's Activities from Perspective of a Firm

We analyze the five types of networks in terms of a simple model of a business. We identify current and potential markets in which the different types of networks operate, assess how they have functioned to date, and look at the relationships of the different network types to other entities, such as the traditional telcom carriers or state governments.

The Marketmaker as the Most Effective Network Type for the 1990's

The Marketmaker's key mission is to advance research, education, patient care and economic productivity by means of high-speed telecommunications techniques. We identify the most effective ways in which the Marketmaker can achieve its goals, by divesting itself of operations, by acting as a general contractor, by stimulating and assuring competitive sources of supply for NREN connectivity, and viewed from the perspective of a for-profit firm by marketing both concepts and services.

Things To Do

- Regionals should start thinking about divesting themselves of actual operations.
- They should broaden their horizons, start acting as general contractors.
- They should begin doing serious marketing of the concept of networking, and educate the appropriate communities about network connectivity.
- They should begin to view themselves as businesses and their publics as markets.
- They should be creative in seeking strategic alliances and partnerships.

Things Not To Do

- Regionals should not continue business as usual

I. The Evolution of the Networks : A Review

A. A Historical perspective

In 1984 as a result of intense lobbying by the physics community and the broader scientific community Congress became convinced that the US must meet the "Japanese Supercomputing Challenge." In response, Congress authorized the National Science Foundation (NSF) to fund the construction and operation of US supercomputing centers[1] which would assure that US researchers had available to them the computing power necessary to stay abreast of the Japanese. In 1984 the NSF issued a solicitation for the establishment of these centers and by the end of 1985 funds for the establishment of five new Supercomputer Centers were awarded by the NSF. These five centers joined the already functioning NSF-funded National Center for Atmospheric Research (NCAR) supercomputer center in Boulder, Col.

The establishment of five supercomputer centers did not fully solve the problem of how to bring supercomputing power to the wide array of US scientists who needed it. The successful University of Illinois at Champaign-Urbana National Center for Supercomputer Applications (NCSA) proposal envisioned providing supercomputer power to researchers primarily by having them or their graduate students come to the University to use the supercomputer. The University consortia which received funding from the NSF for the establishment of the San Diego Supercomputer Center (SDSC) and the John Von Neumann Supercomputing Center (JVNC) at Princeton also received grant funds for the leasing of data communication lines connecting the Universities in the consortia with the supercomputers at their Centers. Both of these consortia thought of computer access in terms of point to point data lines connecting a computer with its potential users and therefore each of them proposed essentially "star-shaped networks" (See diagrams 1 and 2) as their answer to the supercomputing access problem.[2]

In late 1985 the NSF decided that the Illinois paradigm would not adequately serve the needs of the research community. It thus took two steps to extend direct supercomputer access to a larger portion of the scientific community. First, the NSF signed a Memorandum of Understanding with the Defense Advanced Research Project Agency (DARPA) to extend the DARPA-managed computer network ARPANET to the supercomputer centers. The agreement also called for DARPA to allow researchers to use ARPANET to access the NSF centers. ARPANET, which started its life in 1969 as an experiment in sharing Department of Defense–funded, University–based computer resources, had by 1985 evolved to where it connected thousands of researchers at major Universities and government Labs, as well as DOD contractors.

---

[1] Lobbying took the form of both personal involvement by physicists such as Ken Wilson and Larry Smarr as well as reports such as the Lax report of 1982 (Report of the Panel on Large Scale Computing in Science and Engineering, Peter Lax, Chairman, NSF, Dec. 1982) and the Barden-Curtis report of 1983. (A National Computing Environment fro Academic research. M. Bardon and K. Curtis, NSF Working Group on Computer fro Research. NSF, July 1983)

[2] The SDSC proposal featured 56kb lines to institutions as far west as the University of Hawaii in Honolulu and as far east as the University of Maryland in College Park. The JVNC proposal had one T1 line from Princeton to Boston which was shared by Harvard, MIT and Brown, but otherwise was a mixture of point-to-point T1 and 56kb terrestrial lines to the other Eastern Consortium members, as well as 56kb satellite links to the University of Arizona and the University of Colorado .

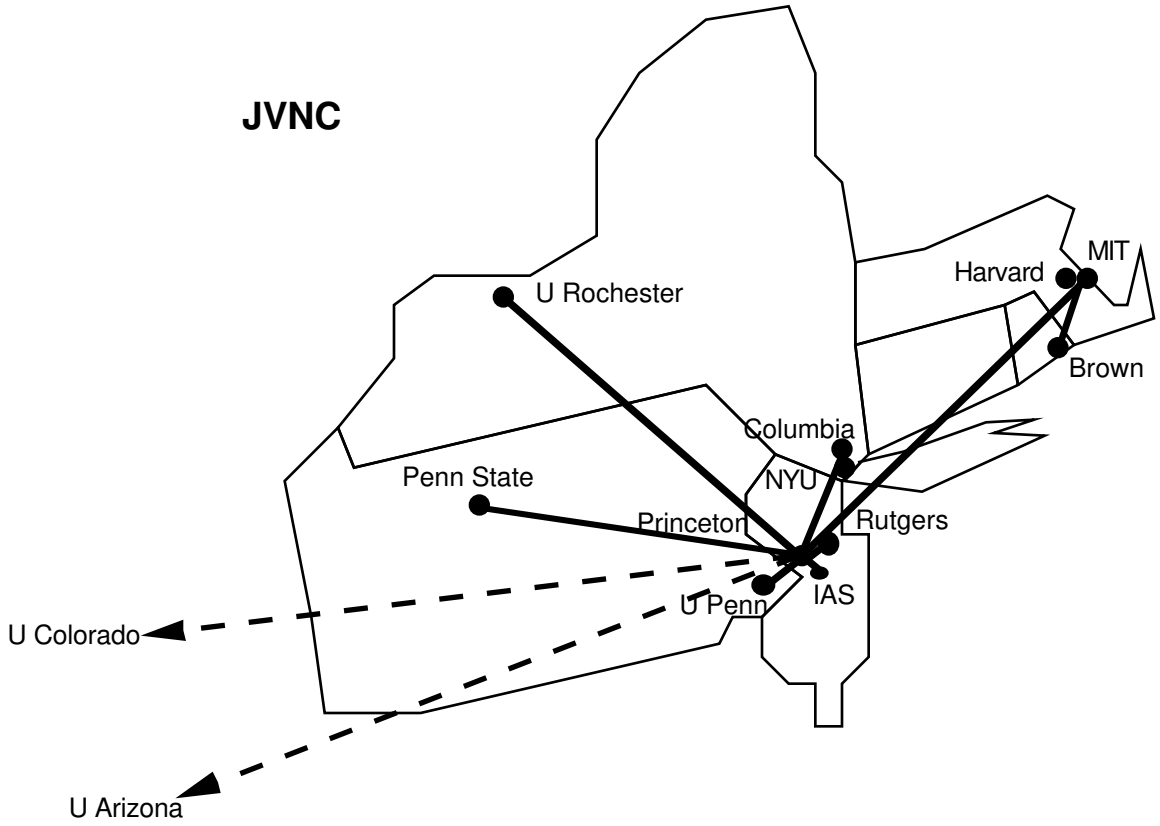

Fig 1. The JVNC Network topology in 1987

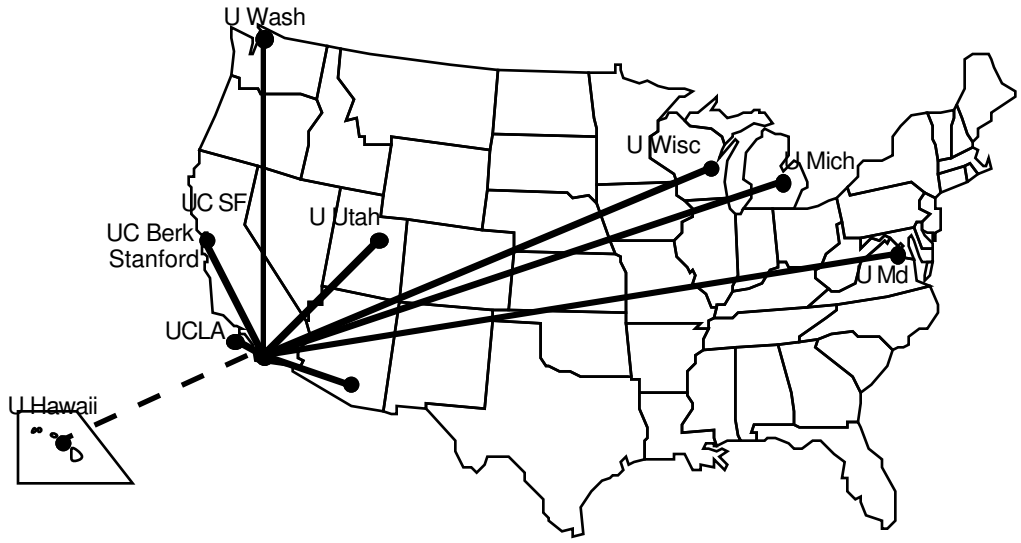

Fig 2. The SDSC Network Proposal (1986)

Second, a new solicitation, the NSF Connections program, was issued by the NSF in 1986 in order to help universities which needed supercomputer access. The implicit network model underlying this program was analogous to that presented in the SDSC proposal. The NSF would help provide hardware and/or a telecommunication line for direct point to point connections between a university computer and the supercomputer center. Furthermore the NSF decided that it did not want to limit supercomputer accessibility to researchers using fixed computer hardware. It therefore mandated that all NSF-funded supercomputer centers and computer networks use the TCP/IP computer communications protocol, which was a non-proprietary protocol allowing the interconnection of diverse hardware under numerous operating systems.[3]

The TCP/IP protocol was not the only non-proprietary protocol which NSF could have chosen. The standard communications protocol in use on the public packet switch networks, such as TYMNET or TELNET was the non-proprietary X.25 protocol. However TCP/IP was the protocol used on the ARPANET and the protocol most favored by the computer science and DOD user communities.[4]

Among the more original responses that NSF received to solve the supercomputer access problem were those for the establishment of SURANet and NYSERNet. The authors of both the NYSERNet and SURANet proposals realized that by piggybacking multiple institutions on each data line to the supercomputer center more sites could be connected to the supercomputer for a fixed cost than would be by connecting each site individually to the center, i.e. the 'star shaped' network. Thus both proposals called for the establishment of networks significantly more complex than the JvNC and SDSC networks. (See Figures 3 and 4).

The SURANet proposal was submitted under the auspices of SURA, the Southern Universities Research Association, a research consortium of 37 Southern Universities. SURA had been set up in 1982(?) to coordinate joint research by this group of universities and would now, along with its other activities, manage SURANet on behalf of its constituent universities. Network equipment would be owned and operated by each individual University and SURA would play a coordinating role.

In contradistinction, NYSERNet Inc. was a new organization whose sole purpose was to satisfy the external networking and supercomputer access needs of the universities and government lab which had founded it.NYSERNet was to be the core of the Cornell Center's own effort to arrange for researchers to access the CNSF. The NYSERNet concept was that this new entity, working

---

[3] JVNC was induced to change its plans to use the proprietary DECNET protocol in favor of TCP/IP. The SDSC network which initially used the specialized MFE protocol, also transitioned to TCP/IP.

[4] The decision by Denis Jennings, NSF's program director for networking, to choose TCP/IP over X.25 as the mandated protocol for the emerging NSFNET, was a far-reaching decision which was to have major consequences. It led almost directly to the establishment of the system of specialized private academic networks we have today, rather than to reliance by the academic and research community on the public, commercial networks which are the mainstay's of the business world. The decision was rooted in part in technical grounds, such as the preference of most of the university networking community for connection-less protocols such as IP over connection-oriented protocols such as X.25. DECNET, however, was a connectionless protocol which was at the heart of almost all of High Energy Physics Networking and is widely used today in ESNet and SPAN. DECNET was certainly a viable option for NSFNET. The choice of a proprietary protocol such as DECNET would have led to a far different networking universe than the one we have today.

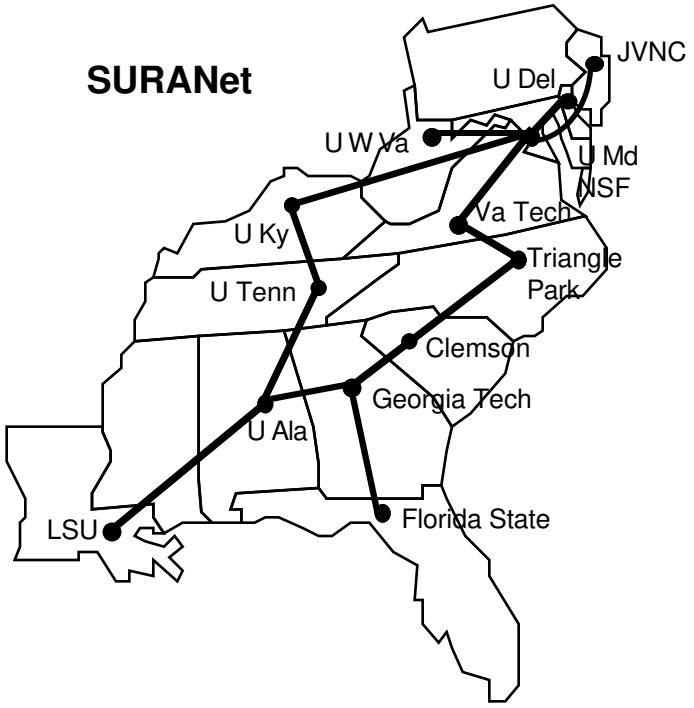

Figure 3 . SURANet (1987)

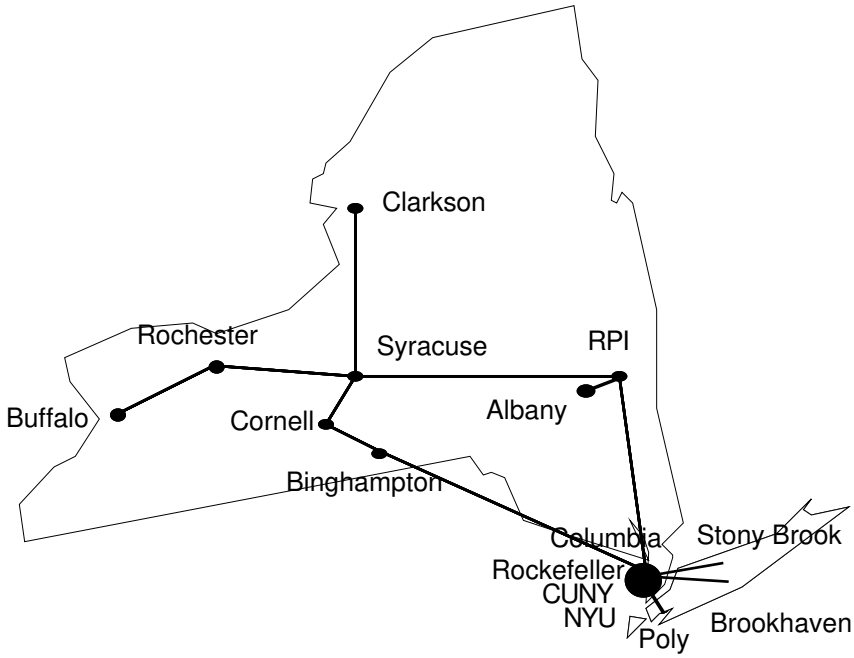

Figure 4. NYSERNet (1987)

closely with the Cornell Center and JVNC, would be completely responsible for networking, including funding, industry relations, network equipment and network monitoring. [5]

The NYSERNet and SURANet examples caused a major paradigm shift at NSF. Instead of funding institutional connections to supercomputer centers, the NSF shifted to funding connections of "cohesive" regional networks. From mid 1986 , when the SURA and NYSERNet proposals were initially funded, to mid 1987 more than a dozen regional networks such as BARRNet (San Francisco Bay Area Regional Research Network), MIDNet, PSCNet (Pittsburgh Supercomputer Net), SESQUINet (Texas based), Westnet etc. came into being.

In order to enable researchers connected to one center to have access to the other centers as well, in 1986, the NSF also funded the creation of a national "backbone" network connecting the super-computer centers and the regional networks connected to them to one another.

The array of networks, both LANS and WANS, which were used to provide supercomputer access were grouped by the NSF into three tiers or levels.

Level 1 - A national 'backbone' network whose purpose was to connect the supercomputer centers and the varied regional wide area networks.

Level 2 - Regional and supercomputer-consortia networks, usually organized around geography such as

Metropolitan Areas	(e.g. BARRNet),
States	(e.g. NYSERNet)
Larger Geographic Regions	(e.g. SURANet)

Level 3 - Campus Networks
- Internal LAN's providing services for a single academic or industrial campus

The first two tiers of this three level structure came to be called the NSFNET; the first tier is the NSFNET backbone.[6] (See Figure 5). The networks in the second tier, primarily regional networks, are sometimes also called the mid-level networks. NSFNET is not a network. It is an inter-network, that is a network of networks, which are organizationally and technically

---

[5] NYSERNet came into being as follows: In March of 1985, following the success of Cornell's Super Computing Facility (CNSF) proposal and the JvNC proposal which the University of Rochester had participated in, representatives of those Universities met to discuss how to extend supercomputer access to the rest of the educational and research institutions in the State of New York. As a result of those discussions a meeting attended by representatives of the 14 major New York State universities, Brookhaven National Laboratory and officials of the NSF and the New York State Science and Technology Foundation (NYSS&TF) was held at Cornell in June of 1985. The representatives agreed to set up a new organization, NYSERNet, whose sole purpose was to satisfy the external networking and supercomputer access needs of those institutions. The initial Cornell meeting was quickly followed by a joint meeting in July at the NYSS&TF offices in Albany with representatives of the major hi-tech research corporations in New York State, AT&T, Corning Glass, General Electric, Grumman, IBM, Kodak and Xerox, in order to enlist industry support for, and participation in, NYSERNet and also to emphasize the economic development and academic- industry cooperation aspects of the network.

[6] Sometimes the name NSFNET is used to refer to only the NSFNET backbone.

autonomous, but which inter-operate with one another. NSFNET is part of a larger inter-net, called the Internet. which includes not only NSFNET but also other federal agency networks such as DOD, DOE and NASA networks.

The three tier model for NSFNET was not an a priori construct. Rather it came into existence in an attempt to rationalize the various types of networking grants that NSF was making . It was first explicitly described in a January 14,1987 recommendation of the NSFNET Networking Program Advisory Group's (NPAG) policy subcommittee to Steve Wolff, NSF program director for networking.

> "...the Policy Committee of the NPAG strongly recommends that NSF adopt a three level hierarchical model for NSFNET as described in the following. The three levels are a backbone network, middle level networks and campus networks.
>
> The backbone network should provide a high speed interconnect for the middle level networks. The backbone network should remain the financial, operational and administrative responsibility of NSF for the foreseeable future. It is imperative that

---

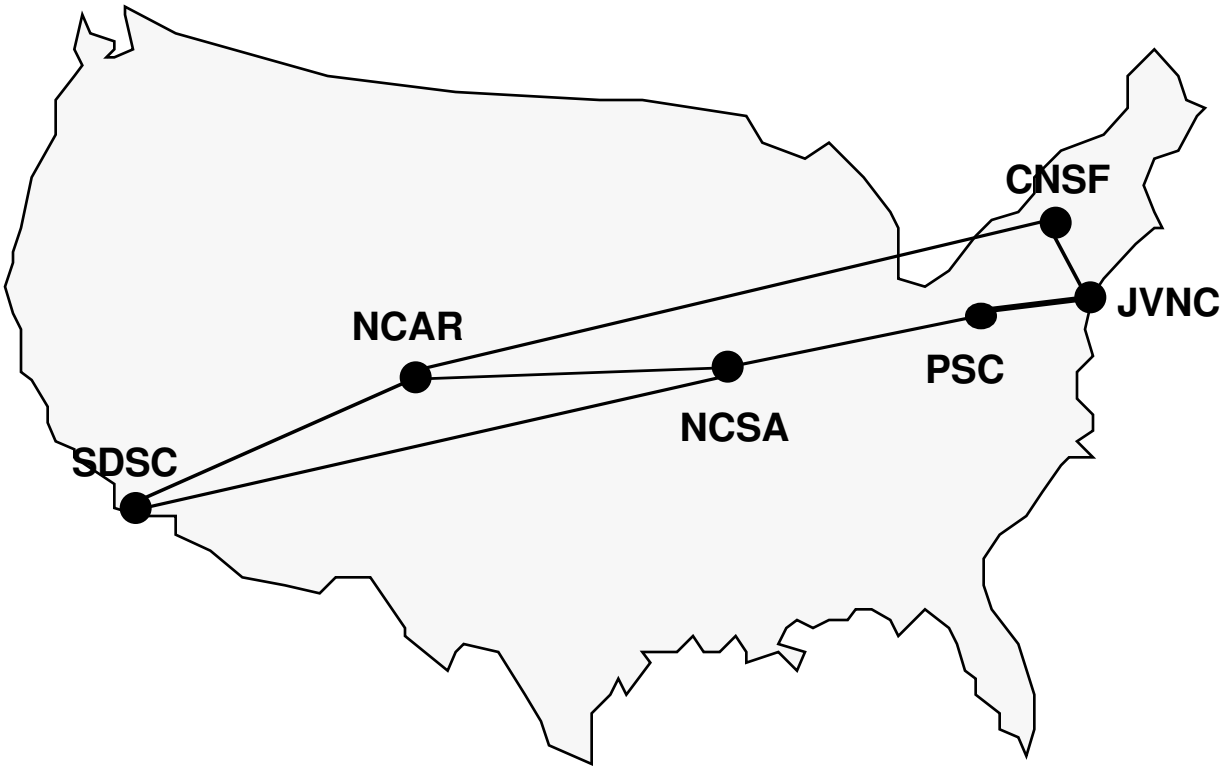

Figure 5. The First NSFNET Backbone

The original NSFNET backbone consisted of 56kb lines connecting the NSF super computer centers to one another. The network topology was determined in a phone-call between Bill Schrader, then Executive Director at the Cornell Supercomputer Center and his local AT&T marketing representative.

some of these functions be managed by an organization or organizations chosen and funded by NSF, with the mission of providing a very high level of reliability and responsiveness.

A campus network should provide for network infrastructure within a single "organization". This organization will have financial, operational and administrative responsibility for its network. This responsibility includes providing direct user support and also affiliating with an appropriate middle level network to which the campus network is connected.

It is expected that there will be two types of middle level networks, primary and secondary. Primary middle level networks will provide a high speed interconnect for campus networks of organizations within a given geographical area. To the extent possible, overlap of primary middle level networks should be avoided. The primary middle level networks should be administered by and in the long term funded by the organizations (e.g., universities and industrial research centers) whose campus networks they connect.

The committee recognizes that at present there are a number of middle level networks not based on geography. These secondary middle level networks include consortium networks (JVNC, SDSC, PSCC), discipline networks (e.g., USAN, CSNET) and other networks (e.g., BITNET, ARPANET) providing broad support to scientific researchers. The secondary middle level networks should be treated as special cases. For each one, the committee recommends that NSF funding be dependent on a case being made that the network provides a type or level of service and reliability not currently supported by the primary middle level networks which are available."

By mid 1987 the regional and supercomputer center networks had proliferated to the point where they founded a new organization, the Federation of American Research Networks (FARNET)[7] to facilitate communication amongst themselves and to represent their interests to the NSF .

1.Technical Awareness

The primary questions facing the early mid-level networks were purely technical. They included such issues as:

1. routers to be used
2. network architecture to be chosen
3. monitoring of the network
4. source of supply for the leased lines.

The operators of these new networks were reacting to a pressing need for access. The force driving them was the need to get a network with some degree of reliability up and running as soon as possible. This phase of network history, which may be called the "Nuts & Bolts" phase, was common to almost all of the early networks in the country.

"Nuts and Bolts" quickly gave way to a "Keeping it Running" phase. NSF made its initial set of networking awards in mid-1986 through mid-1987 and by the summer of 1987, the first fruits of

---

[7] The purpose of FARNET was "...to advance science and education in general by assisting in the interchange of information among research and educational institutions using high speed data communications ... to encourage the formation of a unified nationwide network for education and research..."

the Connections Program began to appear. NYSERNet, for example, began installing lines and routers in January 1987 and had most of its original sites connected by May of that year. It soon became clear at NYSERNet and at most of the other networks, that networking was more than just a question of ordering lines and installing routers. The early networks were based on innovative, inexpensive, router technology and involved both new hardware and software platforms. This relatively untested technology was bug-ridden and the early regional networks were plagued by reliability problems, both in hardware and software, as well as problems related to loss of connectivity, routing instability, network monitoring, and line quality. The operators of the networks urgently needed the ability to monitor network operations and troubleshoot the network, but in 1987 no TCP/IP network monitoring software existed. Furthermore the totally decentralized administrative structure of many of the first regionals resulted in responsibility for the operation of the network residing in the hands of more than a dozen different computer center staffs! The "throw me a line" model of running a TCP/IP network was not working.[8]

This situation led to the establishment of centralized Network Operations Centers to solve the problem of decentralized responsibility and the development of software tools to allow for network monitoring . In 1987-88, NYSERNet developed and began to market its Simple Gateway and then Simple Network Monitoring Protocol (SNMP) implementations. Simultaneously it campaigned for and won the acceptance of these protocols as Internet Standards[9] and eventually as de-facto industry standards.[10] SNMP became the monitoring protocol of the mid-level networks.

The emergence and rapid growth of the mid-level networks led to enormous increases in network usage. By early 1987 it was clear to the NSF that the NSFNET backbone would be saturated within a year. As a result the NSF released a solicitation for a new NSFNET backbone. The idea now was to interconnect the regionals and supercomputer centers using T1 lines. In November of 1987, a contract to engineer, install, operate and manage a new NSF backbone was awarded to a consortium of Merit, Inc. (the State of Michigan Network), IBM and MCI. By July of 1988, the new backbone was up and running. (See Figure 6)

The NSF was not oblivious to the problems the regionals were having in providing reliable high quality services. In the new NSFNET backbone solicitation, the NSF explicitly requested that the managing organization " establish a Network Operations Center as a facility equipped with the resources needed to assess network reliability and performance, estimate node reachability, track hardware outages, monitor network traffic, and produce network traffic analysis and status reports."[11] Merit Inc. took on the role of backbone network operator and monitor, MCI was responsible for the physical line provision and operation and IBM provided routers and router

---

[8] The "throw me a line" model was based on the paradigm that a network came into being by simply connecting computer centers together with data lines and forwarding messages. It was based on the experience many academic computer center directors had with BITNET , which ran exactly in that fashion. It did not take into account the difference in complexity between the running a multi-function network based on the TCP/IP protocol and running a "store and forward" electronic mail network based on the RCSC protocol used by BITNET.

[9] RFC 1067

[10] The NYSERNet implementation of SNMP was licensed by more than 100 commercial as well as non-profit institutions, including almost all of the mid-level networks. In addition NYSERNet sold SNMP redistribution licenses aggregating over $150,000 to companies such as Digital and Wollongong.

[11] Project Solicitation for Management and Operation of the NSFNET Backbone Network, 1987.

support and maintenance. The two stages of "Nuts & Bolts" and "Keeping it Running" had, for the existing networks, become one process. [12]

Between 1985 and 1988, most of the energy of the academic networking community and regional network management was focused on operational aspects of networking. Regionals were identified as providers of lines, routers and technical expertise . The regionals varied widely however when it came to organizational and managerial structure. Some regionals such as BARRNET were extremely decentralized, with ownership and responsibility for the operation and maintenance of routers in the hands of the Universities where the equipment was located. Others, such as JVNCNet, owned and maintained, but did not necessarily operate all of the campus based equipment. NYSERNet, through arrangements with New York Telephone (NYTEL) and Rochester Telephone had the two Telco's provide, maintain, operate and monitor lines and routers used to provide NYSERNet networking services.

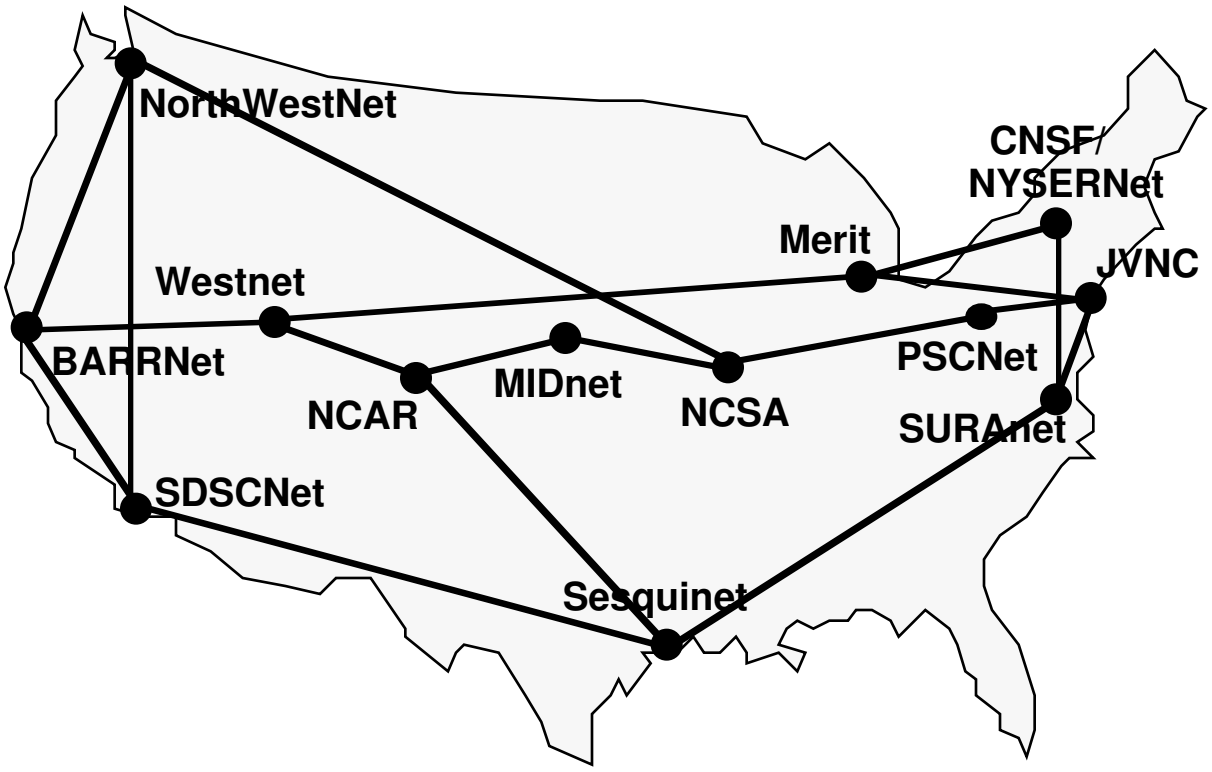

Figure 6 . The T1 NSFNET backbone

---

12 This was not true for new entrants into this field. As late as summer 1990, one of the authors was on a NSF review panel for "Connections - II", looking at proposals which barely touched on the" keeping it running" aspect of networking.

2. Interlude - The Early Players, 1985-1988

It was no surprise that almost all of the early regional networks were viewed from a combination of an academic service and computing research perspective. The early players in organizing, establishing, and running the networks came from two distinct streams of the academic community. The first stream was the networking research community. These were computer scientists and engineers like Bob Kahn,who had started the ARPANET, Vint Cerf, one of the developers of TCP/IP, Larry Landweber, the founder of CSNET; Dave Mills, the father of the "Fuzzball" [13] ; David Farber, first chairman of the NPAG. This stream was augmented by other, younger, technical experts who were primarily interested in the technical side of networking. Although, NSFNET was supposed to be a production service internetwork, it was an outgrowth of ARPANET and in the early days was still looked upon as an experiment in networking.[14]

The other stream came from the computer services segment of academe. People such as Glenn Ricart, Doug Van Houweling, Bill Yundt and Doug Gale had responsibilities for providing academic computing communications services to their respective universities and brought a service orientation to the network.

The networks were there to provide access for scientific researchers needing it. The National Academy Study - Towards a National Research Network talked almost entirely in terms of benefits to first-class researchers and research quality,

> "Because the number of universities housing first-class research facilities tends to grow far slower than the growth in the number of first-class researchers, many first-class researchers are dispersed among institutions with only limited capacity to support them. An NRN would enable those researchers to continue and strengthen their research...[15]

Even the title of that study, referring to the National Research Network (NRN), showed the lack of concern, at that time, with education, the E of the NREN[16]. Networking was viewed as a straightforward, though important, service to a relatively homogeneous community - the scientific research community.

3. Market and Service Awareness

Mid 1988 marked the beginning of a transition on the part of the regionals away from a pure operations perspective on networking. Although the NSF in 1986 had awarded a contract to

---

13 The " fuzzball" was the name given to the routers used in the original, 56 kb, NSFNET backbone. A fuzzball consisted of "home brew" software developed by Dave Mills and running on a DEC PDP 11.

14 During most of the time that the first NSFNET backbone was in operation, systems level changes were made to its "Fuzzball" routers on an almost weekly basis.

15 Toward A National Research Network, National Academy Press 1988, p. 10.

16 The Federal Research Internet Coordinating Committee (FRICC) , building on the National Academy Study started working on a plan for a National Research Network (NRN) . At a meeting in early 1989 between the Steering Committee of EDUCOM's National Telecommunication Task Force (NTTF) and the FRICC, the NTTF strongly urged that the network be renamed the NREN, thus putting the E in. Thus FRICC's May 8,1989 program plan finally spoke of an NREN.

consortium of the Information Sciences Institute of the University of Southern California (ISI), Cornell University, the University of Illinois and Bolt, Beranek and Newman Laboratories, Inc. (BBN) to provide a mix of network engineering, operations, management, and information services[17], little had come out of the information services part of that award. The new operator of the NSFNET backbone, Merit Inc., was also supposed to provide network information and educational services, but the terms of the backbone solicitation specifically excluded information services to end users of the network. It spoke of information services solely in terms of "services which will be implemented by the awardee to support site managers, liaison personnel, and network implementors and operation managers at both second-level and third-level or campus sites"[18] . The issues of identifying the resources on the network and how to reach them, and of identifying users on the network were, in principle, supposed to be addressed, but with the network technical community being the intended audience.

As networks were installed and used in 1987 and 1988 it became clear that most of their users were interested in much more than supercomputer access. With the spread of microcomputers and workstations and LAN's to interconnect them, more and more of the non-traditional user's of computers began to use networks to advance their work. The problem of how to use the network to access libraries became increasingly important . Discussion of medical applications of networking began to be heard. As industrial participation in the networking effort increased, more emphasis was given to questions of using the network to enhance technology transfer from basic research discoveries to usable products and services. The idea of the "Network" as a key factor in maintaining the U.S.'s economic competitiveness in international markets emerged.

In May of 1987 the EDUCOM Networking and Telecommunications Task Force (NTTF), an informal group of more than 30 of the leading Universities in the Country [19] issued a paper entitled "A National Higher Education Network: Issues and Opportunities ". In this paper NTTF included among the goals of a National Network

> • To advance the quality and productivity of academic research and instruction by expanding the opportunities for collaboration and sharing scholarly work through more effective communication;
>
> • To improve our educational system by widening computer network access by faculty and students to expensive, specialized information resources such as research library holdings, discipline-specific databases, and the vast public domain information repositories of federal and state governments;
>
> • To broaden geographical distribution of research activity by allowing wider collaboration throughout the academic community.

---

17 Engineering of the backbone network was performed by the University of Illinois and a Network Operations Center was managed by Cornell University. In addition, a Network Service Center was operated by Bolt,Beranek and Newman Laboratories, Inc., and high-level technical assistance and consulting was offered by the Information Sciences Institute of the University of Southern California.

18 op. cit., fotnote 11, p. 1.

19 The NTTF has since grown to include over 60 Universities.

The NTTF effort marked a clear turning point in the evolution away from of view of the networks as adjuncts to the supercomputer centers and the handmaidens of the research elite, towards a more pluralist view of the network as a tool to "level the playing field". The network was supposed to be a critical part of the educational infrastructure, potentially benefiting all institutions in all locations, not just the chosen few. Henceforth, it was not supposed to be simply a plaything for the scientific research community.In answering the question of "Who needs the Network" the NTTF went on to state:

> Faculty in all disciplines have a need to use networks for communications among their peers and within research projects, Networks which provide a new way of collaborating and disseminating information, are affecting publications and libraries. A network for higher education can be seen as a new national highway system linking universities, colleges, library, research and industry resources, for the transport of information rather than goods.

In April 1988, the first National-Net conference——Public and Private Iniatives to Create a National Education and Research Network, sponsored by NYSERNet , The National Association of State Universities and Land Grant Colleges (NASULGC) and EDUCOMs NTTF, was held in Washington, D.C. The conference brought together a variety of participants outside the supercomputing community and its principal purpose was to" canvass participants and to identify the networking requirements of the scientific, governmental and industrial communities from the broad perspective of the nation as a whole, and to determine where the nation should be moving with respect to the U.S. telecommunications infrastructure". [20] It was the first attempt to establish a national constituency representing academe, government and industry to discuss the broad set of issues intertwined in the building of a national network and was the first gathering at which an economic and marketing analysis of the regional and backbone networks was discussed.[21]

One of the more electrifying aspects of the conference was the announcement by Major Mark Pullen, Associate Director of DARPA's Information Science and Technology Office (ISTO) that the ARPANET was being shut down . The imminent demise of ARPANet did not signal DARPA's intent to exit the networking arena. DARPA was beginning its move onto new playing fields and out of the business of operating production networks.. At the same time as he talked about the death of ARPANet, Pullen announced a new DARPA network, the Defense Research Internet (DRI). The DRI was supposed to be part of a new FRICC-sponsored experiment in internetworking the Research Internet Backbone (RIB). The RIB, a transcontinental T3 (45 megabit/second) backbone linking Boston, New York, Washington D.C., Boulder Colorado, Los Angeles, San Diego and San Francisco was to be an interagency experiment in cooperation and management of a joint backbone. It was supposed to carry traffic of NSF, DOD, DOE and NASA, and be partially funded by each of these agencies. Its primary purpose was to be a networking "testbed" for each of these agencies. (See Figure 7).

As politics surrounding the proposed RIB solicitation impeded its issuance, DARPA and DOE decided they could not wait and in the fall of 1988 DARPA issued a Broad Area Announcement (BAA) for provision of a networking testbed. NYSERNet responded to this BAA with a proposal

---

[20] NYSERNet proposal to the NSF on a Conference for High-Speed Telecommunications

[21] NYSERNet in late 1986 had commissioned a Market and Economic Impact Study on the market potential represented by users of high speed data communications. A session on Economic Impacts was devoted to analyzing the outcome of that study.

for a National Networking Testbed (NNT), initially a 6 T1 line national backbone, for DARPA and DOE, and was awarded a DARPA contract for the NNT in January of 1989. The NNT starting operating in the Spring of that year and marked NYSERNet's first experience in networking on a national scale. DARPA continued to move out of production networking and back into research networking by becoming the lead agency for the Gigabit networking effort later in 1989.

The success of the first National Net conference led to its institutionalization by EDUCOM into a yearly, Washington D.C. based conference on national networking issues.The broad participation in the conference by new constituencies as well as the prospect of reduced direct federal support for production networks made it clear to many network operators that they had to concern themselves with whole new communities of users, each with their own special set of needs and interests. Thus 1988 saw the beginnings of a shift in concern by the networks to finding answers to such questions as:

Who is using the network?
How are different segments of the user community using the Network ?
What are potential new uses of the network?
What is the potential network market?

In the 1988-90 period, network usage questions became primary topics of discussion at FARNET and NTTF meetings and in discussions between regional network operators, the backbone operator and NSF. The regional network managers realized that simply providing for the supercomputing

---

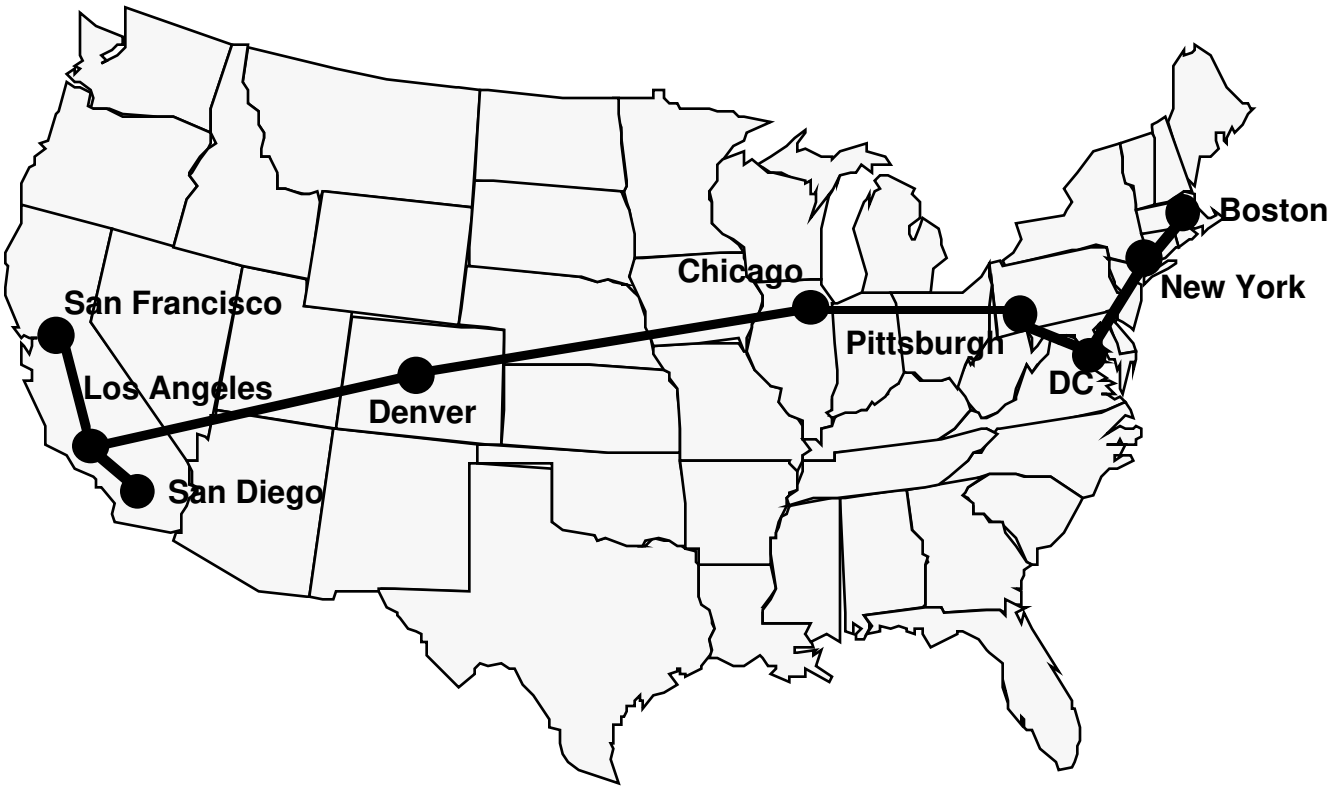

Figure 7. The RIB / NNT

needs of the science and engineering faculties at the top 75-150 U.S. universities was not sufficient. Given the potential of the network in enhancing scholarly productivity and facilitating industry-academic cooperation, as well as the funding requirements of the mid-levels, a new mood of outreach began. This consisted on the one hand of extending connectivity to some of the lower rungs of the academic hierarchy and on the other getting more commercial users on the network. This 'outreach' stage also engendered new problems. As an increasing number of for-profit companies became members of regional networks the necessity to address the question of appropriate usage of the network, given its heavy governmental support, became critical. Although this question had been considered since 1985, as long as the network was small and its users fairly homogeneous it was of theoretical rather than practical concern.

In all of the documents produced by the NTTF as well as in the 1987 FCCSET study and the FRICC program plan for the NREN[22], one of the main uses of the network was to be to facilitate the access of scholars to information resources. Yet, even by 1990, little had been done in this arena beyond the beginning of the connection of University libraries to NSFNET. NYSERNet had almost signed up BRS Inc., a major commercial information provider, as a member in early 1988 but the deal had fallen through at the last moment. Could commercial information providers such as BRS, Lexis or Dow Jones sell their services over the federally subsidized NSFNET ? Could they sell them only to the research and educational community? The prospect of attaching such commercial providers to the mid-levels was an exciting one for the managers of the mid-level networks . However it raised the "appropriate usage" question with a vengeance!

As network managers refocused their attention on users of the network rather than on network technology and operations, they also began to think more extensively about new uses for the network and of and of not only what the needs of current users were but of what the needs of prospective users would bet. Simultaneously, as the network began to be used increasingly by more users, who knew less and less about its internal workings, the necessity for providing a turnkey, well documented, production service grew. The regional networks were passing through the market and service awareness phases and were about to enter a new stage in their development .

4. A New Age

On December 14, 1989, the Board of Directors of NYSERNet, unanimously approved a resolution which directed NYSERNet's officers to enter into a series of agreements with Performance Systems International, Inc. (PSI), a for-profit company, headquartered in Reston, Virginia, and founded by two of the original founders of NYSERNet, which would fundamentally change NYSERNet's future role in the networking arena. The agreements were designed to:

- provide state-of-the-art high speed data communications networking services to educational, governmental, and other not-for-profit institutions in New York State at the lowest possible prices.

- expand and enhance the availability and usefulness of network access to New York State's educational and commercial sector.

---

22 A National Research Educational Network (NREN) was embodied in the Bush Administration's High Performance Computing Program and in proposed legislation S. 1067 and H.R. 3131. The purpose and structure of the proposed NREN and the transition plan from the current Internet to the NREN is described in the National Research & Education Network Program Plan proposed by the Federal Research Internet Coordinating Committee (FRICC) in May of 1989.

•Initiate the creation of a NYSERNet endowment fund to help subsidize the use of high-speed data networks by the educational and non-profit community even after government subsidies have ceased.

Under the terms of the agreements, PSI became responsible for providing full network connectivity to NYSERNet affiliates, including network backbone and local loop connections. It would conduct round-the-clock monitoring of the network via its Network Operations Center and would become the primary party responsible to NYSERNet for performance, including end-to-end and end-to-internet reliability, data rates, response times, and prompt notification of service disruptions. With PSI responsible for providing and operating the packet switched transport infrastructure, NYSERNet would concentrate on:

- being the spokesperson on networking issues for the New York State educational and research community
- arranging connectivity for that community
- negotiating subsidies and optimal pricing
- providing quality control on networking services
- fostering research relationships and technology transfer
- adding special resources to the national network
- educating people about networking and promoting networking and economic development.
- supplying end-user consulting
- playing a lead role in maintaining funding agency relationships and in proposal writing
- maintaining strong ties to the national networking community.

NYSERNet and PSI were to work together on the development of marketing, network refinements, and proposals for enhancements and new services.

Following approval of the transaction by the New York State Attorney General and Supreme Court, the NYSERNet Board Chairman carried out the Board's mandate and signed contracts with PSI on January 5, 1990.

The reasons underlying NYSERNet's decision were based on its experiences in 1989 in attempting to react to the new winds in the networking arena and broaden the scope of its operations.

> "NYSERNet's executive management and Board understood by Spring 1989 that NYSERNet's existence as a self-sustaining operating company depended upon its ability to expand its affiliate base to a large enough number that the resulting economy of scale would eventually make state and federal subsidies unnecessary. Because NYSERNet could not easily expand its base outside of New York State to realize this scale and because NYSERNet, as a not-for-profit, could not raise venture capital, its management feared that NYSERNet would eventually (two years) have to dissolve for failure to keep networking costs low enough for its users to afford." [23]

---

23 Notes Regarding the Relationship Between NYSERNet and PSI. NYSERNet Special Report. February 1990

NYSERNet's officers concluded that a for-profit network service provider, which would not be constrained geographically or organizationally by charter, tax, and unfair competition issues, could better provide the services and expertise required to meet changes in the networking environment. They further concluded that regional networks like NYSERNet could benefit from contracting their network services to such a for-profit provider because a for-profit network service could establish an economy of scale (hence reduce prices) that regional networks could not accomplish on their own. The NYSERNet Board at its May 1989 meeting, had directed its President, William Schrader to:

> "investigate the possibility and desirability of the creation of a new 'for-profit' corporation which might engage in activities for which the 'not-for-profit' status of NYSERNet might not be appropriate but which activities would be beneficial to the interest of NYSERNet and report to the Board on options and consequences."

As a result of his investigations Schrader decided to establish a for-profit corporation, PSI, which would sell commercial quality TCP/IP transport services in the Washington, D.C., and Boston areas. He subsequently felt PSI could help NYSERNet, Inc.provide service to its New York State regional network. NYSERNet entered into the contract described above with PSI and as part of its arrangement with PSI obtained a small equity interest in that corporation. PSI was the first example among the regional networks, of a spin-off for-profit entity-merging out of a not-for-profit regional.

The NYSERNet-PSI spin-off and contract was not the only example of new winds blowing . In late 1989 and early 1990 discussions took place between Merit Inc., MCI and IBM about spawning a new networking corporation. At the June 1990 FARNET meeting, Al Weis, IBM VP for Engineering and Scientific Computing, met with the FARNET executive committee at a non-disclosure meeting to inform them that a new not-for-profit corporation, tentatively called Newnet was being set up. He asked the FARNET executive committee to work with him in helping to define the relationship between the regionals and the new entity. In a series of meetings over the summer the FARNET executive expressed apprehension at the prospect of the regionals competing directly with a corporation backed by such players as IBM and MCI. The FARNET executive committee, in a letter to Weis on Aug 2, 1990, underscored the idea that the regional networks and the coalitions that they have fostered not only provide operations services but

> "are acting as catalysts for information exchange and application development...The midlevels have been able, in many cases, to use revenue generated from larger and wealthier institutions to support the connection of smaller, poorer institutions to the network. If NewNet "skims the cream" from the market or is not sensitive to the balances that currently exist, the position of the midlevel networks, and more importantly of the smaller users of NSFNET, may be jeopardized."

Among the key recommendations that the FARNET executive made to Al Weis and "Newnet" management was that

> "it is important to preserve the local and regional aspect of the current structure. While it may not be essential that the midlevel networks continue to deliver connections to the campuses, they have a vital role in the development of the human infrastructure that is creating the electronic university. NewNet should be flexible in making business arrangements with the midlevel networks and should endeavor to preserve, not to supplant, them.

> One way to support the midlevels would be to require that "members" of NewNet, or users of NewNet services, also be affiliated with a midlevel network. Another way would be to create mechanisms for sharing revenue between NewNet and the midlevels, such as franchise fees, recruiting fees, membership fees, or the direction of NewNet revenue into a fund for the development of appropriate expertise and infrastructure at the state and regional level."

On Sept. 17 Merit, Inc., IBM Corporation and MCI Communications Corporation announced "the establishment of Advanced Network and Services, Inc. (ANS), a new company that will help propel high-speed computer networking into the next century for the nation's research and education communities."[24] The NSF had approved Merit's subcontracting of responsibility for the running of the NSFNET backbone to ANS Inc., which thus started life with responsibility for the existing T1 backbone as well as the yet to be deployed T3 backbone[25]. (See Figure 8). NSFNet would no longer be a definite user-defined[26] network but instead would now become a virtual subnet of a larger ANS defined network. The NSF was no longer paying for a network, it was now buying a network service.

At a press conference in Washington, D.C. on the 17th, Weis, president and CEO of ANS said,

> "The success of ANS will expand the base of financial support for the evolving national network. Fees charged to ANS subscribers, together with contributions from industrial companies such as IBM and MCI, will help reduce the financial burden of the federal government in its initiative to provide the nation with a high-speed computer network. Because we are broadening the community of those using the network, the fixed costs of national networking will be more widely distributed. This will free up funds which could then be allocated to assist the neediest organizations to connect to the national network, as well as to continue to support and enable the national network to remain in the vanguard of new technology."

ANS, at the time of the press conference, although it had been promised 10 million dollars in initial funding from IBM and MCI, was itself a virtual organization with only one employee. It had subcontracted with Merit Inc. to provide it with NOC, network engineering and planning and network information services. In further discussion with representatives of the regional networks at FARNET's September meeting, Weis said that one of the main reasons for the founding of ANS was to provide an alternative network which would allow commercial information suppliers to reach the research and educational community without worrying about the usage restrictions of the NSFNET. He maintained that ANS was not interested in attracting the business of purely commercial entitities who were not interested in interacting with the research and educational community . Nineteen Ninety ended with a new backbone, operated by a new manager and a new perspective in the networking world on the future.

---

[24] Press Release , Sept 17, 1990

[25] In early 1990 NSF had announced it was adding an additional node to the T1 NSFNET backbone in Atlanta as well as deploying a new T3 backbone as an overlay over the existing backbone.

[26] Technically, the T1 backbone was not a physical structure but at the bit level was itself multiplexed with other MCI voice and data transport. However the new relationship meant that multiplexing was now going on at the packet level. The user no longer defined the subnet, the vendor did!

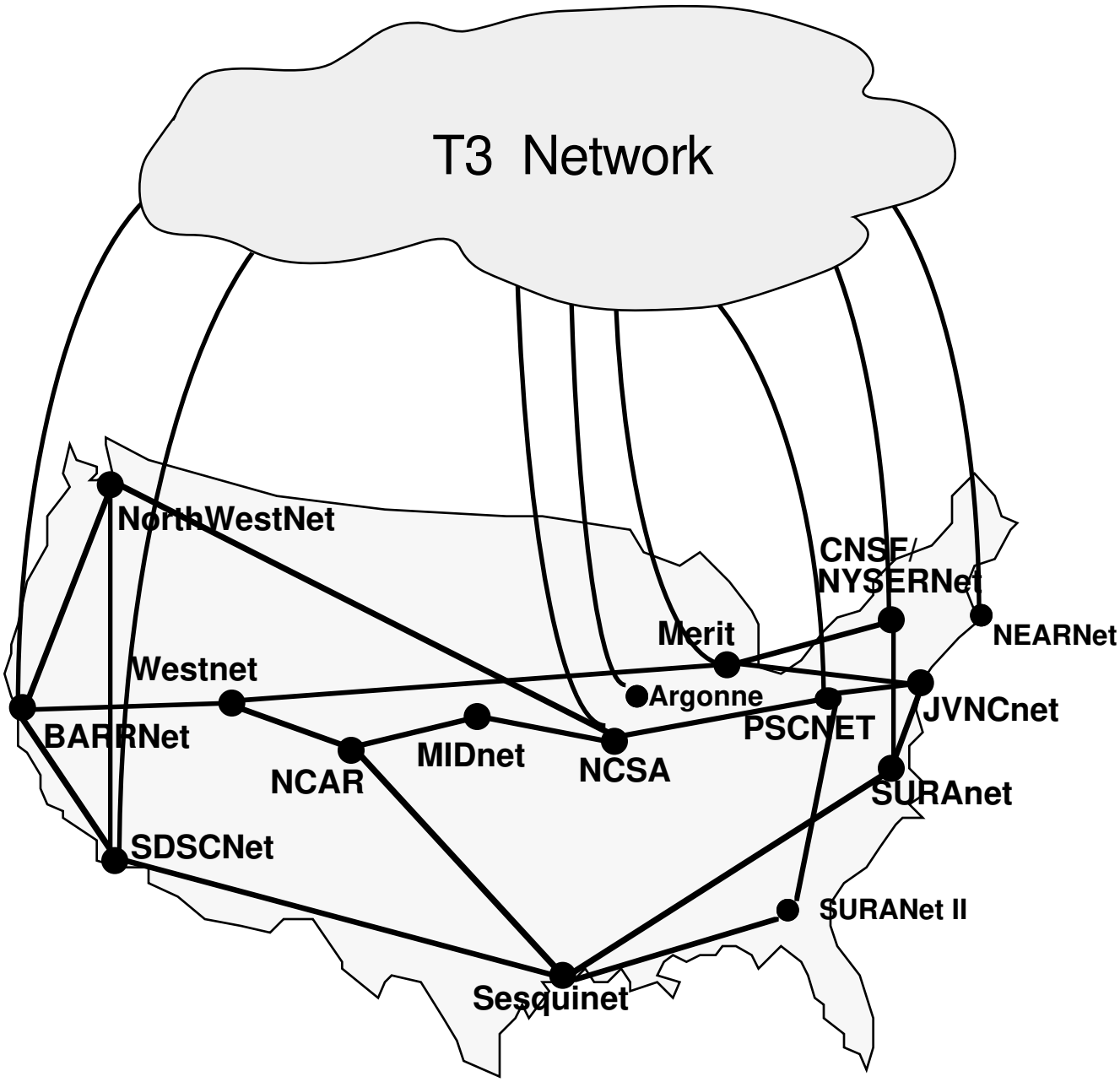

Figure 8. The New NSFNET T1 and T3 backbones

B. Network Evolution – A Conceptual Model

As an aid in understanding the evolution of the regional networks between 1985-1989, we turn to a model presented in the 1989 OTA background paper on the National Network.

> "The national research and education network can be viewed as four levels of increasingly complex and flexible capability:
>
> . • physical wire/fiberoptic common carrier "highways";
> • user-defined, packet-switched networks;
> • basic network operations and services; and
> • research, education, database, and information services accessible to network users." [27]

These four levels are essentially a recasting of the OSI 7-layer model (See Figure 9) in a form more useful for analyzing a organizational and managerial construct rather than a technical one. Summarizing the OTA discussion we can characterize the levels as follows: (See Figure 10)

Level 1 - The Physical Network Infrastructure

Level 1 consists of the physical circuits that carry digital signals including telephone wires, optical fibers, microwave lines and satellites. It corresponds to layer 1 of the OSI model.[28] Both the backbone and regional networks in NSFNET lease these circuits from common carriers such as MCI, NTN or AT&T. Level 1 concerns include such issues as the topology of the network, line quality, monitoring, and local loop bypass.

Level 2 - The User-defined Subnet

This level concerns itself with the actually moving message between users. It corresponds roughly to layers 2, 3 and some of layer 4 of the OSI model. This is the key operations service provided by "the conglomeration of smaller foreign, regional, state, local, topical, private, governmental and agency networks," which make up the Internet. Level 2 concerns include:

router architecture
routing algorithms
congestion
addressing
interconnection of networks

---

[27] U.S. Congress, Office of Technology Assessmnet (OTA), High Performance Computing and Networking for Science: Background Paper (Washington, DC:US Govt Printing Office, Sept. 1989)

[28] Andrew S. Tannenbaum, Computer Networks ,Second Edition (Prentice Hall, New York, NY 1988) , pgs. 14-19

THE OSI MODEL

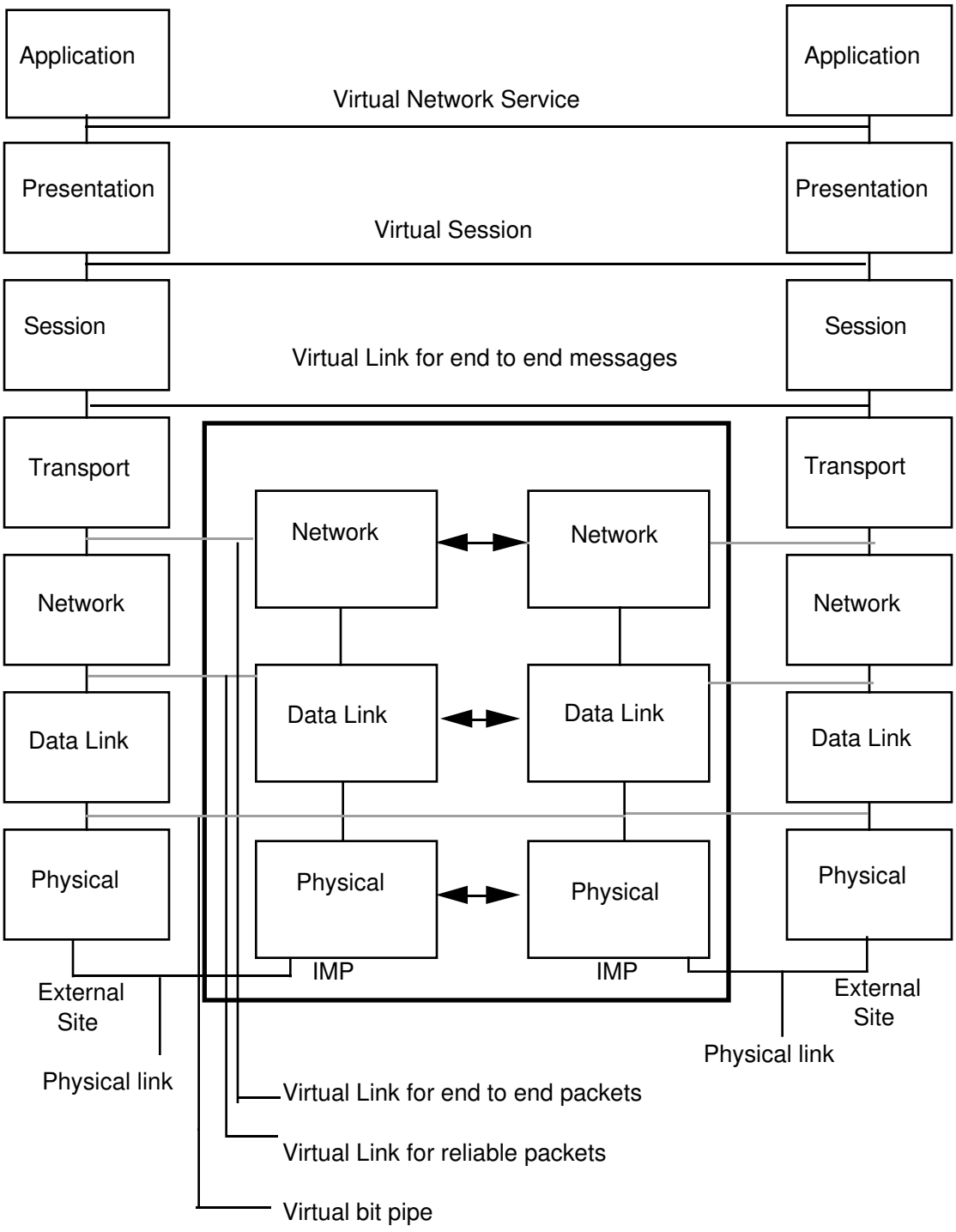

Figure 9.The ISO Open Systems Interconnection (OSI) Model

Level 3 - Network Services

Level 3 is the level supplying the basic network operations and services which keep the network running and make it accessible and useful by end-users. It includes responsibility for

end-end connection
basic services (E-mail, file transfer, remote log-in)
network monitoring
network security

This level corresponds to part of layer 4, layers 5, 6, and part of layer 7 of the OSI model.

Level 4 - Value-Added Superstructure

This layer consists of the links of the network to research, education and information services. In the OTA background paper it is defined as follows:

" The utility of the network lies in the information, services, and people that the user can access through the network. These value-added services provide specialized tools, information, and data for research and education. Today they include specialized computers and software, library catalogs and publication databases, archives of research data, conferencing systems, and electronic bulletin boards and publishing services that provide access to colleagues in the United States and abroad."[29]

What occurred in 1985-90 was a journey by the regionals up through the four levels described above. Focus moved from physical infrastructure, through subnet operations and network services to value-added superstructure. Simultaneously one saw the beginnings of movement towards more centralized management of the networks. Many of the regional networks which went into operation in 1987 and early 1988 had network hardware owned and operated by the end-user sites. Network operations were frequently add-on responsibilities to computer center staff at such sites. Decisions about network topology, software and operations as well as policy was frequently made in large committee settings with participation by all interested members of the regional network .

By 1990, most networks had hired executives responsible for delivery of services. Hardware was more often owned by the network with responsibility for hardware and software upgrades in the hand of network management. Network Operations moved toward a 24 hour a day, 7 day a week basis , provided by personnel specifically assigned such responsibilities.

There was more of a bifurcation on delivery of the network transport service with some networks (e.g. PREPNet) subcontracting this out completely and others, (e.g.JVNC), providing all network services, including transport, as a completely in-house operation.

---

[29] Ibid

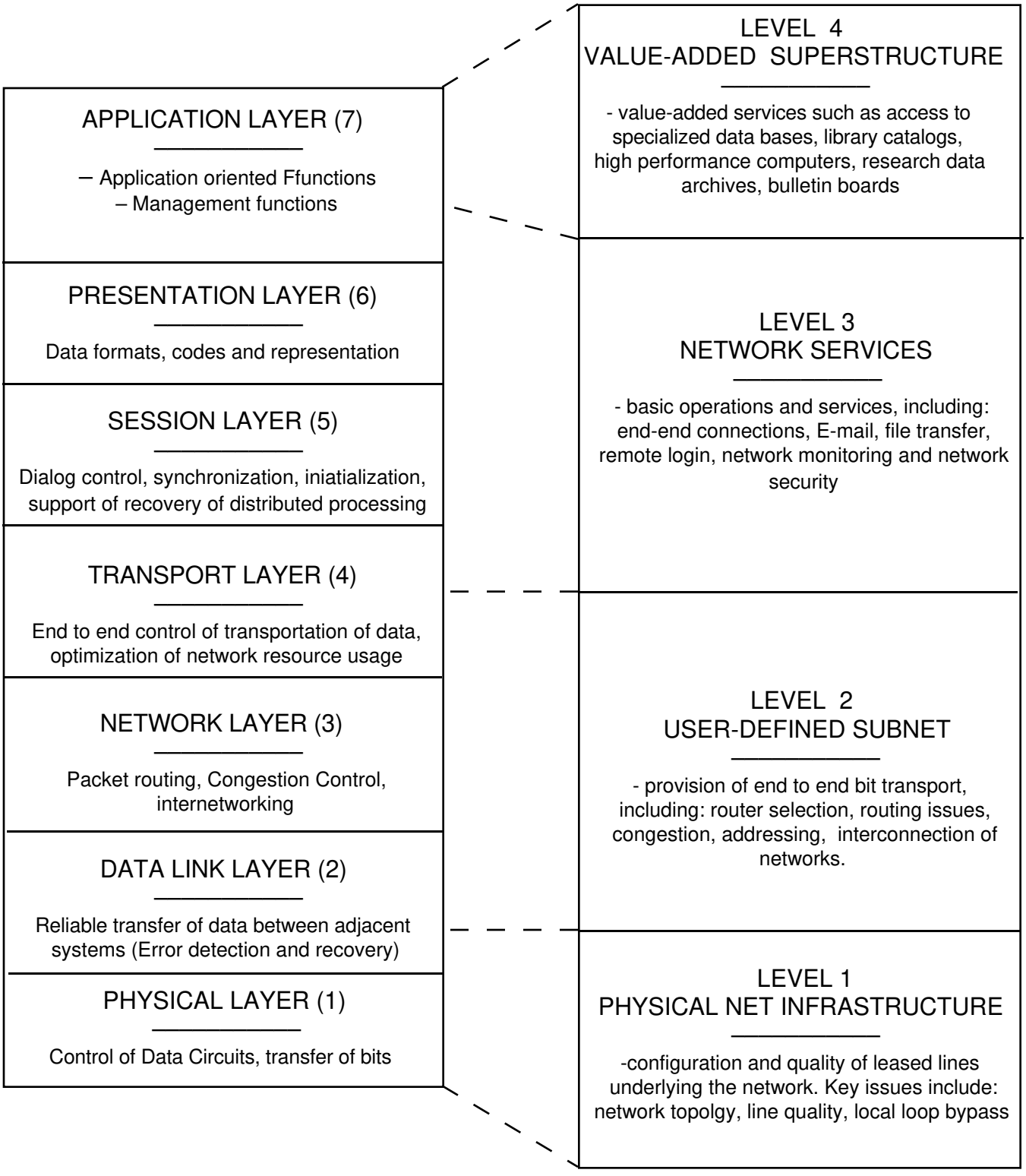

Figure 10 . The 4 level Model and its relationship to OSI.

The internal organization of the regional networks in this period can be placed in a two-dimensional framework characterized on a vertical axis running from Decentralized to Centralized Management and a horizontal axis running from Complete Inhouse Operation to Complete Outsourcing. (See Figures 11A and 11B)

The boundaries of network behavior are perhaps best exemplified, by BARRNet and PREPNet, two examples of radically different network organization. BARRNet is an unincorporated interest group of institutions with common, networking needs in the San Francisco Bay area. All of the hardware used in the network is owned by the participating institutions and management and decision making is a collective effort by appropriate working groups. PREPNet exemplifies the other extreme. Operations are the responsibility of a regional telephone company, Bell of Pennsylvania, with hardware owned and operated by it. telephone company. Between BARRNet and PREPNet lie the many regionals which subcontracted parts of the network operations functions such as Northwestnet which used Boeing Computer Services and NEARNet which uses BBN.

Although the organizational structure of the various regionals must be viewed two-dimensionally, their area of concerns, until the very end of this period was still one dimensional and focused on the establishment of the physical network infrastructure and the operation of a user-defined subnetwork, level 1 and 2 concerns in the OTA model. Even the networks which had outsourced their network operations function had established what were essentially joint-operating agreements with their suppliers. In–house network personnel were still intimately in topology, architecture , engineering and operations decisions about the network. All networks had their own Network Engineering, Network Operations and Technical Groups, which were heavily involved in working with their Operations Vendor. The relative immaturity of large-scale TCP/IP networking made it impractical to purchase turnkey services and pay for an end product - the delivery of specified and agreed upon end-user services.

As the networks continued to move towards Level 4 – the delivery of value-added services, this one-dimensional focus broadened. For example, in late 1988, NYSERNet, Inc., and NYTEL decided to terminate the experimental market trial under which NYTEL provided operations services to NYSERNet. NYSERNet recognized that the differences between the requirements for voice telephone service and those for high speed data communications were so significant that it would be extremely difficult for even the best voice telephone service organization to provide the state of the art data communications operations required by the research community. It decided to operate, maintain, and grow the network on its own. NYSERNet's understanding by late 1988 that a new perspective on networking was required, a perspective beyond "Nuts and Bolts" made it clear to NYSERNet's management that it was necessary to move forward with a more business-like structure. NYSERNet established subdivisions for technology development and marketing and sales, and a marketing and sales manager was hired in early 1989 .

An even better example is given by the CICNet experience. In 1989, CICNet hired an Executive Director, Joel Maloff, with a commercial telecommunications, marketing, and business background. He was previously Director of Marketing for NTN, the National Telecommunication Network, a general partnership of seven independent regional telephone companies. The choice by CICNet of an individual with this type of background was unique within the research and educational network environment. The CICNet business plan [30] envisions both a service manager responsible for the maintenance of user satisfaction and a marketing manager responsible for the

30 CICNet, Inc. : Operational Business Plan, July 20,1989

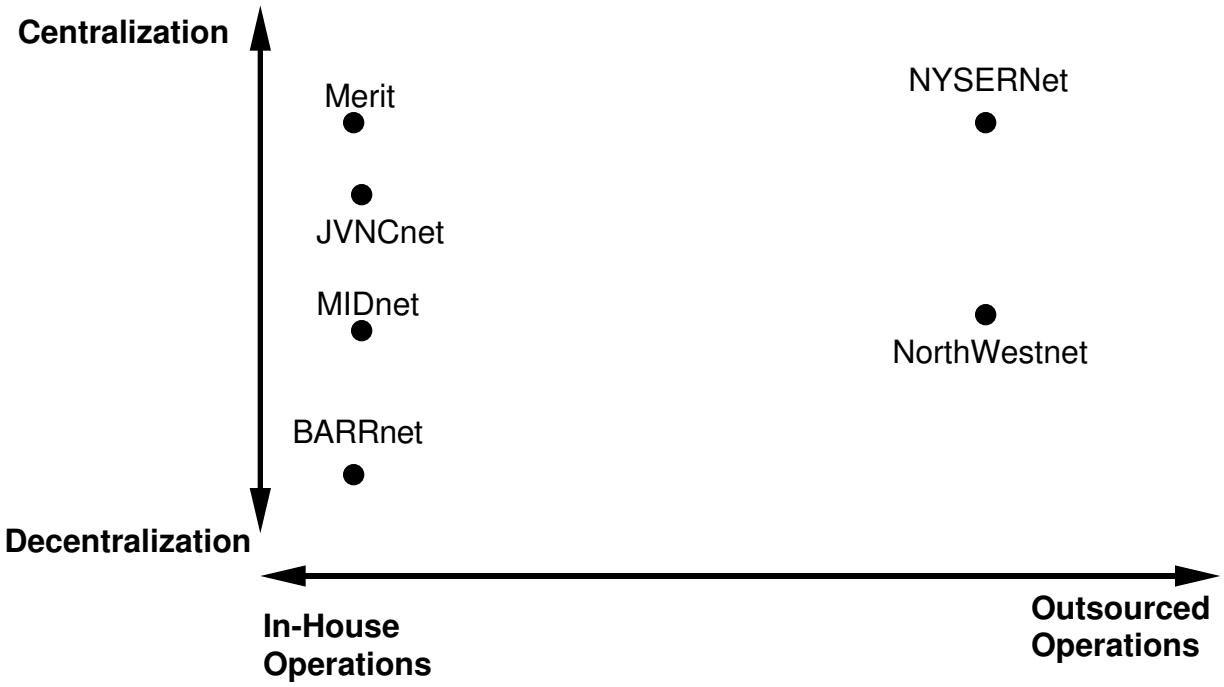

Fig. 11A The Regional Networks in 1987

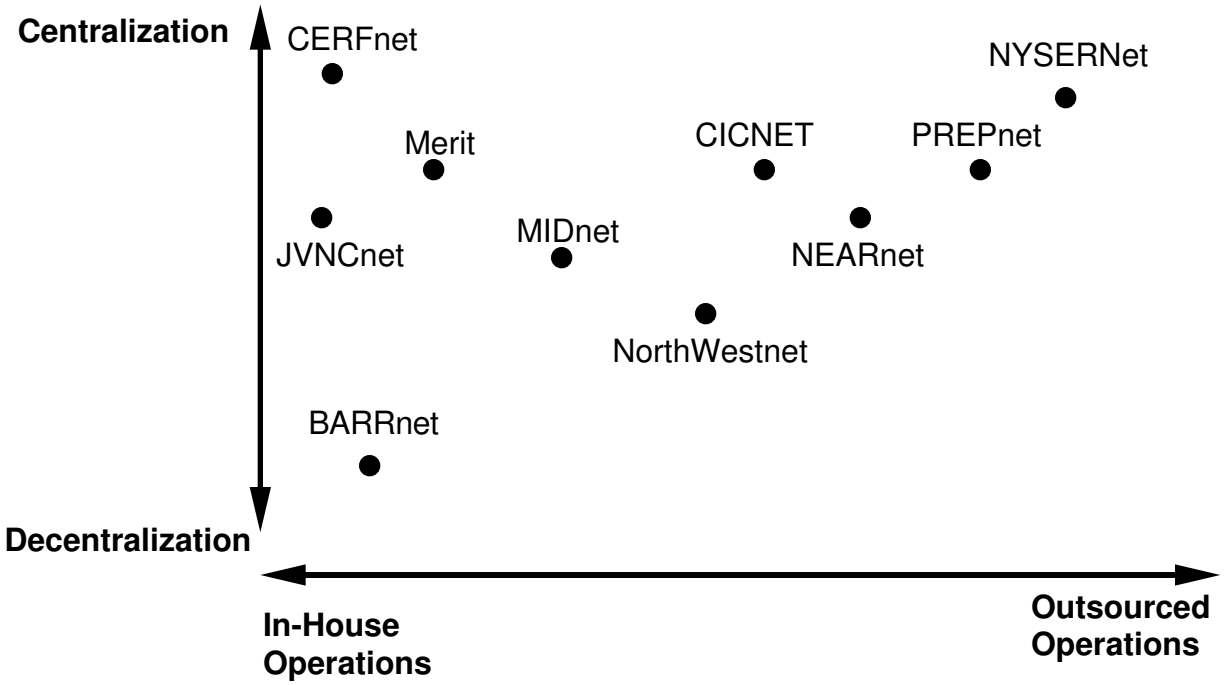

Fig. 11B The Regional Networks in 1990

"identification and solicitation of new members." Among the long-term plans of CICNet one can find "An active but economical public relations program must be undertaken."[31]

The cases of ANS and PSI best characterize the evolution which was occurring between 1986 and 1990. The two most successful of the regionals, Merit and NYSERNet had decided that new organizational and structural models were needed to meet the networking challenges of the 90's. Both networks had acquired experience at running operations on a national scale - Merit through its operation of the NSF backbone and NYSERNet by virtue of its establishment and management of the DARPA/DOE funded NNT. Each decided to spin off new entities to take advantage of new opportunities. NYSERNet constrained by low state funding and limited access to capital decided on spinning off a for-profit entity, PSI. Merit with much better access to capital due to its association with MCI and IBM and with the backing of key individuals in those companies, Richard Liebhaber, executive VP of MCI and John Armstrong, Vice President for Research at IBM was able to give birth to the not-for-profit ANS. Both new entities were structured as "real" businesses, with strong executive authority, attention to marketing and sales as well as technology and a determination to provide a broad array of high-quality networking services. These were true full service value-added (level 4) providers.

The emergence of PSI and ANS points out the artificiality of the 3-tier model. Once a network is founded there are no intrinsic reasons to limit its activities. Both PSI and ANS started out as 2nd tier networks, went on to manage first tier networks, and emerged as combined first and second tier operations.[32]

By the end of 1990 it was clear that a new paradigm for differentiating between types of networks and understanding and predicting their futures was needed. Furthermore, it was almost universally accepted that the regional networks should think of themselves in a more professional fashion and structure themselves more as businesses than as charitable foundations.

---

[31] Ibid

[32] The agency networks, such as SPAN or ESNET, have only a 2 tier structure - campus network and agency network. Even some of the mid-level networks such as CREN encompass both tier 1 and tier 2 functions.

II The Networking Challenge

A. The Issues

In order to assess which models of regional organization are most viable and which would serve the academic community and nation the best, we must reexamine the challenges the networking community faces which can be classified as follows:

1. Increased Connectivity

> "In the near term, the most important step is getting a widely connected, operational network in place. " [1]

Increased Connectivity refers to both adding additional users at institutions currently connected as well as connecting additional institutions of higher education, government laboratories and hi-tech industries. However the challenge of increased connectivity also implies trying to add new types of institutions and new types of users, e.g. Libraries, the K-12 sector and other potential beneficiaries of a national research and educational network.

Connectivity includes the concept of high quality, reliable service. Reliability in terms, not only of the network being there, but of the ability of the user to count on the services he requires being available and accessible at the 'speeds' he needs. In addition, if the network is inoperable or its performance is severely degraded the user should be notified, in a timely fashion, and told when to expect normal operations to resume.

2. Equitable Access

The concept of equitable access to communication and information resources has a long history in the U.S. [2] It was one of the bases for establishment the U.S. Postal Service and was important in the public school movement in the 1860's and in the inauguration of Rural Free Delivery in the 1890's.

With the coming of universally available phone service in the late 1920's and early 30's the idea of equitability came to mean "communication services with adequate facilities at reasonable charges".[3] This was implemented in the telephone system in the form of AT&T's adoption in the 1930's of "a pricing structure that was based not on cost of usage, but rather on value of use." [4] This idea was further enshrined by the FCC's 1941 adoption of a policy of "equal charges for equal services." In the context of the 1990's the nation faces the challenge of how to implement a policy of reasonable rates for network services which are independent of location.

---

[1] op.cit., footnote I-27, p 21.

[2] U.S. Congress, Office of Technology Assessmnet (OTA),Critical Connections: Communications for the Future, OTA-CIT-407 (Washington, DC: U.S. Govt. Printing Office, Jan. 1990) p. 94-96

[3] Communications Act of 1934

[4] op. cit., footnote 2, p. 97

The challenge of equitable access also concerns itself with how to subsidize the have-nots. These challenges do not mandate the provision of a homogeneous service at a fixed price. Every institution and every user does not need the same type of access. Greater attention must be paid to "types of service" within the networking world. Although some type of "lifeline" access, guaranteeing the ability to use some network resources, should be available to all users at a fixed low cost, higher quality access must also be available, though not necessarily as ubiquitously. The networking community should guarantee to all users the ability to send a reasonable quantity of E-mail messages and have them delivered in a reasonable amount of time. It does not need to guarantee gigabit access or real-time full color, full motion interactive video to all.

3. **Simplicity of Use**

The existence of widely available networks affording equitable access is not very helpful if people don't know how to use them. The OTA identified two major factors that prevented people from using the new communications technologies.[5] These were technological skills and access to navigational tools. The challenge of simplicity of use thus includes:

i. the production of "How to Use" documentation
ii. the development of standard and graphical user interfaces (GUI's) which allow people to use the network with a minimum of specialized knowledge or training.

Such documentation and interfaces can help make up for the lack of technological skills on the part of potential users of the network. Furthermore the provision of navigational tools can to some extent make up for lack of skills. Thus a third aspect of simplicity of use is then:

iii. the provision of standardized and easy to use navigational tools which will help "guide users through the maze of information, enabling them to identify and locate relevant information and communication paths." [6]

4. **Information Resource Provision**

An additional challenge is to create and connect to the network important information resources such as databases, high technology instruments and computation centers.. In addition the multitude of problems connected with the provision of the full content of articles, books and multimedia works over the network must be solved. These are not only problems of copyrights,

---

[5] In its analysis, OTA sought to ... "identify the factors (in addition to cost) that prevent people from taking advantage of opportunities that new communication technologies afford. The two most important factors OTA identified are technological skills and access to navigational tools."

a) Technological Skills

"To both communicate and use information effectively, one needs to have certain technical skills. ... it is likely that people will need to be much more technically sophisticated in order to communicate and use information to their best advantage.

b) Navigational Tools

"Navigational tools ... are the means by which individuals and groups interact with their communication and information environment and discover the options available. In some cases, navigational tools can help to compensate for a user's lack of technological sophistication. For some people, the fact that navigational tools are not widely available represents a significant barrier to their ability to access information."

[6] op. cit., footnote 2, p

but also problems associated with the perspectives and attitudes of the creators and marketers of those works and with the economics of the worlds of book publishing, video and music. Similarly, the goal of attaching commercial information providers and convincing federal and state repositories of information to connect to the network is part of the challenge of providing information resources.

5. **Standards and Interoperability**

> "The internet is a conglomeration of smaller foreign, regional, State, local, topical, private, government, and agency Networks... In addition, there are more and more commercial, State and private, regional, and university networks (such as Accunet, Telenet, and Usenet)... This division into small, focused networks ... demands standardization and some central coordination to realize the benefits of inter-connection." [7]

The current situation in the U.S. in the field of data communications is reminiscent of telephone communications at the turn of the century. "In 1902, 451 out of 1002 cities with phone service had two or more companies providing it." [8] The challenge of standardization and interconnection is based on the premise that an interconnected communication system simultaneously maximizes value and minimizes cost to the user. It is economically efficient. Thus, combining the diverse standalone networks we now have into an interoperable system would lower the cost and increase the benefits of access. This is both a question of supporting a standard communications protocol such as TCP/IP or ISO CLNP and encouraging the true interoperability of networks provided by private carriers such as Alternet or PSI so that Vail's vision of "universal, interdependent and inter-communicating, affording opportunities for any subscriber of any exchange to communicate with any other subscriber of any other exchange", [9] which came true in the context of telephony, can be realized in the data communications arena as well.

6. Technical Development

The challenge of technology development is addressed primarily to the communications research community, which is engaged in expanding the frontiers of networking and to the hardware manufacturers and software developers who sell the products underlying the communication infrastructure. However the regional network community has and should continue to play a major role in stimulating the development, production and deployment of the technologies it needs to fulfill its mission. Furthermore this community must continue to partner with the vendors in field testing new advances in networking technology. In those cases where the vendor community is not fulfilling its mandate in advancing technology the regional networking community has, in the past, taken on that role as well.[10] In the context of the NREN effort the development of advanced

---

[7] op. cit.,footnote I-27, p.

[8] Ithiel de Sola pool, Technologies of Freedom (Cambridge, MA: Harvard University Press 1983), p. 102.

[9] Theodore N. Vail, in AT& T, Annual Reportof 1910 (Boston: Alfred Mudge & Sons, 1911)

[10] The example of Dave Mills and his "fuzzball" code which provided the technical infrastructure for the first NSFNET backbone in 1986-88 is an example of where there was no suitable commercial product.

networking technology and services is seen as necessary "to maintain international competitiveness and the viability of American jobs in the future".[11]

B. The Business of the Regionals

In order to understand the best way for the networking community and in particular the regional networks to meet the challenges we have discussed we must first identify the business the networking community is in and, more specifically, the business the regionals are in. In particular we will answer the following interrelated questions.

Offerings - What is the product/service being offered ?
Marketplace - What is the nature of the marketplace? How well are customer needs being satisfied?
Geography - Where is the product or service delivered? Are there geographic constraints?
Funding - What is the cost and how much is the price of the product, and, who pays?
Internal Business Structure - What are the production and support services?

1. Offerings - The Products and Services

We will use the term product to refer to the programs, services or activities offered to the consuming public.[12] In the context of the networking community we can identify actual or potential products described below.

a - Network Operations Service

This consists of all of the activities, such as network design, ordering of lines, choice and installation of routers, network monitoring and troubleshooting etc., associated with the operation of a computer communications network. All parts of this service can be directly provided, as in the case of JVNC, where the regional actually operates the physical infrastructure, or some can be indirectly provided, e.g.the NEARNet - BBN relationship, where NEARNet shares responsibility for the actual operations service with its subcontractor BBN.

b - Education and Consultation Service

These Services consist of the production of documentation and publications ,the organization of workshops and seminars, as well as special purpose consulting and management services. The Education Service is aimed at teaching various segments of the consuming public about what the network can do for them and how to take advantage of, and use the network. It is closely coupled to the marketing aspect of networking, but is in fact a distinct activity. The running of Network Information Centers (NIC's) is part of this product as is the User Services or User-Consulting function.In addition the provision of special purpose consulting or management services is part of this product.

---

[11] NTTF NREN pamphlet , pg

[12] Armand Lauffer, Strategic Marketing for Not-for-Profit Organizations (Macmillan, NY, 1984), p. 7

c - Marketing

The marketing function consists of all activities aimed at securing additional funding or additional customers for the network. Activities such as the writing of grant proposals to the NSF or the running of subsidy programs for new members, such as NYSERNet's ASAP program , are all part of marketing. Network "evangelical" efforts aimed at getting more people to use the network or lobbying and advocacy efforts directed towards securing federal funding for the NREN are marketing programs.

d - Information Provision

The addition of information resources to the network is the heart of this service. Information Provision can be direct, where the regional actually creates a new information resource and attaches it to the network. An example of this is PSI's X.500 program, which provides on-line white-pages directory services to its users. Alternatively, this service may be provided by the regional simply arranging for information services to be created and/or attached to the network. An example of the latter arrangement is NYSERNet's Technology Database project, where NYSERNet has subcontracted the building of a pilot "Yellow Pages" directory service to UNIPEG, a New York State supported technology development organization (TDO). UNIPEG will build databases of :

1) projects and interests of existing industries in New York State's Southern Tier,
2) university research projects at SUNY Binghamton, Cornell and Alfred.

NYSERNet will manage this activity, arrange for IP connectivity for these databases and investigate the feasibility of a statewide extension of the project.

e - Technology Development

The product consists of either direct technology development such as NYSERNet's creation and implementation of the SNMP protocol or CICNet's role in sponsoring the development of FAX services over the INTERNET, or the participation of the regionals in testing new networking technologies introduced by the vendor community.

f - Standards Services

In general, communications systems become more valuable to their users as their scope increases. As we discussed previously in our section on challenges, the more interoperable our networks are the more useful and valuable they are. Thus a crucial product in the networking arena is the setting of standards, their testing and their enforcement. Part of this function, closely connected to the technological development, is of providing an environment for the testing of standards and for testing interoperability in a "real-world" setting. This would include a technical coordination service. For example, the recent suggestion by Hans-Werner Braun [13] that FARNET coordinate the use of the OSI-CLNP protocol[14] in a multi-regional setting is an example of such a coordination service.

---

[13] HWB's letter to FARNET members of Sept. 1990

[14] The OSI-CLNP (Connectionless Network Protocol) is the OSI protocol most similar to the IP protocol used in NSFNET. In order to test the use of this protocol in a real life setting, some body must coordinate its deployment.

2. Nature of the Marketplace and Responsiveness to the Market

The regional networks have failed to meet the six networking challenges. While various groups are meeting different parts of the challenge, there is very little coordination, and there is overlap and resulting inefficiency. Whereas the regionals' missions should have motivated them towards selling a broad range of services in the networking marketplace, the networks have concentrated on the operations service, treating education and consultation service, marketing, information provision, technology development and standards very much as stepchildren.

A detailed presentation of the structure of the market and the background of existing networking organizations and personnel, goes a long way toward explaining the regional networks' focus on operations, and their slow response to changing user and customer needs.

a - The Market and the Publics

In analyzing a business one of our key questions is, "What does the market look like?" In the context of the not-for-profit, the consumers of a service are generally not the same as the payers and the concept of "publics" is more applicable. Publics consist of "all those individuals, groups, and organizations external to an organization that either provide it with inputs or are the recipients of its outputs as well as those internal publics that carry on the organizations business" [15]

Input publics include the suppliers of resources (like money...), the providers of auspice or legitimacy (like the board of directors) etc.

Output publics are those that receive some benefit from the service...

Internal or *"thruput"* publics are the people who convert the resources into services and programs.

In our case the input publics consist of:

1) Federal Agencies (NSF, DARPA, DOE, NASA) and their "umbrella" coordinating group, the FRICC (Now reconstituted as the FNC)
2) State agencies
3) Congress
4) Executive Branch of Federal Government (Presidential Science Advisor, OSTP)
5) Board of Directors of Regionals
6) Directors of Computing/Communication Services, departments on the network,
7) Senior executives of universities, for third tier networks.

The output publics consist primarily of the institutions belonging to the networks and the end-users of network services, i.e., the researchers, educators, doctors, etc. who use the network. Depending on one's perspective one can think in terms of a restricted set of users or a broader set of users. In the networking arena, there are four distinguishable sets of increasingly larger output publics; they are: (See Figure 12)

1) scientific research community
2) research, education and health care sectors, and commercial institutions which interact heavily with that sector

---

[15] op.cit., footnote 12, p. 6

3) entire academic, business & government sector
4) the general public.

The primary output publics which the regionals have viewed as their market have been 1 and 2, the scientific research community and then later the education and health care sectors. During the last 12 - 18 months there has been increasing interest in public 3, the broader academic, business and government sectors.

The following players constitute the internal publics:

1) The not-for-profit network operators and their associations, consisting of the backbone and regional network providers and FARNET,
2) coalitions of primararily third tier (campus) institutions, such as the NTTF or the Coalition for Networked Information (CNI),
3) commercial network systems integrators such as BBN, PSI or commercial network education companies such as Dan Lynch's Interops Inc.,
4) technology research, development and standardization groups such as the Corporation for National Research Initiatives (CNRI), the Internet Engineering Task Force (IETF), or the Internet Activities Board (IAB).

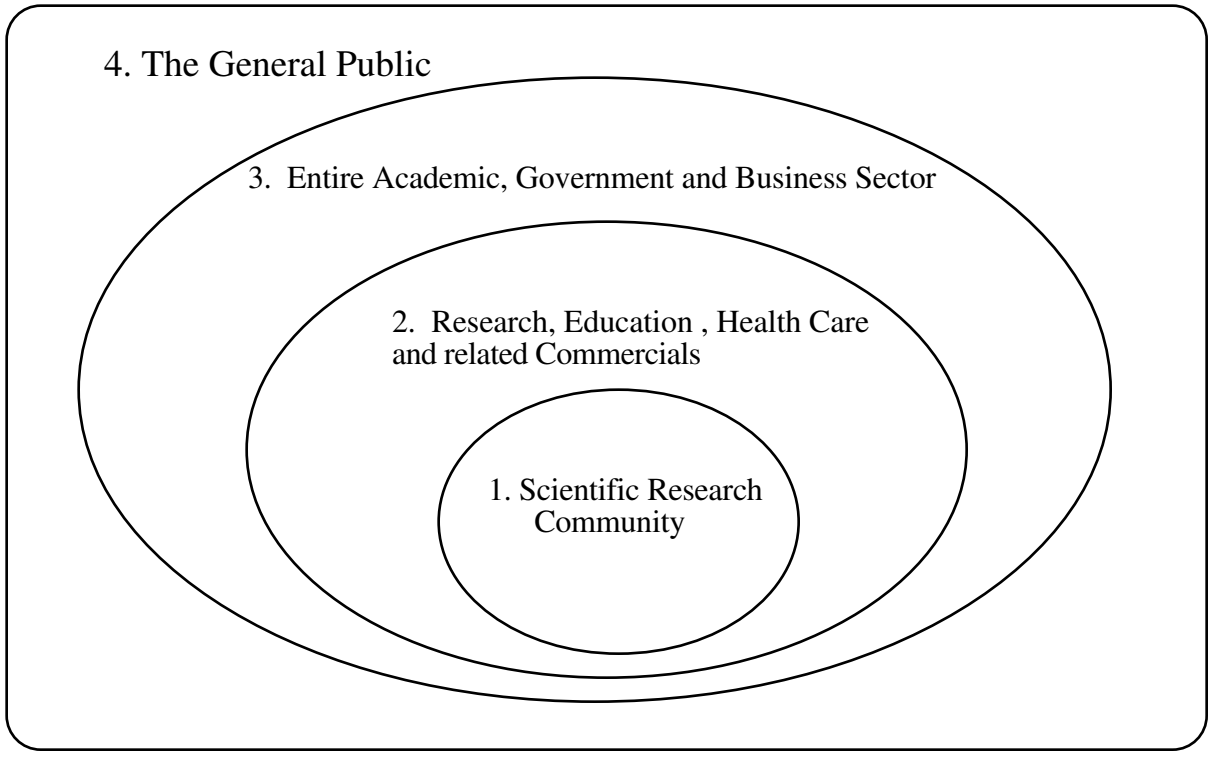

Figure 12. The Output Publics

b - Responsiveness of the Regionals

i. Network Operations Services

Until mid 1989, the primary focus of all of the regionals as well as the backbone operator has been on providing the Network Operations Service. As noted earlier, the movers and shakers in the regional network community, the key input publics, are rooted in either university computing and telecommunications service provision or the network research community. Almost none of these players came from the business community. The backgrounds of these players are one of the key reasons why the regionals have chosen to concentrate on servicing the research, education and health care sectors, and related industry research sector.

The Commercial Network providers have also focused primarily on the Network Operations Service. As businesses, some of them have had more of a customer- orientation and this did emphasize marketing and sales efforts directed towards paying clients.

ii. Education

In the realm of Education Services the picture is similar. Again, these were areas the regionals considered important but didn't invest much effort on. As a result of its contract with the NSF, Merit Inc. sponsored a number of workshops on networking as did NYSERNet, CERFNET and a few other regionals, but on average significantly less than one workshop or seminar per regional per year was held. The most significant effort in the realm of education services is the yearly Inter-Ops conference sponsored by Interops Inc.- a commercial entity.

iii. Marketing

Although there has been some activity to influence legislation on behalf of networking on the part of the regionals, most of this has been on a state level. The NTTF has been the key player in attempting to influence legislation at the federal level and has worked closely with the House and Senate subcommittees who have jurisdictionover the various bills affecting the NREN. In addition, as was mentioned earlier (cf. footnote I-16), the NTTF was the key player in the discussions with the FRICC which led to their sponsorship of an NREN as opposed to the National Research Network (NRN) , discussed in the National Academy report,[16] and in the discussions with OSTP and the President's Science Advisor, Allen Bromley, which resulted in the HPC initiative.

There has also been a good deal of focus on the grantsmanship part of the marketing function. Marketing to potential customers, though talked about, has not been actively pursued. Very few of the regionals have any employees whose primary job was marketing and sales.

The current structure of the networking community is one, where, with the exception of the for-profit operators, the primary interest of most of the other players is in satisfying their sponsors. In the case of a regional this means satisfying its Board of Directors as well as the Federal and State entities which help fund it. The regionals have set up close linkages with those publics and good feedback loops exist whereby the input publics can ask for new or different services or discuss the quality of current offerings. Very few linkages exist between the regionals and their ultimate customers - the end users.

---

16 op.cit. footnote I-15

iv. Information Provision.

Efforts in the Information Provision arena on the part of the regionals has also been limited. The most noteworthy results in the last years were the attachment to the Internet in 1989 of the RLIN database operated by the Research Libraries Group (RLG) and of CARL - the Colorado Alliance of Research Libraries, as well as the attachment by other regionals of individual libraries or groups of libraries to their own networks. In terms of production of new directories or information databases, the record shows spotty results. The two most significant outcomes of efforts by regionals or their members was the production by the Texas Higher Education Network (T.H.E. Net) of a guide to networks on the Internet and the various guides to Library Resources on the Internet produced by either individual Universities or through the auspices of the NTTF. In the commercial arena, the attention to this area was similarly minimal. BBN, also as a result of an NSF grant, produced a Guide to Resources on the Internet, but this was a very modest and incomplete effort at best. The most significant event in the area of Information Provision in the last five years was the formation, in April of 1990, of the Coalition for Networked Information by EDUCOM, CAUSE [17], and ARL (the Association of Research Libraries).The mission of the coalition is "to promote the creation and utilization of information resources in network environments..." The regional networks played no role in the establishment of CNI and almost none are members.[18]

v. Technology Development.

In the case of Technology Development, responsibility has been largely abdicated to the IETF and CNRI, with the regionals playing a secondary role. The most notable exception to this trend has been NYSERNet and now PSI, which were active in the development of SNMP and the Z39.50 database query protocol and in the deployment of a distributed X.500 directory service as well as in the creation and management of the DOD/DOE sponsored National Network Testbed (NNT). The major contribution of the other regional networks has been through the participation of some of their personnel in IETF work groups and in work done by individual universities (more accurately, by their computer science and/or engineering departments) in cooperation with CNRI on the gigabit research effort or directly on behalf of Federal sponsoring agencies e.g. Wisconsin's X.400 work or "IP for the Mac" software development on the part of NCSA and Stanford . When the regional networks first came into existence, they did play a major role in field testing new routing hardware and/or software from vendors such as Cisco or Proteon. Similarly, NSFNET has to some extent served as a testbed for IBM's TCP/IP routing technology. However, the importance of this service by the regionals has diminished in the last year or two.

vi. Standard Setting and Enforcement.

Lastly, with respect to Standards Services the regionals role has been minimal. The standards body in the TCP/IP networking community has been the IAB with much of the input into the process coming from the IETF. One of the primary venues for testing has been Interop Inc.'s yearly interoperability conference. The Standards areas where the regionals could be most effective, enforcement and technical coordination is one which they have just begun to think about, with the most likely purveyor of that service being FARNET.

---

[17] CAUSE is the Association for the Management of Information Technology in Higher Education — the administrative computing counterpart to EDUCOM

[18] As of November 1990 the only network belonging to CNI was NYSERNet.

3. Geography and Funding – The Place and the Price

Place refers to the location at which service is delivered and price refers to "the costs that someone has to pay for the development, distribution, and utilization of the product."[19] The price can, but need not, be paid by the customer. In the case of networking, the price is paid by a combination of sponsors and customers.

Place. In the networking environment the actual operations service is delivered either at the end-users desktop or at the backbone/regional's router. The Network Operations Center (NOC) which is responsible for the delivery of the Operations service has generally been located at a single institution, not too distant from the users of its services. However, the very essence of networking renders geography irrelevant. This is most true for the NOC and its services. It is generally accepted that to provide a high-quality communications service one needs a NOC which is manned 24-hours a day, 7 days a week.

Cost and Price. NOC costs increase slowly as the network grows, i.e. A NOC for a 200 node network costs little more than a NOC for a 50 node network. The NOC thus represents one of the most expensive start-up cost components of a network. This is especially true for the pricing schemes of all currently operating mid-level networks whose price for each new customer includes the cost of leasing the transmission lines and buying the routers needed to add the customer to the network. The price usually has a line cost component and a service-cost component. The service-cost component either has a one-time equipment charge up-front and a smaller periodic operations cost component (e.g. JVNCNet pricing) or a single operations cost component which includes the equipment costs in an amortized fashion (e.g. PSINet). The price is not necessarily a direct charge to the new customer. It is often distributed between the sponsoring input publics (e.g. the NSF and the New York State Science and Technology Foundation (NYSS&TF) [20] in the case of NYSERNet) and the new customer. This fact has been one of the major problems in "Commercializing" the Internet[21] and in resolving the whole host of problems surrounding appropriate usage of the Internet.[22]

The other products offered by the regionals have generally been provided through a single point-of-contact, usually geographically close to where the service is made available. In particular, NIC services and NOC services are usually co-located and generally workshops and seminars are held at the home site of one of the regional members.

The pricing structure for regionals described above generally focuses on the operations service with the cost for all other services being bundled. In most cases this bundling is explicit, e.g. BARRNet has a membership cost component related to an institution's size and to whether it is a for-profit or a non-profit and a services component related to the size of the communications bandwidth being purchased. In a few cases, e.g., JVNCNET, this bundling is less explicit, with pricing dependent only on bandwidth and for-profit vs. not-for -profit status. In all cases, however, the customer is buying some or all of products b) through f) described above in addition to the basic network operations service.

---

[19] op.cit., footnote 15, pps 7-8.

[20] The NYSS&T foundation is in fact a state agency chaired by the State's Director for Economic Development, Vincent Tese.

[21] Commercializing the Internet - A Summary Report

[22] Discussion on Com-Priv in Sept and Oct 1990

4. The Internal Business Structure

The key production activities that all businesses carry out are: [23]

Operations – activities associated with the direct delivery of a service or manufacture of a product.

Customer Service – activities designed to maintain or enhance product value.

Technology Development – activities involved in research and development of the technological applications and know-how needed by a firm.

Firm Infrastructure – activities required for planning, coordination and management of a firm, including financial and human resource management functions.

In addition the firm engages in support activities such as:

Product Logistics – activities involved in procurement and in the receiving of product inputs and disseminating finished products.

Marketing & Sales

Thus a reasonable organizational structure for a networking business might appear as shown in Figure 13 below. This is in fact essentially the business structure of a typical Telco such as RCI.[24] The regional networks, despite their movement toward becoming Level 4 – value added suppliers for the most part are still structured as "academic" service organizations.

The regional networks generally have a single individual, the "network executive", responsible for management, planning, coordination and finance. The network executive may be directly employed by the network (e.g. CICNET) but is often an employee of one of the members of the network (e.g. BARRNET) with duties on behalf of the regional network an "add on" to "real" responsibilities to a primary employer. The network executive usually reports to a large oversight subcommittee of the Network's Board of Directors and, provided that network operations is done "in-house", has direct line responsibility for the networks operations group. Even in the case of an "in-house" network operations group, the people working in such a group are not necessarily the employees of the regional network, but may also be employees of various members of the network. In the latter case, responsibility for network operations is again an "add-on" to their primary duties. In most cases supervision of network operations is a responsibility shared with another voluntary, Board of Directors appointed, "technical" oversight committee.

The Customer Service activity of the regional is usually deemed to be satisfied by virtue of the staffing of the various oversight committees by representatives of the networks membership. Although there is some attention to Marketing and Sales by the "network executive", only five or six of the 26 not-for-profit regional networks represented in FARNET employ an individual who is assigned solely to that task. Formal attention to Technology Development is even more inadequate. None of the above not-for-profits currently employ anyone whose primary job that is. The fact that the network executive's powers are so circumscribed and that the regionals are generally "managed by committee" rather than by a true CEO complicate the networks ability to react to change and adapt itself to new circumstances.

---

[23] See Michael Porter, Competitive Advantage: Creating and Sustaining Superior Performance (New York,NY: The Free Press, 1985), ch.2. We have condensed the 5 production and 4 support activities that Porter discusses into the 4 production and 2 support activities we describe.

[24] RCI, Annual Report 1989.

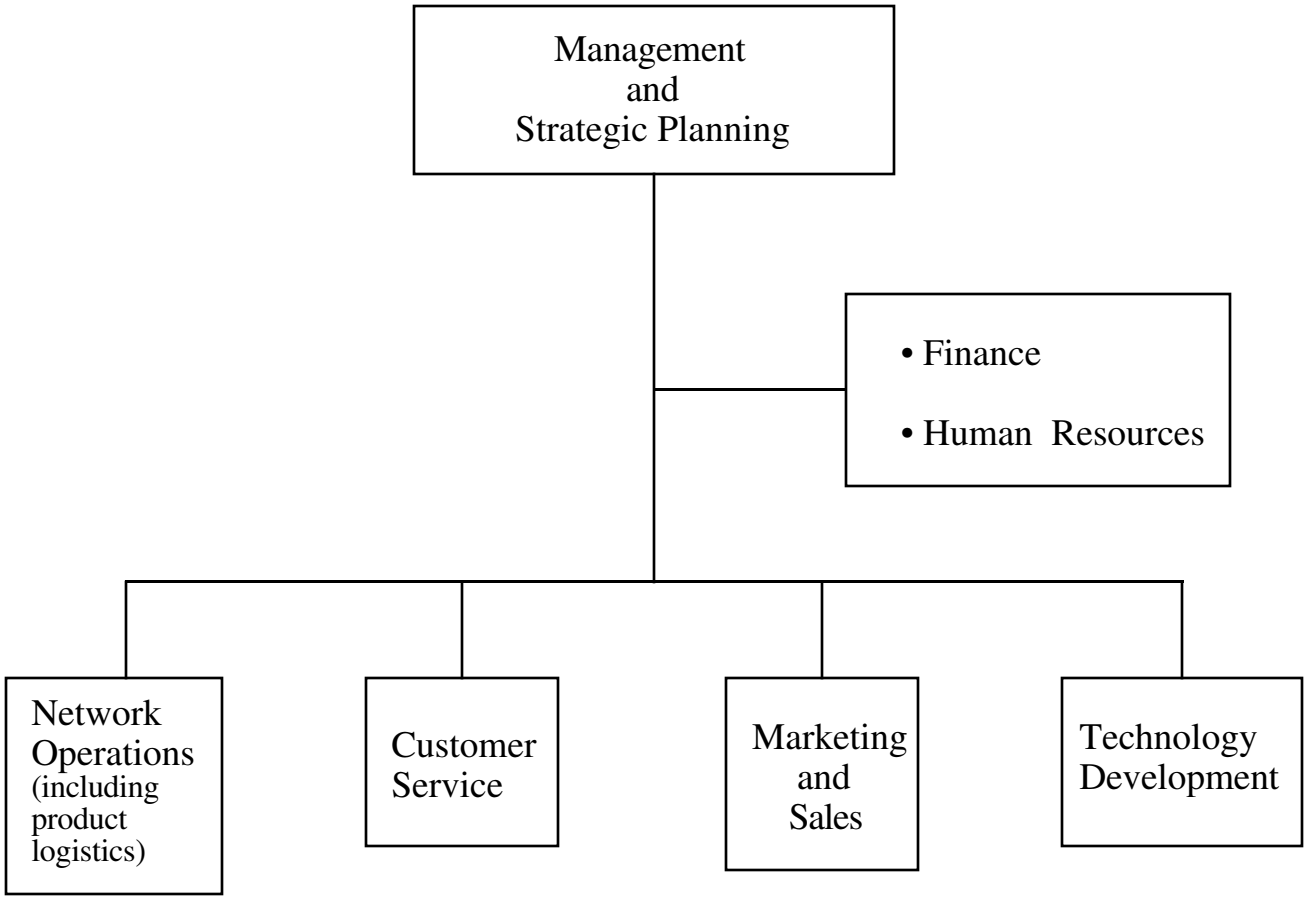

Figure 13. The Internal Business Organization of a Networking Firm

III. Models for Regional Networks: A Critical Assessment

We now turn to a critical examination of the various categories which either characterize current patterns of behavior of the regional networks or represent models towards which some of the regionals are evolving. Each model is analyzed below in terms of (1) ability to meet the networking challenges of the 1990s, and (2) power as a viable model to be emulated by other regionals.

A. The Regionals Today - A Summary

As we noted above the regionals are, for the most part, not very well structured. They are heavily biased toward operations with some emphasis on service and marketing. Educational services and information provision are areas more discussed than acted upon. Technology development and standard setting are functions which have been left to others. They have put almost no emphasis on firm infrastructure, particularly on strategic planning and coordination. They have a limited scope of operations, both geographically and conceptually. In general they are drastically understaffed and usually under funded as well.

The primary publics toward whom the regionals are oriented are their sponsors and the funding agencies. The markets they are most concerned about are the research, education, health care markets and the commercial community contiguous to them. They have little interest in either the pure commercial sector or the end-user populations of their own institutional customers. They have virtually no interest in serving the general public .

For the most part, the regionals are not doing an exceptionally good job providing even what they do provide.

> "the current structure has been accepted only because of low expectations coupled with high hopes and has depended for what success it has had primarily on the high expertise of its users and extraordinary dedication on the part of the administrators and technical personnel who keep it running.....We have a structure intrinsically unable to solve end-user to end-user problems in a consistent and satisfying fashion..." [1]

The network services the regionals currently offer are not sufficiently reliable, secure, nor consistent. They are not easy to use nor are they well-documented. Help is not readily available nor are trouble-shooting or problem notification procedures well established. The networks do not offer enough services or information resources and it is usually difficult to find out what is available.

---

1 R.Mandelbaum, Free Market Networking, Educom Review, Vol. 25, No.1, p. 10.

B. The Limited Network Model

The first pattern, that of the Limited Network Model (LNM) is an abstraction of the current state of many of the regionals today. Moving from the reality of the "standard" regional to the abstract category of the Limited Network Model we can characterize the LNM as follows:

> 1) Restricted Set of Products/Services - The primary focus of the LNM is on operations, i.e. - the delivery of adequate TCP/IP transport services. Some degree of monitoring and troubleshooting is provided. Additional services and/or products may exist but are not emphasized.
>
> 2) Limited Quality and Customer Service. – The key emphasis of the LNM is on adequacy of service rather than excellence. Some corners are cut, thus, for example, network operations are generally not provided on a 24 hour a day/ seven day a week basis, but absolute lowest cost is not the goal either.
>
> 3) "Reasonable Prices" – The price charged by the LNM will be "reasonable". For example SURANet and JVNC's prices are not as high as the price of PSINet service nor as low as that of BARRNet's offerings.
>
> 4) Intermediate sized scope - The LNM does not act on a national scale geographically nor does focus on a specialized product niche within the networking marketplace.It attempts to service all of the vaguely defined "research and educational market".
>
> JVNC or SURANet would fall within the category of the Limited Network Model, BARRNet with its distinct focus on a specific metropolitan area would not.

The limited network model does not match well with the challenges which the networks have set for themselves. Nor is the LNM a particularly viable model. We have stated earlier that the regionals are not executing their current functions well. However, even were they to improve their ability to function dramatically, there are structural forces mitigating against the success of this model. These forces and trends were discussed in the analysis in Section I.4 of why NYSERNet, felt the need to "privatize" its network operations. In summary they are:

1. without economies of scale costs are high and remain high.
2. achieving economies of scale necessitates an easing of acceptable usage policies in order to sign up a broader range of commercial customers as well as expansion beyond accepted regional boundaries.
3. expanded operations may constitute unfair competition by the non-profit sector vs.the commercial sector.
4. a not-for-profit, cannot easily raise venture capital

As long as the Internet continues to function like a regulated marketplace, with the playing field kept artificially level because of direct federal subsidies to regional networks to provide operations services, the regionals have some chance of surviving as niche providers in the "business as usual" mold. However, once the subsidies go away--- so will those niches!

The type of regional most likely to survive in such circumstances is the State-funded regional – the State Network. The State network, sometimes considered a "fourth tier" of the three tier model, is either positioned between the third tier "campus" network and the federally subsidized regional network (e.g. the CONCERT network in North Carolina lies between SURANet and the campus

layer), or is an NSF recognized mid-level itself, such as Colorado Super Net. Most state networks exist either to interconnect branches of the State University system (e.g. T.H.E.Net services the Texas University system) or are outgrowths of such networks. (e.g. Merit started life as a network interconnecting some of the publicly supported universities in the state of Michigan, but evolved into a network servicing the private universities in Michigan as well.)

The latter type of State Network is a good example of an LNM which will probably be viable in the long run. As a result of direct subsidization of the network by the state, the state network is not totally subject to the market forces which exist in a deregulated and unsubsidized marketplace. The state network can charge its customers a fee which represents only its marginal costs or , in the case of other state supported entities, often no fee at all. Thus it is a "low cost" provider and because of political considerations will tend to stay low cost. Furthermore the rising quality of operations services, brought on by competition in the commercial networking marketplace is likely to force the State network to improve the quality of its services as well, without necessarily leading to dramatic increases in the fees it charges.

The "pure" state network, which services only the state's public college and university system , as well as those regionals,which cater to a very limited region and have a homogeneous, hi-tech class of users, are better characterized as Low Cost Operators.

C. The Low Cost Operator

The low cost operator provides a low-cost, no frills communications service. In addition to the "pure" state networks discussed above, Alternet is an example in the for-profit sector. Alternet operates over a broad geographic territory and aims at a large marketplace. It extends little technical support, and assumes that the customer handles his own technical problems.

BARRNet is an example of a low cost provider which targets a very specific set of customers. Here, the market is concentrated in the Bay Area, is relatively homogeneous, and requires little technical support when compared to the needs of a more diverse user base. In addition BARRNET, among the regionals, has the most stringent restrictions on usage. Because of the need to concentrate on low cost communication service, little attention can be paid to other services and markets which we have described, and few resources can be directed to them. Low cost is thus sometimes achieved by skimping on quality.

In the case of other newly de-regulated markets, low-cost providers have generally migrated quickly to other niche roles via higher cost specialty services, and have lost their interest in low-fee markets. Their low-cost structures and no-frills approach are usually not sustainable in the long run except in very special circumstances.[2] Thus though some regionals, especially the state networks, will continue and be viable in the long term as low cost operators; this is not a reasonable model for the majority of regionals. Furthermore, the LCO model, even more than the Limited Network Model, clearly cannot serve to meet the networking challenges of the 1990s.

---

[2] Joel A. Bleeke, Strategic Choices for Newly Opened Markets, Harvard Business Review, Vol 68, No 5, (1990) 158-166

D. The Challenge of the Full Service Providers

The third pattern, that of the Full Service Provider (FSP), is typified by PSI or ANS, respectively the "private" and "quasi-private" which evolved from the regionals. The Full Service Provider sells a broad array of the products and services over an extensive geographic area. It is organized as a true business with attention to operations, services, technology, marketing and sales, and planning. By operating over an extended area and catering to large publics, it has the potential to benefit from large economies of scale and to pass this advantage along to the customer, by offering high-quality networking at an affordable price to all of the market.

The Full Service Provider is akin to a category of successful businesses in other industries. Thus, for example, in markets which opened after de-regulation of the airlines and telephone industries, a recent review showed that companies which offered a wide range of services to a broad public were among those that best survived the chaotic, post-deregulation period.[3] As the Internet moves into the era of commercialization and privatization the experience of such companies may be relevant, and the model of the Full Service Provider may have the best chance of long-term viability. However, a closer examination shows that this model will probably not prove to be an effective one to emulate for most regionals.

1. The Full Service Not-For-Profit Provider (FSP) Analyzed

As indicated above, the Full Service Provider model has been assumed by for-profit and not-for-profit entities. The crucial differences between the two patterns are:

1) in the degree of cross-subsidization of revenues from one product line to another or from one output public to another;
2) the nature of the marketing effort; and
3) the publics to be "satisfied".

Because of its public support, the not-for-profit FSP feels more of a responsibility than would the for-profit to meet the challenges of universal service and equitable access, and thus a greater incentive to attempt to subsidize publics who would not ordinarily be served in a competitive market. The not-for-profit has a great incentive to please its sponsors who provide subsidies or pay directly for the offering of certain services and thus can tend to downplay the needs of its real end-users. By contrast, the for-profit must market to and be responsive to the needs of the purchaser of its services. The for-profit will market to the commercial sector, while the not-for-profit tends to market to more limited groups, like academe and the research community, consistent with its non-profit mission.

Although a not-for-profit FSP is well-suited to meeting most of the networking challenges we have articulated, the self-imposed limitations on its potential market call its ultimate survival into question. A crucial characteristic of the successful FSP is that it enjoys major economies of scale because it sells to a large geographic region. The decreasing cost per connection of NOC services as scale increases, as well as the substantial decreases in cost for bandwidth as larger bandwidths are leased, render success dependent on attracting as large a clientele as possible to any particular service. By imposing severe limitations on the customers it will accept and catering primarily to

---

[3] In Bleeke's article , (cf. footnote 2), the experiences of U.S. companies after deregulation was analyzed. Among the four distinct types of companies which were able to survive and prosper are found:,"broad-based distribution companies that offer a wide range of products and services over an extensive geographic area ;"

the research and education community, the not-for-profit FSP fails to realize its economies of scale. It will therefore be compelled to charge higher prices or seek subsidies in a world where subsidies are evermore unreliable, and will find it harder to compete with a national for-profit entity.[4] This inability to compete with the for-profit is further exacerbated by the tendency of the not-for-profit FSP to engage in cross-subsidization if it is to realize its own charitable and/or educational goals. While the not-for-profit can always enlarge its potential market by attempting to sell competitively to the commercial market, this would cast its not-for-profit status into doubt. Alternatively, the not-for-profit can spin-off a for-profit subsidiary to provide network operations services.In this case the parent not-for-profit would no longer directly provide an operations service, except through its for-profit subsidiary.This act would change the non-profit FSP into a different entity, more closely related to the"Marketmaker" we discuss in the next chapter than the true full service provider.

Despite our assertion that the not-for-profit FSP's are probably not viable in the long run, they can certainly play a role in the intermediate term. ANS with its large initial capitalization of $10 million dollars has the potential to be an active player for a long time. The crucial questions are not whether it is viable or not, but for how long it will refrain from providing purely commercial services and how it will restructure itself when it decides to do so.

In addition to the question of how well the FSP model meets networking challenges, we must look at how likely it is for a current regional to become an FSP. For the most part the chances for such evolution are not good. Despite the example of ANS, it is exceedingly unlikely that an additional consortium can be put together to provide the large amounts of capital necessary to become a not-for-profit FSP. IBM and MCI have had a strong relationship with MERIT, in the running of the NSFNet backbone. But there do not currently appear to be any other "sugardaddies" waiting in the wings to fund not-for-profit networking undertakings. The major other possible underwriters of such ventures, AT&T , the RBOCs or another major computer vendor do not seem to be interested in funding "charitable" forays into the networking arena.

2. The For-Profit Full Service Provider Analyzed.

The for-profit FSP is less suited to fulfilling the network missions of the 1990s. Motivated by profit, it is much less likely to respond to major policy challenges, such as universal service and equitable access. Similarly its commitment to interconnections with other networks, like the regionals whom it views as competitors, is questionable.

Although the for-profit FSP model offers the opportunity of securing funds through either the Venture Capital Market or by partnering with an established commercial entity such as DEC or ATT, it is also not a likely route for a regional to travel. The current players in the regional networks are, for the most part, not interested in running a for-profit entity nor do they have any special talents to do so. The contradiction between the goals of a for-profit entity and the current goals of the regionals make the spinning off of new for-profit FSPs by established regionals appear improbable. The case of the NYSERNet spin-off of PSI is to be viewed as an exception, rather than a model for regionals development. Among the key players in NYSERNet were several who had a longstanding and deep commitment to create a private networking entity, free from the restraints imposed by non-profit structures, such as unwieldy Boards of Directors. There do not

[4] The NSF decision to terminate support for JVNC, even after an initial investment of $50 million, argues very persuasively that we cannot take continued subsidization for granted.

appear to be any other such groups in the not-for-profit segment of the regional networking community today.

Although it is unlikely that any of the remaining not-for-profit regionals will evolve into an FSP, there are potential candidates from the for-profit sector. The most likely of these is CERFNet. CERFNet is a networking project of GA Atomics, the for-profit operator of the San Diego Supercomputing Center. Thus CERFNet is already part of a for-profit entity and can consider evolving into a for-profit FSP, provided that its parent organization has the will to do so. CERFNet's expansion into the Bay Area, its high quality response to the CICNET RFP for Network Operations Services and its interest in being included as a potential bidder in Networking Operations RFP's issued by other regionals, indicates that it is interested in expanding. Other likely candidates for for-profit FSP's are BBN– which operates NEARNet, Infocom, the commercial network operator partially owned by MCI, the Japanese and some of the European PTTs, which operates some of the Army's supercomputer installations, or some new entry coming from the world of the RBOCs or other commercial Telcos.

Having discarded the Limited Network Model and its cousin the Low Coast operator as well as the Full Service Provider model for most of the regionals, we are left with one last model. This is the model pioneered by NYSERNet and to which some of the other regionals such as NEARNet or PREPNet are evolving --The Marketmaker.

IV. The Regional Network as Market Maker: A New Model

A. The Contemporary Landscape

1. The Role of the Regionals in Operations Is Challenged

The regional networks are currently being challenged in different market segments by private or quasi-private operating companies such as PSI or ANS, which can provide reliability, consistency, 24-hour a day Network Operating Centers, customer orientation and other communication benefits desired by the user.

However, so far, the number of "privates" is too small to promise the kind of real competition, and the resultant pricing and quality of service which would characterize a truly competitive market. Nor does the emergence of the new "privates" guarantee the research and academic network user that a monopoly situation has been avoided. Ironically, it is likely that as markets are developed, a broad-based telecommunications firm, such as AT&T or Sprint may decide to enter the market.[1]

Given that IBM-MCI has spun-off an independent non-profit ANS, which is currently making its way into the market with strong IBM-MCI support, it is highly probable that within three years one of two developments will occur: (1) ANS will establish a for-profit subsidiary, or (2) IBM and MCI, an alliance of giants, may decide to enter the market themselves[2]

The smaller privates, like PSI and Alternet may not have the economies of scale which make flexibility in pricing possible. Hence, they could find themselves unable to compete with one or two big companies, short of recruiting backers with very deep pockets. It is also unlikely that they will be able to deliver significantly better quality than the giants. Even if they could provide better quality, it would be a hard sell to convince the market that this was the case. All told, the smaller privates could easily be driven out of business, unless they penetrate specific focused markets, and contrast themselves sharply with the bigger firms in their own market niche.

2. The Academic and Research Communities As Potential Losers

When the dust settles, and the entrants to the high-speed telecommunications network have fought their battles and the survivors emerge, it is all too possible that the general market, including the research and academic communities, may find itself facing one or two large suppliers firmly in

---

[1] Digital Equipment has recently become a potential player as well. Kodak has outsourced its telecommunications to Digital. Always a major player in the production of network hardware, DEC is now becoming an experienced operator of external networks, and in partnership with an independent telephone company could be a contender in the race.

[2] An ANS spin-off, with IBM-MCI behind it, or an IBM-MCI division, would be capable of offering the general market a highly integrated turn-key network service. Working with the Fortune 1000, ANS or IBM-MCI could also obtain high fees and high prices. A small company, like AlterNet, might be able to survive by marketing to smaller firms which boast a reasonable level of skills in such areas as telecommunications and programming. These firms, particularly in the software and other high technology areas, could be offered "no frills" services art prices significantly lower than those offered by the giants.

control. The regional networking community is thus confronting a dilemma. Short term, the regionals may find themselves driven from the operating role by the appearance of "privates". But the very privates which drive the regionals out of the business may themselves become the victims of a large operator. As a result, services which have been provided to the academic and research communities to date by the regionals, but which are unprofitable or unattractive to the large for-profits, may be lost entirely.

The regionals are at a critical juncture. They must look to fulfill their missions and goals with great sensitivity and long term vision. By looking to fulfill their goals with great creativity, the regionals can accomplish them, and simultaneously create for themselves a future far more exciting than the present.

B. The Marketmaker Model Exploits the Regionals' Key Strengths

The regionals face a two-fold threat, as their position in operating transport weakens. First is the danger outlined above, the loss of specialized service for the research community. Second is the loss of a raison d'etre for themselves. But a close examination of telecommunications markets today, and other markets in similar states of flux, strongly suggests that these threats can easily be converted to new opportunities.

1. The Marketmaker Model Applied

We find that these opportunities are best represented by our fourth model of regional networking, the Marketmaker. In the context of viewing the regionals as the representatives of the research and academic communities, the Marketmaker's primary functions are:

(1) to see that conditions flourish which encourage competitive sources of supply,
(2) to protect the interests of the academic and research communities in the high-speed telecommunications market, and
(3) to stimulate demand for network services.

The Marketmaker also has secondary functions which are discussed below.[3]

2. Stimulating Competitive Sources of Supply

A key task of the regionals, having shed their operating functions, would be to ensure that the "cutting edge" of the networking market - the research community - has at least one reliable source of supply, and preferably, that there is a competitive market in network service provision. In short, the regionals should be searching for ways to stimulate competitive sources of supply.

The regionals can accomplish this seemingly overwhelming task by functioning as amalgamated structures with effective buying power, that is, by acting as buying co-ops. As we have shown,

---

3 Bleeke, (op. cit., III-2) reports that in newly de-regulated markets ---- similar to ours because a new market is opening up---a "shared entity" has been one of the few successful models for staying in business during the shake-out period. The "shared utility", as Bleeke calls it, looks for its niche to the needs of smaller , individual companies for services which they cannot obtain alone.

geography is irrelevant to high speed telecommunications. Thus, it is no longer of any interest to a regional or national operations provider that a particular second-tier network is located in the northeast, southwest or both.

The barrier to entry into the business of networking is the initial Network Operations Center. If a firm can obtain the business of one or more regionals for a guaranteed time period, the new business gains sufficient economy of scale to allow it to launch operations on a competitive scale. Thus, for example, PSI came into existence with the stroke of a pen, as NYSERNet guaranteed PSI its business. The same guarantees by a campus network, even as large as that of Michigan or NYU, would not have accomplished the same task. The potential for regionals to sign contracts with new entrants regardless of geography similarly encourages new businesses to offer services, by providing the newcomer potential economies of scale without attention to its location. Any provider of commercial operations is able to sell to any part of the country . If the Modified Final Judgement related to the divestiture of AT&T[4] were to be changed to allow the RBOCs to offer network services, any RBOC could sell to any regional. (Several paragraphs below discuss this point.)

3. Maintaining Competitive Pricing

While geography is not of importance to network operations providers, economies of scale are of great interest. The provider characteristically will benefit from selling to a large buyer, and will respond with discounts. For example, the National Telecommunications Network significantly discounted its pricing to NYSERNet for the National Networking Testbed (NNT). The regionals can buy network services from any provider and can therefore play and negotiate pricing in the national marketplace. Third tier networks–campuses – cannot have this sort of impact on prices. By buying and selling as "buying cooperatives" – groupings of 3rd tier networks–the regionals, as Marketmaker, can create pressures for competitive pricing.

4. Protecting the Interests of the Research and Academic Communities: Serving As A General Contractor

Where competitive sources of supply are available, the Marketmaker may serve as a general contractor. As a general contractor, the Marketmaker would select the provider of network service, and supervise and coordinate implementation. Specifically, this could involve functions like designing RFPs, evaluating responses, and ascertaining whether or not the network is being delivered as promised. In addition, as general contractor the Marketmaker would play a major role in quality assurance.

a. Providing Quality Assurance

Quality assurance is a complex factor in networking. Upon connecting to a TCP/IP network, the customer is purchasing a complicated service. Many purchasers of the service do not have the technical resources, know-how and experience to diagnose their problems. While ensuring that competing sources of supply exist is an indirect way of providing for quality assurance, the regionals would serve a useful function by actually providing quality assurance. The regionals, via

---

[4] For a discussion of the Modified Final Judgement and the breakup of the Bell System, see Steve Coll, The Deal of a Century (New York,NY Atheneum, 1986)

a Network Technical Committee, would become the primary party responsible for assuring quality of performance, including end-to-end and end-to-internet reliability, data rates, response times, and prompt notification of service disruptions. Given the importance of this area, the regionals could take the lead in pioneering new approaches to quality assurance in educational and research networking. In addition to trouble shooting, staff of the regionals could implement periodic audits or reviews which could evolve into standards for customer service.

b. Evolving To Interoperability and Promoting the Testing and Enforcement of Standards

Currently, in spite of denials, neither PSI nor Alternet strive to interoperate, very likely because they would like to hold on to customers through the offering of proprietary services. In other segments of the telecommunications industry, user groups have joined forces to design and develop their own sets of service standards. In high-speed telecommunications markets, the regionals represent the academic and research user, and could band together as an umbrella users-group, perhaps within the FARNET structure, to promote service standards, including interoperability, and via the Quality Assurance role, to enforce them.

5. Stimulating New Demand and Increasing Existing Demand

The mission of the regionals requires that they spread the word about networking and educate broader markets about the advantages of networking. This role has many facets, and we will mention each briefly.

a. Lobbying/Public Relations

This is the most general form of marketing, and involves lobbying and testifying before state and federal executive, legislative and administrative agencies to obtain legislation, regulation and implementation favorable to the cause of networking. It also involves the more minor role of keeping in touch with the media and informing and educating the media about the principles of networking as well as events taking place.

The policy areas in which the Marketmaker would very likely be active include:

(1) the extent of federal support of the NREN and second tier networks,
(2) commercialization of networking,
(3) increasing the number and types of firms which can enter the market. (As was noted above the RBOCs could enter the market if the MFJ was revised).

b. Market Research, Strategic Planning and Grantsmanship

The regionals should be in the forefront of research which assesses and discovers potential demand for networking in new areas, educational, industrial and consumer. Similarly, the regionals should be in the forefront of disseminating research which identifies new networking approaches and technologies. They ought also to maintain a front-line position in strategic planning, to assess the new technologies which will be available in five years, and to identify applications and markets for these technologies. Beyond market research and grantsmanship, the regional networks would continue to apply to the state and federal government agencies for funding which will further national networking goals.

6. Engaging in Secondary Functions - Good Business

This section starts off with the premise that while the Regionals are not for-profit entities. There are areas in which the mission of the Regionals suggests that these entities should provide certain functions as a business. These are areas in which the Regionals have unique strengths, and in which gaps exist in the services provided by the for-profit market. In particular this would include any area in which the regionals can best provide the services necessary to increase demand for networking--- a stated mission of the Regionals. Where these conditions coincide, we feel that it is reasonable, and perhaps even necessary, for the Regionals to take on business functions.

a. Marketing As a Business Service

If we look at the Marketmaker as a business, we note that the regional actually has a built-in but somewhat underdeveloped capability- that of marketing. Whereas the transport of information has no geographic constraints, and firms do not have serious advantages as a result of their location in one part of the US or another, successful marketing and successful customer service are affected by regional and local factors. The Regional knows the research, academic and educational communities in its region, i.e., the regional markets, far better than the privates or quasi-privates can hope to as they begin complex operations in multi-segment markets.

The role of the regionals in marketing network services must be clearly defined and delimited. In order to maintain the freedom to stimulate competitive sources of supply, and to negotiate for favorable pricing, the Marketmaker cannot tie itself to a specific supplier by becoming an agent of that supplier. But the Marketmaker is in an excellent position to market the concept of networking. The regionals as Marketmaker would market network services to hospitals, undergraduate colleges, community colleges, high schools and the like, and sign them on as members. The network operations service providers selected for the different regions or niches across the country would have reason to offer incentive pricing to the Marketmaker , because of direct benefits accrued from dealing with a large co–op. In addition, the providers would have good reason to award grants or membership fees to the Marketmaker, in order to support the marketing of the concept of networking, certainly an activity which benefits them. The operations provider would benefit from the sale of a large chunk of bandwidth, from all of the advantages of dealing with one vs. many points of contact, and the advantage of receiving complaints which have been aggregated and filtered. These benefits to provider could be reflected either as a direct discount to members of the respective regionals, or as a fee, paid by the provider to the Marketmaker, for each network member signing on for the provider's services. If the regionals adopted a leadership role in quality assurance, they could obtain additional discounts and/or fees as payment for this service.

b. Development of New Business Areas

There are several areas of the information technology business which are not currently attractive to the commercial sector, and which the regionals are naturally suited to enter, because of their technical expertise and their knowledge of the market. (These business areas are identified below.) While there is no reason why the regionals should NOT enter these markets, there are two different motivations for entering them, leading to different approaches.

The first motivation is that of achieving the national networking mission, that is, the desire to expand networking in all possible directions. This motivation suggests that the regionals develop these new businesses only until they are profitable and commercially viable, and then look to privatize them. Implementation of this idea could take many forms. In the case of NYSERNet, there were individuals within the regional networking organization who were committed to

privatization, and who took the risk of actually investing in privatizing the network operations service themselves. Developers of a new product or service may wish to take it to the private market themselves, just as the developers of certain NCSA software went out and established a private company, Spyglass Inc, to market the software. Barring this, regionals could look for investors outside the immediate community of the regionals.

The second motivation is the need to raise funds for the regionals key functions. This motivation suggests that the regionals should incorporate these businesses, marketing the new services and collecting fees for them, and realization of the two goals can dovetail one another. NYSERNet, for example, has retained an equity interest in PSI for the express purpose of creating an endowment fund to support its primary goals and activities.

i . Aggregating Non-Commercial Information Services.

Universities have large, untapped databases of information submerged in departmental and other files. IBM and Sears have spent more than $500 million to put the Prodigy package together, an offering of more than 400 electronic data services - in this case delivered to consumers in their homes, over standard telephone lines.[5] There are similar opportunities for collecting the hundreds of data bases available in the universities and research centers and presenting the data in the form of a single service - a product these types of institutions might subscribe to, whereas they could never access or afford to access one data base alone. Since this is a task which is difficult for non-specialized organizations to accomplish, but is relatively routine for a specialized organization, the role of the Marketmaker here might be (1) to undertake to execute the functions which it specializes in, namely the networking portions of the project, (2) to contract the specialized development of the data bases to an organization specializing in that area, as NYSERNet has done with UNIPEG. (see section II.B.1.d)

There is also a potential new business for the Regionals in the area of state economic development data bases. These are data bases constructed for tracking commerce and industry, and include such information as the largest companies in all counties of the state, the industries most commonly found in the state and the like. Because of their connections to state government, which affords the regionals access to economic development data bases, and their expertise in manipulating data bases, the Regionals are uniquely suited to offering the additional service of locating and brokering information-sharing partnerships, as well as the more mundane role of giving broad sections of the community access to these economic development data bases.

ii. Formal Alpha and Beta-Testing of New Information Technologies

Since their birth, the Regionals have been heavily involved in alpha and beta-testing of new networking technologies, such as new router technology, new protocols and new software. Actually, since the regionals were the first networks, and since all technologies were new and first deployed at the regionals' operating centers, the regionals de-facto were continual alpha and beta-test sites. The regionals will be the initial test site for the Gigabit Network in the future. Other information technologies to be tested in the future are knowbots and digital libraries. However, in the future -e.g., in the case of the Gigabit network - the regionals should move away from the de-facto beta test role, switch paradigms, and set up formal relationships with the providers, ANS, PSI, or any new entrants into the marketplace. "Formalizing" would involve a clear definition of

---

[5] Benn R. Konsynski and F. Warren McFarlan, Information Partnerships – Shared Data, Shared Scale, Harvard Business Review, Vol 68, No. 5, (1990), p.116.

the relationship between the provider and the regional, a clear statement of the regional's obligations with respect to the test, and a precise schedule of discounts and benefits available to the regional .

iii. Marketing the Concept of Information Sharing

As industry is now beginning to understand the critical importance and usefulness of information technology, one area in which information technology can be used hits right at the heart of the success of a business---i.e., the sharing of customer information (databases). One of the most exciting new uses of information technology is the sharing of customer or market data, called "the information partnership." "Information technology empowers companies to compete, ironically, by allowing them new ways to cooperate." [6] To gain the advantages of working closely with companies in reciprocal industries, US firms are realizing that they need not takeover the desired company, but may actually do better by sharing access to customers. An example is the way that American Airlines has allied itself with CitiBank: Frequent Flyer mileage on American is given to users of CitiBank's credit card, on the basis of l mile per dollar spent.

As this concept becomes increasingly accepted in the marketplace, the need for industry connection to a high-speed link will grow rapidly. Already, commercial services are trying to serve this market. The regionals have several unique strengths to contribute to this growing area of business.

For small companies which cannot afford the expertise and infrastructure needed for information sharing, but would benefit from the service, the Regionals may be the only show in town that is both willing to and capable of bringing information-sharing to these customers at a price they can afford to pay. Small companies will surely not be able to build their own WANs; participation in the commercial information sharing services is extremely costly. The Regionals can market the supereconomics of obtaining plug-and-play capacity to a long list of potential small-business information partners across the country. By connecting to the NREN through the Regionals, the small businesses would avoid both the cost of infrastructure and operating costs. In addition, the Regionals would serve in the capacity of the "general contractor" described above, providing a panoply of services.

iv. A Yellow Pages for Science and Technology

There are thousands of talented, expert scientists and technologists scattered among academe and research institutions throughout the United States. They are unknown to industry, particularly to entrepreneurs in start-up firms, and often are enthusiastic about venturing out into the real world. Creating an electronic Yellow Pages of such persons by field and interests would be a major service to the US economy. It is also practical. The State of New York has contracted with NYSERNet to design and create the New York State Technology Database, a project which will identify researchers, their projects, their specialties, and their identifying information.

c. Strategic Alliances: An Approach to New Business

The new business ideas outlined above represent only a small and impressionistically gathered group of potential areas to be tapped by the Regionals. The crucial point is that the in order to be successful, the Regionals, like firms in any other business sector, must have a focus and an approach. It is unlikely that any of the Regionals can hope to develop a broad range of "new businesses" on its own. On the other hand, were the different Regionals to develop expertise in

[6] Ibid p. 114

different "new business" areas and markets, the potential which could be tapped through strategic alliances among the Regionals is almost unmeasurable. By the same token, strategic alliances could be forged by a "meta-Regional" with even the largest of private firms in the market.

The regionals can capitalize on strategic alliances in three ways: (1) they can license particular types of expertise; (2) they can offer services and product in exchange for dollars; (3) they can obtain equity in the strategic ally, in return for awarding that firm the right to turn a nascent idea into a business.

7. Engaging in Secondary Functions - Good Citizenship

The mission of the regional networks, which may be summarized as marketing both the concepts and the services of the networks suggests that they should be involved in a series of functions apart from their role as Marketmaker.

a. Aggregating the Have-Nots

Not all campuses will be connected to and well-served by the connection of the major research institutions to the national network. Nor will all potential users at smaller institutions be allocated the funds needed to link up with the networks. The regionals should be engaged in discussion and activities to create services for this group of potential users.

b. Network Information Center Services

No formal entity exists to serve the end-users, that is, persons like the academics, researchers and physicians who actually use the INTERNET. Perhaps the most astounding examples of the lack of attention to end-user needs is the fact that there is no documentation and no single manual for the end-user of the network, except for a few produced on single campuses. The NSF has carefully avoided the end-user in defining the population for its funding. There are only 100 to 150 institutions which are thought to have user service departments which can effectively fill this gap, while the NREN proposal calls for connecting 1300 institutions by 1993. The regionals could effectively provide end-user services, such as more systematic documentation, training for NIC trainers, and ongoing telephone support to end-users in the large number of institutions which will be joining the network without appropriate support. Interestingly enough, this function would actually support the regionals in their efforts as "marketers". First, it would provide them information about a market which is their primary responsibility, and second, it would provide them direct access to individuals in the market.

c. Affinity Group Formation.

As described in the above sections, network users are a very diverse group. The regionals could sponsor Affinity Groups, and provide special services for them. For example, a user's group on mappings of non-English keyboards or on transmission of foreign alphabets, for users interested in foreign languages.

C. The Viability of the Market Maker

1. One or Many?

The Marketmaker model offers an attractive path into future for most of the regional networks. It allows them to meet the networking challenges of this decade without forcing them to drastically alter their not-for-profit character and academic origins. It provides them with many varied functions to perform and goals to achieve. However, a key question exists concerning the best way to achieve these goals and to meet the six challenges of networking. The question is the one of "one" or "many". Will the nation's goals in the networking arena best be served by many regionals, competing to offer similar services and fill primary functions? Or, would it be advantageous to have some measure of coordination, so that the regionals specialize, and no more than a few regionals supply a particular service.

There is movement in the direction of coordination among the regionals today. FARNet has recently decided to engage a professional firm to do long-range strategic planning for its membership.[7] There have been discussions within FARNet and the NTTF of the possibility of a merger of the two organizations. BITNET and CSNET merged last year to form CREN.

Another type of specialization and the coordinated activity that goes along with it, can be discerned at the level of the regionals themselves. Networks have been formed at state levels, by state agencies. But the state networks use the regionals to take advantage of economics of scale. In CISNet, MIDNet, SURANet there is a splitting of authority between the regionals and the states they serve, with functions related to economics of scale performed by the regional. CICNet recently awarded a grant to Ohio State University to develop an implementation of "FAX over the Internet". This is an example in which the regional paid a contractor to perform a service for all of its members.

It thus appears that persons active in the networking community are open to the paired ideas of coordination and specialization at different levels. A push from federal funding agencies would help to accelerate the trend, and could spearhead attempts to understand and identify the tiers at which various services are offered and functions executed. For example, quality assurance is best performed at the regional level, whereas documentation on how to navigate and use the resources on the Internet could be designed and prepared at the national level, and distributed by the regionals. Professional and user networking publications, which inform the user about developments and trends in networking, currently abound; there are about twenty different publications circulating, and almost none of them is of sufficiently high quality. One or two publications, prepared by professional editors through a national entities such as FARNet, would very likely be of higher quality and certainly be more useful. In the area of policy-initiation and lobbying, coordination and specialization again are the order of the day. Naturally, working with state legislatures and officials is a function carried out most effectively by the state networks. On the other hand, there isn't a single major industry or professional group in the United States which has not formed a centralized unit to be its representative to the federal government. Effective treatment of this subject might require a merger or some weaker form of combination among CNI, NTTF and FARNET.

While there is some movement in the direction of coordination, there is no real evidence of effective specialization. FARNET is a weak body and the NTTF is specialized and serves only the lobbying

---

[7] Minutes of September FARNET meeting

needs of the academic networking community. The memberships of both are reluctant to give up control over almost any functions, even one as unrelated to the essential activity of the network as publications of newsletters. There is much to accomplish in order to bring the full benefits of high-speed networking to he American people, but little is being done. Perhaps in this arena, more than any other, federal funding agencies can use the power of the purse to give the regionals a gentle push in the direction of greater coordination and specialization.

There is also the question of coordination as it applies to the Marketmaker. Which is the best shape for the Marketmaker to assume ——

(1) a group of independent regionals,
(2) a few regionals loosely joined in some sort of federation--but with the economic power, i.e., buying power at the regionals' level, or
(3) various local and second tier networks tightly organized into a single buying cooperative?

We have evidence that the weak forms of coordination do not work. We are at the beginning of a new era. The regionals are increasingly moving away from providing operating services. CICNet's contract for operations, awarded to a consortium of a local AT&T unit and Ohio State, is the latest example. As the regionals move away from operations, and as operating contracts are awarded to entities which have no commitment to the "networking challenges", higher quality transport service will emerge. But at the same time, the more fragmented the regionals are, the weaker their influence will be and the opportunity to respond to the challenges of the 1990s may be lost. To assure, that all types of users will be served, rather than only those who can pay full price, coordination by a strong central unit, functioning as a"Global Marketmaker" appears to be the most effective approach. Perhaps, federal funding agencies together with wise decisions by leaders in the networking community can accelerate the trends toward commercialization, encourage specialization, and bring the realization of network goals that much closer.

2. Funding Mechanisms, Organization and Viability

There are four basic sources of funding which would potentially be available to the Marketmaker: direct grants from the government, user fees, revenues from operating and payments for special services. The more diverse its sources of funding, the greater the freedom and independence of the Marketmaker from both financial and policy perspectives, and the greater the insulation from the effects of shifts in government priorities. Wisdom requires that the regionals attempt to recruit funds from as many of these different types of sources as possible, and the goals and organization of the Marketmaker are perfectly suited to this type of diversity.

a. Direct Grants.

Federal and state sources will continue to fund services useful to federal and state agencies, respectively. The need and the opportunity to obtain grants from both levels of government demonstrate that the Marketmaker must itself either be organized in two tiers, or represent a federation of entities, since state funds are most successfully obtained by persons knowledgeable about the particular state governments, while federal dollars are most effectively obtained by persons operating in the federal arena. The Marketmaker would be most effective in obtaining funds from these sources by organizing as a highly coordinated, multi-state structure.

b. User Fees.

The Marketmaker will continue to receive fees from the universities, national laboratories and industrial R&D laboratories which it serves.

c. Fees from Providers

The Marketmaker will receive discounts from transport providers for delivering large blocks of customers. If the Marketmaker passes a percentage of those discounts on and retains a portion, it will actually be collecting fees from its providers. Here again, the ability to represent a single, large block of users determines the nature of the discount. In addition, the Marketmaker would collect fees for services to the providers, such as quality assurance.

d. Special Project Grants from Industry

In this instance, the Marketmaker staff acts as "brain trusts" in the area of networking, and applies to industry for grants in support of innovative experiments and pilot projects. Thus, NYSERNet recently applied for a grant from IBM to create a plan for connecting secondary schools to the high-speed networks. In a Marketmaker, organized in two layers, central and other entities, all layers could fill the "brain trust" role. In fact, the various parts of the Marketmaker could compete in this particular area - that of special projects - with no ill effects on the buying power or political clout of the agency.

Writing about the federal/state relationship in American government in the 1960's, Daniel Elazar argued convincingly that the structure of the federal/state relationship was more like that of a marble cake than that of a hierarchy or tiered-blocks. His analogy is well-suited to our concept of the Marketmaker as well. Tightly coordinator to obtain best pricing, high quality service and efficient specialization, the Marketmaker need not be tightly coordinated in areas in which tight coordination brings no benefits. Brainstorming and creative research appear to be cases of the latter.

3. Contribution of the State Networks.

State networks are network operations providers which interconnect state agencies or state colleges and universities . They were founded for a variety of reasons in different states, ranging from an urgent need for reliable service to accommodating political realities. Today, the state networks have multiple formats and personalities, including that of MERIT - forward looking, aggressive and a leader in all areas of networks, to state networks which confine their interests to serving very specific needs in the state capital. However, regardless of their origin, the state networks, as we noted previously, are very likely here to stay, and can provide solid members of the Marketmaker. As Elazar's marble cake analogy implies, there would be no contradiction involved if a limited-service provider, in the form of a state network, were to become a member of the Marketmaker in order to benefit from a sub-set of Marketmaker services, or simply to act in support of "the challenges".

4. Relations With the Regional Bell Operating Companies (RBOCS)

The RBOCs could play a significant role in high-speed networking in the coming decade. Their activity will mesh well with that of the Marketmaker (s) in three important areas. These are:

(1) as potential suppliers of lines and network operating services,

(2) as potential users of the Marketmaker's network for"living laboratories" and test-beds, and
(3) as political allies in the effort to extend deregulation of high-speed telecommunications.

a. Potential Suppliers.

The baby Bells can reasonably be thought of as potential suppliers of network services to the Marketmaker(s) and their customers. In the mid-1980s, when networking was in its infancy, the RBOCs were technically unsophisticated in an area in which technology was continually changing. In 1986, when NYSERNet first began its discussions with NYTEL/NYNEX, TCP/IP was almost unknown in these firms. More recently, technology in high-speed telecommunications has stabilized, the 'nuts and bolts' and 'how-to' issues have been resolved, there are experienced persons available to be hired, and the RBOCs have become more knowledgeable about high-speed telecommunications. Moreover, it appears that the RBOCs have become interested in entering the high-speed telecommunications market. PREPNet has contracted its network service operations out to Bell of Pennsylvania (a subsidiary of Bell-Atlantic), and appears to be satisfied with the results. Ameritech bid with the University of Illinois/Urbana-Champagne, albeit unsuccessfully, in response to CICNet's RFP for network operations services.

b. Test Beds.

As the networking world begins to use OSI technologies and ATM-based fast packet switches, the second tier networks can help provide the RBOCs a "living laboratory" for future telephone services, particularly if the Modified Final Judgement (MFJ), related to the AT&T divestiture January 1, 1984, is revised to allow the RBOCs to enter the protocol conversion and information provision businesses.

c. Deregulation.

Since the key role of the Marketmaker is to assure competitive sources of high-speed network services, the Marketmaker would greatly benefit from a decision allowing the RBOCs to enter the area of information provision, thus creating additional potential players for the Marketmaker to deal with. This would be especially true in the areas of provision of general operating services and provision of shared data-bases and information.

As discussed above, an important secondary function of the Marketmaker is to gain access to information and to make it available to its members at reasonable prices. The RBOCS, newly entering a market in which commercial providers such as CompuServe, Dow Jones and General Electric Information Services have already carved niches, will be looking for a customer base. As a large buying cooperative, the Marketmaker would provide a large, reliable customer base. From the Marketmaker's perspective, there would be price advantages to dealing with RBOCs, as opposed to the commercial providers currently in the market. First, as noted above, these players have already established niches, such as Dow Jones in the business arena or GEIS' penetration of the banking world. They are not interested in capturing the university and research market in exchange for low prices. Second, the commercial providers are not interested in the technology of high-speed telecommunications as such, and do not derive the benefits of a "living laboratory" and test-bed from dealing with the academic and research communities, a further reason for the RBOCs being more likely to provide attractive pricing to the Marketmaker than the current commercial providers are offering. Finally, the RBOCs can offer more favorable pricing to the Marketmaker because they are very big compared with others in the market, and have large economies of scale.

Given the Marketmaker's interest in the potential offered by the RBOCs entering additional markets, the regional and/or federated Marketmaker is likely to become a political ally of the RBOCs at the federal level. The RBOCs are already actively soliciting support in the academic world. At the latest EDUCOM meeting in Atlanta, Georgia, a coalition of RBOCs sponsored a booth at the meeting for the sole purpose wooing the support of conference attendees for a revision in the MFJ. The RBOCs have shown an increasing interest in the NREN, and are even more likely to support it the future.

Prognosis

If the regionals evaluate their current situation astutely and adopt the Marketmaker model and activities which seem most likely to lead to success, viability in the short term (over the next five years) seems certain. Although the GORE Bill died in the House this session, most experts expect that the NREN will be funded, perhaps at less than the $390 million level. In the longer term, too, the chances of regional viability are strong. Once the right structure is established, and we believe that all indications are in favor of a strongly federated Marketmaker, and as long as the Marketmaker and the groups it represents remain in the forefront of communications, the regionals will have a strong role to play over the next 20 years.