DCE 25-MAY-73 10:03 16807

Phone Log: 25 May 73, Peter Kirstein, University of London

Visit w. Kudlick here Thurs 31 May; Breakfast w. DCE (JCN/RWW too if desire) Thurs 7 Jun at NCC

Phone Log: 25 May 73, Peter Kirstein, University of London

Peter Kirstein is in the Institute of Computer Science, Universty of London, 44 Gordon Square, London WC1, England. He is the man who is responsible for England's ARPANET interface (I believe with a TIP going in this Spring, at like 1200 baud to the Norwegian node that is satellite coupled to the U.S.). 1

Peter wanted to arrange to see me; he'll arrive in Bay Area Wed evening, 30 May, and Dick and I are leaving for Detroit Thursday morning. Timing too close; Peter and I arranged to have our talk at breakfast at the New York Hilton the next Thursday morning, 7 Jun. 2

His particular interest in talking with me is in the possibility of arranging some explicit collaboration between our establishments, over the ARPANET. He wants to do something with facsimile transmission, and I gather that he could see a facsimile-transmission (storage, manipulation ??) capability being integrated into ARPANET communication and dialogue operations. He said that their position, being at a significantly different distance from the rest of us in terms of travel and telephone costs, puts "an extreme need" upon any degree of collaboration having as many media dimenions as possible. 3

He plans to come to ARC on Thursday 31 May to talk to Mike Kudlick about NIC services etc. 4

Mike: I gathered that Peter had made independent arrangements for visiting you -- if not, this note will provide you with a bit of warning. 5

It would be well if you could also learn as much as you can from Peter about his ideas in the facsimile area. It would seem that they would probably bear (in their operational application) upon NIC operations. 5a

Jim and Dick: Let me know if you'd like to be included in the breakfast meeting in New York. 6

16807 Distribution
James C. Norton, Richard W. Watson, Michael D. Kudlick,

DVN 25-MAY-73 10:47 16808

Thanks and Backup on Dealing with DMCG

I got your 24 may sndmsg(vanNouhuys,bostnls,099). 1

DMCG should only have one place and I will be firm with Abhay if he gets in touch with me. If they want more people to learn TNLS they can host a class. 2

I only resorted to TENEX to try to reach Abhay, by the way, after several days of unsucessful telephoning and telephone message leaving. 2a

At one point when I was talking to my 4th or 5th MIT operator, I mentioned that he was inthe Dynamic Modling Group, and she connected me with some sort of modle railroad museum. 2a1

I know the problems of getting together a class here where we are used to it, and I thank you lots for your efforts. 3

16808 Distribution
Nancy J. Neigus, Michael D. Kudlick, Marilyn F. Auerbach,

RML IN THE CAPACITY OF ARPANET MANAGER IS INTERESTED IN ESTABLISHING AT RML A CENTRAL REPOSITORY OF PROGRAMS ADVERTISED IN THE NETWORK RESOURCE NOTEBOOK BY THE HOST SERVER SITES AS AVAILABLE FOR USE BY THE NETWORK MEMBERS. IT IS ALSO DESIRED THAT PROGRAMS GENERALLY AVAILABLE FOR USE BY NETWORK MEMBERS BUT NOT LISTED IN THE RESOURCE NOTEBOOK ALSO BE INDLUCED. AVAILABLE DOCUMENTATION ON THE PROGRAMS IS ALSO REQUIRED. THE TYPE OF PROGRAM DOCUMENTATION DESIRED INCLUDES BUT IS NOT LIMITED TO* 1. PROGRAM DISCRIPTION, 2. LISTING, 3. RUNNING INSTRUCTIONS A) OPERATING INSTRUCTIONS, B) INSTRUCTIONS FOR THE PREPARATION OF THE DATA TO BE PROCESSED 4. PROGRAM LIMITATIONS, 5. ANY OTHER AVAILABLE DOCUMENTATION IN THE ABSENCE OF THE ABOVE. YOUR COOPERATION IS THEREFORE SOLICITED IN PROVIDING COPIES OF THOSE PROGRAMS WITH THE ASSOCIATED DOCUMENTATION ADVERTISED BY YOUR SITE AS AVAILABLE FOR USE BY NETORK. IF THERE IS A CHARGE FOR THE MATERIAL PLEASE PROVIDE THAT INFORMATION BEFORE INITIATING ANY ACTION. IN THOSE CASES WHERE THE PROGRAM RESIDES AT A GIVEN HOST SITE AND THE DOCUMENTATION IS LOCATED ELSEWHERE SIMPLY PROVIDE THE LOCATION INFORMATION. RML IS ALSO ESTABLISHING A FILE OF HOST SITE PERSONNEL OR STAFF INTERESTED IN OR PROCESSING PARTICULAR TECHNICAL TALENTS OR CAPABILITIES IN ANY SCIENTIFIC FIELDS. THE PERSONS NAME, CREDENTIALS AND A SHORT SUMMARY OF PARTICULARS IS DESIRED AND WILL BE APPRECIATED. PLEASE MAIL COPIES OF THE PROGRAMS, DOCUMENTATION AND PERSONNEL INFORMATION TO: LT. COL. E.P. SCHELONKA, RANGE MEASUREMENTS LABORATORY, ENLD, PATRICK AFB, FLORIDA 32925. PLEASE SEND ACKNOWLEDGEMENT OF RECEIPT OF THE MESSAGE INDICATING IF YOUR SITE WILL PROVIDE THE REQUESTED MATERIAL AND INFORMATION. SEND REPLY TO RML LARKCA 1

(J16810) 25-MAY-73 10:20; Author(s): George R. Havermahl/GRH;
Sub-Collections: NIC; Clerk: GRH;

Test Message

this is a sample message from GRH in MBY file to GRH in GHR file. The orimary purpose is to check out the effects of not being able to use carriage returns in composing meassages. It would appear that this is a definite handicap for the inexperienced user. Particuarly if he requires a format that uses indenting of tabs, etc. End of message. 1

16811 Distribution
George R. Havermahl,

**2

Susan ... I would like to send a note of thanks to Howard (your boss, of course), but I don't recall his last name. Can you help me ??
Thanks ... Mike Kudlick. 1

16812 Distribution
Susan S. Poh,

Comments on the Tektronix 4023 vidio terminal

This is brief list of the things I would like to see on the Tektronix vidio display. 1

It is not possible to perform several functions from the computer, which are possible from the keyboard. Most of these functions are crutial for us. We are especially interested in doing the following from the computer: 1a

Insert line and character. 1a1

delete line and character. 1a2

erase to end of line (called clear line on Delta Data). 1a3

moving the cursor in any of the four directions one character. 1a4

In our implememtation of DNLS, we need to somehow mark a character on the screen. The obvious way to do this is to insert field attribute codes before and after the character to make it blink, reverse vidio, or whatever is satisfactory. But even if we could insert from the computer, this would not be a satisfactory way since the field attribute codes take up a vidio character position and are visible as a dark rectangle (at least this is what happened on the model we had). We are secretly hoping that the production models will not do this. 1b

We can understand the necessity to take up a memory position with the field attribute characters, but it should not take up a position on the screen, i.e. not be visible in any way, except that the line cannot have as many characters on it. 1b1

What we would like most of all is to mark a character (from the computer) the same way that the cursor marks a character. The cursor on the 4023 is absolutely marvelous - easy to see, does not make the character harder to read, and easy to find with the keyboard key that makes it blink. In our implementation it would not be confusing to have several characters on the screen marked in the same way as the cursor. 1b2

We would like to have the characters "up-arrow" "left-arrow" rather than tilda and circumflex or whatever they are on the 4023. 1c

It's just a frill, but it would be nice to have a reverse-vidio switch somewhere -- That is, a hardware switch rather than field attribute coding. 1d

Other than that, this dude is far and away the nicest terminal I know about, because: 1e

Comments on the Tektronix 4023 vidio terminal

It is QUIET 1e1

It has a satisfactory keyboard (but a little stiff). 1e2

24 by 80 is enough display area. 1e3

It performs line deletes, etc. in one frame time 1e4

The reverse vidio and blinking capabilities are fine for marking special stuff on the screen (except as memtioned above). 1e5

The cursor does not blink (except when you want it to) and is very visible. 1e6

You can position and interrogate the cursor location from the computer. 1e7

It goes 9600 baud. 1e8

16813 Distribution

Martin E. Hardy, Douglas C. Engelbart, Richard W. Watson, James C. Norton, Charles H. Irby, Kenneth E. (Ken) Victor, Diane S. Kaye, Donald C. (Smokey) Wallace, Request for Comments on Network Management Survey

I would appreciate any comments that you are able to provide on the attached document. The report is not entirely complete, so a few sections are blank. Thank you for your assistance.

NETWORK MANAGEMENT SURVEY

by

Ira W. Cotton

Institute for Computer Sciences & Technology

National Bureau of Standards

Introduction 1

This report presents some of the results of a study of management practices in different computer networks conducted by the Institute for Computer Sciences and Technology, National Bureau of Standards. The approach to management taken in this report is positive (i.e., reporting on current practices as they exist); the normative approach is taken in a separate report. 1a

This survey is meant to be representative and illustrative rather than exhaustive or conclusive. The networks covered were chosen to be typical of different approaches to network implementation and management. 1b

The ARPA network is a large distributed network of autonomous, heterogeneous computer systems. It has focused on the development of network technology, rather than network organization. 1b1

MERIT is a controlled experiment in networking on a regional basis with heterogeneous computer systems. Considerable attention has been focused during the network's development on the organizational problems. 1b2

TUCC is another controlled regional network, but with homogeneous computers and a larger user base. TUCC has also given considerable attention to organizational issues. 1b3

The Oregon State network is representative of many centralized or "star" networks serving a regional clientele. 1b4

TYMNET is the only commercial network included in the study. It was desired to include a profit-seeking network in the study, so as to be able to compare managerial practices in non-competitive environments with actual business practices. (Of course, the inclusion of TYMNET in this study in no way implies endorsement of this network). 1b5

A common format was employed for presenting the details of each network. The table of contents which follows is an outline for each of the five reports which follow it. Network architecture is separated from network management, and the latter is broken down into a number of different functional areas. This approach was adopted to permit easy comparison of specific managerial concerns from network to network. Some empirical observations from such comparisons are presented in a concluding section which follows the same format as each of the reports. 1c

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A. Bibliography 2f1

B. Special Vocabulary 2f2

ARPA Network 3

I. Introduction 3a

The ARPA Network is characteristic of large decentralized networks of autonomous computer systems. Its successful operation has been widely publicized in the professional literature and trade press, and has demonstrated the technical feasibility of packet-switching for large networks. 3a1

II. Network Identification and General Description 3b

A. Sponsoring Organization 3b1

Advanced Projects Research Agency (Department of Defense) 3b1a

B. Purpose/mission of Network 3b2

The ARPA Network was begun as a research effort to investigate multiple computer resource sharing and demonstrate the feasibility of packet switching technology. 3b2a

The network currently operates in support of many ARPA-sponsored research programs by providing access to resources not available locally. 3b2b

C. Status and Topology 3b3

The network has been operational for approximately two years. Figure 1 illustrates the topology of the network as of January 1973. The network currently includes over 30 sites with over 40 independent computer systems connected. 3b3a

Reliability of the various network components varies widely. Currently the communications subnet of IMPs and circuits have extremely high reliability, with only occasional outages for particular IMPs or circuits. Since all nodes are doubly connected, the outage of a single circuit does not disturb network operation. The service sites are generally less reliable, although the statistics vary widely from site to site. 3b3b

D. Technology Summary 3b4

The ARPA Network may be characterized as a distributed store-and-forward network of heterogeneous computer systems (hosts). Hosts are connected to the communications subnet by means of a software interface called the Network Control Program (NCP) and a hardware interface which may have the characteristics of either a channel or a communications line. Each host is connected to a switching center in the subnet called an Interface Message Processor (IMP) which contains an augmented Honeywell 516 or 316 computer; up to four independent hosts may be connected to the same IMP. Each IMP is connected to two or more neighbouring IMPs by means of dedicated 50kb comunications lines. Host to host messages are passed from the sending host to its IMP, where they are broken into packets and relayed to their destination by the subnetwork of IMPs and communications lines. The routing is adaptive; i.e., the route of any given packet is not established in advance and in general the several packets of a message will follow different routes. The destination IMP will reassemble the message and deliver it to the proper host. 3b4a

Protocols in the network are constructed according to a layered approach. The lowest level protocol is a binary synchronous communications protocol governing traffic exchange between IMPs. The so-called "first level" protocol governs the logical exchange of information between host and IMP. The "second level" protocol governs the logical exchange of information between Network Control Programs in communicating hosts. The "third level" of protocol refers to any communications occuring between processes in the host machines. Such third level protocols include the Initial Connection Protocol (ICP), data transfer protocol, file transfer protocol, remote job entry protocol, graphics protocol, and others. 3b4b

A special third level protocol called TELNET defines a network virtual terminal and permits all terminals on the network to provide a similar interface to processes in a separate host computer system. A special IMP which is augmented by the addition of memory and a multiline controller (a specially designed component containing central logic and line interface units) can provide direct network access to terminals without going through a separate host computer system by providing the TELNET function itself. Such an IMP is called a Terminal IMP, or TIP. 3b4c

III. Network Organization 3c

A. Structure and Extent 3c1

Figure 2 illustrates the present organizational structure for the network. 3c1a

The Advanced Projects Research Agency (ARPA) of the

Department of Defense initially conceived and funded the network, and presently directs its operation. The conception of the network may in large part be attributed to one individual in this agency, Dr. Lawrence G. Roberts , Director, Information Processing Techniques. ARPA is not a large agency, serving primarily as a granting agency, and only several people spend their full time on network activities. 3c1b

ARPA is currently in the process of turning over the day to day operation of the communications network to the USAF Range Measurements Laboratory (RML) at Patrick AFB in Florida. RML will serve as the procurement agent for IMPs and maintenance, and will serve as the focal liaison point for DECCO and the common carriers, BBN, NAC, and prospective new users. 3c1c

Bolt Beranek and Newman (BBN) of Cambridge, Mass., is the primary ARPA contractor in the development and operation of the network. BBN designed and constructed the IMPs and TIPs which comprise the subnet, wrote the software for these processors, and participated in the specification of the network protocols. BBN currently oversees all network modifications, dealing directly with the Bell System for the wideband circuits, and with Honeywell Information Systems for the procurement of H-516 and H-316 processors for inclusion in the IMPs and TIPs. BBN also operates a Network Control Center (NCC) which monitors the operation of the network on a round-the-clock basis and which aids in the diagnosis of failures and initiates and coordinates maintenance efforts. 3c1d

Honeywell Information Systems is an OEM supplier of basic H-316 and H-516 processors, from which BBN fabricates the IMPs and TIPs. Honeywell field engineers also assist in the installation of these devices, and is responsible for maintenance. 3c1e

Network Analysis Corporation (NAC), Glen Cove, N. Y., serves as an ARPA contractor for analytical studies to determine the optimum topology of the network. 3c1f

The Network Measurement Center (NMC) is an ARPA-supported research group at the University of California (Los Angeles) which investigates the performance of the network. 3c1g

The Network Information Center (NIC) at Stanford Research Institute provides a reference center serving to receive, record, index, and transmit, online and offline, information produced by and about the Network. To do this it designs information-handling tools for dialogue and record-handling. 3c1h

The NIC currently operates a PDP-10 TENEX system which is used both for development and network services. However, it is planned to separate the development activities from the service functions through an arrangement with Tymshare, Inc. 3c1h1

The involvement with Tymshare is strictly on a "facilities management" basis. That is, Tymshare will operate a computer system virtually identical to the one at the NIC, to provide reliable Tenex, NLS, and Journal service to NIC users and other selected customers. 3c1h2

The NIC staff --- the people who provide the documentation services and dialogue support services --- will remain at SRI, as will the responsibility for further developments in these areas. 3c1h3

Approximately 18 hosts may be classified as research sites. These sites perform research in a number of areas under ARPA contracts and utilize the network in support of their research. 3c1i

Five sites are classified as service sites: UCLA (360/91), SRI (NIC), UCSB (360/75), BBN (PDP-10) and MIT (MULTICS). Some of these sites offer services to the network community on a fee basis; others are subsidized by ARPA. 3c1j

The remaining sites are users, although intersite arrangements are often made for the sharing of resources. Almost all of the sites make some of their resources available, but not all guarantee to interact as a service organization. 3c1k

Each site has a Liaison to answer technical questions, and a Station Agent to handle questions concerning administrative, documentation, and similar questions regarding the network resources and the NIC 3c1k1

The "network facilitators" are an informal committee of experienced users who proselytize and attempt to solve network problems for users. Other groups that are in a sense "network facilitators" are these special and general interest groups 3c1l

ANTS Support Group
ARPANET Satellite System

Computer Based Instruction Group
File Transfer Protocol Interest Group
Imlac Interest Group
International Network Working Group
International Packet Network Working Group
Network Associates Group
Network Graphics Group
Network Information Center
Network Liaison Group
Network Measurement Group
Network Station Agent Group
Network Working Group Steering Committee
Principal Investigators
Packet Radio Group
Remote Job Entry
Speech Understanding Research Group
TIP Users Group
TNLS User Group
TENEX Users Group 3c1l1

B. Functions Performed 3c2

1. Planning 3c2a

Network growth is controlled by the sponsoring agency, ARPA. There does not appear to be any fixed or published policy for determining what sites are to be added. 3c2a1

When a new site is selected, however, Network Analysis Corporation determines for ARPA the new topology for the subnet. The network topology is not optimized each time a node is added, since that might entail too costly and disruptive alterations of existing circuits, but the new node is added in as cost-effective a means as possible. Occasionally, more extensive changes are made to the network topology as needs warrant. The planning function is thus centralized and supported by appropriate analysis. 3c2a2

All hardware procurement for the network is controlled by ARPA; the individual sites are not involved. ARPA places orders (through RML) for IMPs and TIPs with BBN. Communications circuits are ordered by ARPA from the Defense Commercial Communications Office (DECCO) which deals with the various common carriers. As explained below, in practice BBN coordinates circuit installation with the carriers. 3c2a3

2. Installation 3c2b

Each site which is added to the network is responsible for fabricating the interface to the IMP or TIP and for coding a network control program. Specifications for each are available from Bolt Beranek and Newman. The host organization is also responsible for site preparation (floor space, power, air conditioning, etc.) for the IMP, which will reside at the host's own location. 3c2b1

Bolt Beranek and Newman serves to coordinate IMP installation through the Network Control Center. The normal installation team consists of a BBN representative, the person from the local Honeywell office who will maintain the machine, possibly an additional person from the main Honeywell office, and telephone company personnel. 3c2b2

3. Operations 3c2c

The local host organization is responsible for maintenance of its host processor, NCP and IMP interface. The local Honeywell office will maintain the IMP itself. AT&T long lines division is responsible for maintenance of the modems and communications circuits. 3c2c1

For diagnostic and control purposes, BBN operates a special host system in Cambridge, Mass., which is called the Network Control Center. The NCC regularly receives status reports from all the IMPs in the network regarding the operational status of their communication circuits and their neighbouring IMPs. Special programmable debugging and fault isolation procedures (such as looping lines back into the same IMP) may be initiated remotely from the NCC. Fault isolation may or may not require the assistance of local host personnel. 3c2c2

The maintenance function, which may involve several organizations including the Bell System, Honeywell, BBN and the local host, sounds complicated, but actually isn't. The Network Control Center is very effective in diagnosing failure and coordinating maintenance among the various groups involved. 3c2c3

The division of responsibility for software is similar to that for hardware. All IMP software is controlled by BBN and is currently loaded via the network itself. Host organizations are forbidden to modify the software in their IMPs. 3c2c4

Functional protocols are specified by committees of host, ARPA and contractor personnel. At the lower levels these are fairly well agreed upon and debugged, and hosts agree to abide by them. At the higher levels, the protocols are still evolving, and subsets of hosts often experiment with variants among themselves. 3c2c5

At the present time, all of the lower level protocols are sufficiently well defined and debugged as to be of little or no concern to the average user. The higher level protocols, or more precisely, the lack of generally accepted and debugged higher level protocols (for example, remote job entry) have and continue to be a major hindrance to increased network utilization. More formal direction from ARPA and/or the reestablishment of the network working group (which formulated the lower levels of protocol and then disbanded) to meet on a regular basis might help. 3c2c6

4. User Services 3c2d

Users at one site seeking to utilize resources at another site are required to be familiar with the characteristics (log-on procedures, operating system commands, program conventions, etc.) of that site. Documentation is, in general, provided by the serving site according to its own conventions. Several organizations do exist, however, to help users access remote resources. 3c2d1

The Network Facilitators Group is an informal committee of experienced personel at various sites around the country who organized to promote network utilization. They advertise themselves at their local site as a focal point for network assistance, and communicate among themselves in order to help solve user problems and establish personal contacts. 3c2d1a

The Network Information Center is operated by Stanford Research Institute to facilitate the collection and dissemination of data produced by and about the Network. The NIC maintains online files of data about the Sites and people on the Network, maintains online tools for access to the data, and produces offline notebooks, indexes and directories of the data for use by the Network and other networking agences. The NIC also functions to reproduce, catalog, index and distribute online and hardcopy documents as requested by Network Sites in the process of building and using the Network. 3c2d1b

The user support function is probably the least well-provided function in the ARPA network. The quality of documentation and the general availability of assistance from sites varies tremendously from site to site. The network facilitators help at selected user sites, but because of the informality of their organization and because they are not located at all sites they have not proven to be a general solution. The NIC has not been really effective in distributing all the documentation needed to run at a particular site, let alone enforcing any documentation standards. 3c2d2

C. Interfaces (relationships with other organizations) 3c3

The question of the ARPA network's future status has yet to be settled. The network is a closed community, available only to governmental agencies and their contractors, but the network has been connected for demonstration purposes to other (commercial) networks (e.g., TYMNET). The network is actively serving as a marketplace for the sale of computer time to the network community. 3c3a

ARPA has indicated on several occasions that it does not intend to operate the network indefinitely. Several proposals have been submitted to operate the network commercially, but non have received approval. It remains to be seen what the future of the network will be. 3c3b

In another vein, the technology developed for the network has already received commercial attention. Several companies have filed applications with the Federal Communications Commission to set up an operate similar networks as common carriers (in some cases, using basic communications circuits provided by other common carriers in a so-called "value-added" configuration). 3c3c

IV. Financial and Legal Concerns 3d

A. Capitalization 3d1

The network was funded by ARPA and so required no capitalization. ARPA continues to subsidize the subnet communications circuits. Each of the IMPs and TIPs was either paid for by ARPA or the participating host organization. In general, some of the early sites were ARPA contractors, and so had their IMPs provided, while most of the newer sites are users who are paying for their own. 3d1a

B. Accounting 3d2

Participation in the network requires access to the communications subnet and access to individual hosts on the network. IMPs and TIPs are available for a fixed fee from ARPA, which obtains them from BBN. Monthly maintenance charges must be paid after the first year of operation. Communications charges are assessed by ARPA according to usage: a base fee plus a variable fee for traffic above a given minimum. In fact, most network participants have been supported by ARPA in one way or another, and communications costs continue to be subsidized. 3d2a

Accounting for resources at the host sites is done by each of the hosts concerned. Each user who desires to utilize remote resources must open an account at the appropriate site. The friendliness of sites to external users varies considerably, as do billing rates. Billing procedures vary widely (some sites have been known to close an account when it ran out of funds without notifying the user) and require using sites to deal with many vendors. The overall situation is less than satisfactory. 3d2b

C. Tariffs 3d3

The wideband communications circuits used in the subnet are leased by ARPA through the Defense Department at less than commercial rates. The communications charges assessed to users, even in the absence of subsidies, thus do not represent what "real world" charges would be. 3d3a

D. Regulation 3d4

No commercial users or non-research commercial servers are currently permitted on the network. 3d4a

E. Security 3d5

The communications subnet will insure that messages are delivered to the proper host. The non-deterministic routing of the individual packets of a message could be viewed as providing some degree of security to the subnet. At that point it is the responsibility of the host to insure delivery to the proper user. 3d5a

File security is the responsibility of the individual hosts. Log-on procedures, keyword access and the like are among the procedures employed by the various hosts as protective mechanisms. 3d5b

In general, the ARPA community does not seem very concerned with user security. Passwords are easily obtained, and it is easy to logon as someone else and inspect (and even alter) his files. There is no checking on the origin of messages to insure that they agree with the identification given in a logon sequence. 3d5c

V. Conclusions 3e

A. Summary of Problems 3e1

Start-up Requirements - Fabrication of the IMP interface and coding of the Network Control Program have been major obstacles to new host joining the network. BBN has fabricated some interfaces, but prefers not to do so. This problem is expected to continue, as the character of sites joining the network changes from research-oriented to user. However, a mitigating factor may be the inventory of interfaces and NCPs which have already been constructed. 3e1a

Cost - The question of cost is growing in importance as the network operation is examined by potential commercial suppliers and as the full costs become known. Published documentation on costs have thus far dealt mainly with the communications subnet. Even here, the costs may be distorted, because the government obtains circuits at a discount and because published figures are derived from loading factors which have never been realized. Also, the cost of network access (an IMP or TIP) remains high (though lower cost replacements are currently under development). However, the most significant concern is that the cost of the subnet may not be the major network cost. Recent studies have shown that the overhead associated with the NCP may be substantially larger than was previously believed. Additional cost studies are indicated, as well as a reevaluation of the current protocol strategy. 3e1b

Reliability - In contrast to the now high reliability of the subnet, the host sites, at which the real work is done, vary widely in reliability. Nothing can more surely stifle network success than uncertainty over whether a resource will be available or not when it is needed. 3e1c

Heterogeneity - Except for the TELNET system, no commonality of operation has been achieved between hosts of different type. Executive level commands are all different, text editors are different, log-on procedures are different, etc. This is a problem which networks have only exacerbated by making additional systems available to potential users. 3e1d

User Services - The need for readable, accurate, complete and available documentation cannot be stressed too much. Of equal importance, however, is the occasional need for hand-holding. On-line tutorials may provide some relief, but personal assistance by knowledgable and friendly personnel will never be completely replaced by documentation. The current level of these services on the ARPA network is not acceptable. 3e1e

Protocols - Lack of particular protocols such as graphics and remote job entry has cut off potential usage in some cases. 3e1f

B. Lessons Learned 3e2

In fairness, it must be recognized that the ARPA network began as an experiment in networking among research-oriented sites. It has achieved its objective of demonstrating the feasibility of the packet-switching approach. Many of the problems which have been identified have arisen as the network matured and the complexion of its participants changed from research-oriented to usage-oriented. 3e2a

In general, the network has functioned best where there has been formal responsibility and organization, for example, the Network Control Center. The less directed efforts have been correspondingly less successful, for example, the higher level protocol committees. 3e2b

One of the clearest areas requiring additional work is that of standardizing the usage of all the systems, possibly by means of some intermediary translator. Perhaps a standard "network control language" is required to facilitate usage of all the different systems involved. 3e2c

Annexes 3f

A. Bibliography 3f1

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B. Special Vocabulary 3f2

IMP - Interface Message Processor - A specially modified Honeywell 316 or 516 processor which serves as the communications computer in the network. 3f2a

TIP - Terminal IMP - An IMP which is augmented by additional memory and a multiline controller. The TIP contains a network control program and a TELNET program within it to permit terminals to access the network directly through it. 3f2b

Multiline Controller - A specially designed multiplexor-like device which supports the access of up to 64 terminals of varying type into a TIP. 3f2c

Message - A logical unit of data exchange between processes. 3f2d

Packet - Physical segments of a message which are the transmission units in the subnet. 3f2e

Subnet - The array of IMPs, TIPs and communication circuits which deliver messages from one host to another. 3f2f

MERIT Network 4

I. Introduction 4a

The MERIT Network is representative of a controlled experiment in networking on a regional basis. The straightforward design of the communications system and the limited size of the network permit attention to be focused on the managerial problems of the network. 4a1

II. Network Identification and General Description 4b

A. Sponsoring Organization 4b1

In 1966, Michigan State University, Wayne State University and the University of Michigan formally established a program of mutual cooperation known as MICIS (Michigan Interuniversity Comittee on Information Systems). MICIS established a non-profit corporation, MERIT (Michigan Educational Research Triad, Inc.), for the purpose of receiving and distributing funds for research. It is this non-profit corporation which operates the network. 4b1a

B. Purpose/mission of Network 4b2

The Merit Network is a prototype educational computing network that seeks to enhance the educational and computing resources of each university by permitting network participants to share resources. The objectives of the network were broadly stated as gaining, through the development and successful implementation of a network, knowledgeedge about and solutions to the problems of network operation in an established educational computing environment. 4b2a

The three computer systems in the network are sufficiently different as to make desireable the directing of particular types of work to one of them from the others. 4b2b

The University of Michigan's system, using duplex IBM 360/67 hardware, was designed especially for timesharing. 4b2b1

The Michigan State University computer (CDC 6500) is unusually fast and therefore well-suited to large, compute-bound jobs. 4b2b2

The Wayne State University Computer Center, with a half duplex IBM 360/67 running the TSS timesharing system, has developed a special competence in administrative data processing. 4b2b3

At the time of organization of the network, a cooperative policy in acquiring special peripheral equipment was considered feasible. It was suggested that relatively unusual equipment, such as a film recorder-scanner, might be purchased by one installation to serve all three universities. 4b2c

C. Status and Topology 4b3

The network became operational in the summer of 1972. The topology of the network is three node, fully connected. Presently the network provides communication service, on a nearly continuous basis, whenever the host systems are up; usage through 1973 has been light, however. Aupperle (1973) reports that current network-use data indicates that between one and two million bytes are transmitted daily by an average of twenty individual users. About 100 different users have tried the network during the second half of 1972, the first six-month period of statistical data gathering. 4b3a

D. Technology Summary 4b4

The three host systems in the MERIT network are tied together through small communications computers located at each host site, which are themselves interconnected by means of modems through the switched telephone network. The interface which the communications computers present to the host system are uniquely adapted to the requirements of each particular host; the interface which the communications computers present to the telephone network (and thus to each other) are identical. A somewhat novel capability is the ability to dynamically vary the bandwidth of the communications paths available between pairs of hosts. This is accomplished by providing each communications computer with four separate modems and an automatic calling unit. The bandwidth represented by the four lines may be allocated to communications with either of the other two hosts as dictated by immediate communications requirements; normally at least one line is kept open to each other remote site. 4b4a

The communications computer consists of a standard Digital Equipment Corporation PDP-11/20 with 16K words of 16-bit core memory. Four different types of interfaces are required: 4b4b

1. Data set interface 4b4b1

2. Automatic calling unit and multiplexor interface 4b4b2

3. IBM 360/67 interface (one for each of two host systems) 4b4b3

4. CDC 6500 interface (for one host system) 4b4b4

The data set interfaces are designed to transfer entire messages over the telephonic network directly to and from the PDP-11's core memory without program intervention, once the transfer is initialized by software action. These interfaces are designed to function as either half-duplex or full-duplex units over a wide range of frequencies and are compatible with binary synchronous communications procedures. 4b4c

Automatic calling unit and multiplexor interfaces provide the communications computer with the ability to dial, under program control, a single telephone call. The automatic calling unit may be shared among eight telephone lines. 4b4d

The host interfaces (IBM 360 and CDC 6500), like the data set interfaces, are designed to transfer entire messages without intervention, once appropriate action is initiated. The interfaces transfer data in parallel between the host and the communications computer, and they partially resolve the word length mismatch that exist between these machines. The host interfaces also cause the communications computer to appear as a number of identical, but separate, devices to the host, thus simplifying the logical structure of multiple user activity over the network. 4b4e

The systems programming requirements for the MERIT computer network consist of device suport for the communications computer in each of the hosts, and an operating system in the communications computer which provides support for the message switching function and an interface to each host. Each host treats the communications computer as an I/O device. Together, the software elements in the host and communications computers permit a user to establish a path to a remote host and to utilize services there. All terminal access into the network is through the local host; there is no direct terminal access into the network which bypasses the local host. However, this capability is being considered for future implementation. 4b4f

III. Network Organization 4c

A. Structure and Extent 4c1

Figure 1 presents a simplified view of the organization of the MERIT Computer Network. 4c1a

The Michigan Interuniversity Committee on Information Systems (MICIS) is made up of representatives from each of the three participating universities. A few are computer experts, but most are not. MICIS members in turn are responsible for selecting the Director of the MERIT Computer Network. 4c1b

The project director is responsible for the orderly execution of all of the technical and contractual responsibilities, broadly divisible into three, staff supported functions: 4c1c

1. Educational and promotional; 4c1c1

2. Research and technical development of the network; and 4c1c2

3. Financial administration. 4c1c3

For the initial phase of network design and construction, MICIS chose a computer expert, Dr. Bertram Herzog, to lead the work. The director's office is located at the University of Michigan. 4c1d

In the educational and promotional functions, the director is assisted by three associate directors, one located at each campus. The associate directors are chosen by the director from nominations made by the universities. The special responsibility of each associate director is to promote and encourage the development of the network within his own community of users. He has esentially a dual role: to support the director and the network so that the implementation of the network at his particular site proceeds as efectively as possible, and to insure that his own university's interests are equitably served with respect to the demands made on its resources by the network. The associate directors have no direct responsibility for the technical details of the project, but they are kept informed of relevant developments and provide advice. 4c1e

Four groups are concerned with the technical research and development function: the Network Central Staff, and the separate Network-Michigan State University, Network-University of Michigan, and Network-Wayne State University staffs individually affiliated with their respective host sites. Further, the Network Central Staff has two components: the senior staff with technical responsibility for all of these groups, and the programming staff, charged with developing software for the common part of the network. Approximately the equivalent of 12 full-time engineers and systems programmers are involved in this facet of the project. This number represents (equivalently) two systems programmers located at each of the three campus computing centers and six members of the Network Central Staff located at MERIT headquarters. 4c1f

Wayne State University acts as fiscal agent for the network, fulfilling such functions as the receipt of funds from several sources, the distribution of these funds to the various MERIT groups and vendors, and the preparation of all contractural and budgetary material. 4c1g

B. Functions Performed 4c2

1. Planning 4c2a

Long range planning responsibility rests with MICIS, which continues to function as a committee and currently meets on a bimonthly schedule. Each university has appointed several representatives, officially four, to MICIS for an indefinite term. The representatives from each university consist of one high-ranking member of each university's administration and of faculty members, usually including the computing center director and others interested in computer application areas. 4c2a1

In its efforts to develop a computer network, MICIS sought both state and federal support. A three-member Joint Executive Committee was established by the participating universities to administer any funds provided by the State of Michigan. Further, in the fall of 1966 the Michigan Educational Research and Information Triad (MERIT) Inc. was created with its three man Board of Directors, and charged with the responsibility to solicit and receive non-state funds for the network. Wayne State University was designated as the fiscal agent for all state and non-state funds. 4c2a2

Once funding was assured, a network research and development project was established and work began in July 1969. Initially designated the Tri-University Computer Network, it later became known as the MERIT Computer Network Project. Thus the director of the MERIT Computer Network Project submits budgets for approval to the Joint Executive Committee and the Board of Directors of MERIT, Inc. (the same three people serve on both boards) whereupon the fiscal agent executes the appropriate contractural operations. 4c2a3

2. Installation 4c2b

The special communications facilities for the network were developed by the project staff under the guidance of the Director. This development included communications computer hardware and common software. Software specific to a particular site, and all software residing in the host computers, is the primary responsibility of each host site's staff. A common design for network software was developed by the central project staff. 4c2b1

The Associate Director at each of the participating universities is responsible for matters relating to the installation of the network facilities at his site. 4c2b2

3. Operations 4c2c

Day-to-day management responsibility for the network rests with the Director and his staff. 4c2c1

The MERIT staff is developing procedures to closely monitor the performance of the network. Statistics gathered on message errors, traffic distribution, and overall throughput will significantly help in adapting the original network design to actual usage patterns. Moreover, a study of machine utilization should facilitate the development of an equitable interuniversity rate structure. 4c2c2

4. User Services 4c2d

Responsibility for promoting the network within each of the member universities and for providing the required user services rest with the associate directors. 4c2d1

The distribution of system documentation throughout the user community is the joint responsibility of MERIT and the individual universities. At the present time, MERIT disseminates information relevant to the design and operation of the communications subsystem and its interfaces. Each university is required to maintain and distribute its local facilities documentation and is responsible for issuing notices reflecting any significant changes. 4c2d2

C. Interfaces (relationships with other organizations) 4c3

As explained below, the MERIT network was funded by the Michigan State Legislature and the National Science Foundation. While this has not received much attention in the open literature, it is clear that the network will need to be responsive to the wishes of the Legislature. Along these lines, it is the intention of the network's developers to provide the capability for network access by many of the smaller colleges and universities in the State of Michigan without host computers. 4c3a

IV. Financial and Legal Concerns 4d

A. Capitalization 4d1

The Merit Computer Network has been funded, initially for two years, by the Michigan State Legislature, the National Science Foundation and each of the participating universities. The Michigan State Legislature provided in successive appropriation bills the total sum of $400,000, provided that matching support could be obtained from other sources. By the end of 1968, a proposal in the amount of $400,000 was submitted to and subsequently funded by the National Science Foundation. 4d1a

B. Accounting 4d2

The Director and the Joint Executive Board of MERIT have focused much attention at the accounting difficulties encountered in even so controlled a network as this. The MERIT network follows the basic policy of permitting each site to set prices and charge for services individually. The problem is not in getting sites to offer resources for sale, but in convincing management at each of the sites to permit usage of resources at other sites. The problem is that the possible "balance of payments" deficit (excess of outside use by local users over inhouse use by outside users) cannot be predicted in advance, and therefore is very difficult to budget for, especially on a normal annual basis. 4d2a

In MERIT's case, relief was sought and obtained from the universities' administrations to pledge, from sources other than the computing budgets, an amount of monies to protect the potentially unbalanced budgets of the wholesaler (local university computer centers) due to the presence of the network. By so doing, a deterrent to utilization was removed. 4d2b

C. Tariffs 4d3

Communications between sites in the MERIT utilize a pre-existing, inter-university, voice-grade telephone network. 4d3a

D. Regulation 4d4

The MICIS and the MERIT efforts have been formally approved by the Michigan State Legislature, the State Board of Education, and the governing boards of each of the three universities. 4d4a

E. Security 4d5

No special security procedures have been developed for the MERIT network beyond the normal access control mechanisms for the individual host systems. However, all users of remote resources presently must be validated by their own system as well as the remote system, since there is no access to the network other than through a local host. 4d5a

V. Conclusions 4e

A. Summary of Problems 4e1

The most publicized problem of the MERIT network has been the budgeting problem: getting the computer centers of the three universities to budget for possible net deficits in network usage (excess of work sent to other nodes over work taken in) for a period greater than a single calendar year. 4e1a

With this problem apparently solved (as explained in IV-B), the main problem has been insufficient network usage to justify its existence. It appears that the three participating universities each have sufficient computing resources to satisfy local needs, so that there is no compelling reasons to use the network. Also, the double charges for use of the network (charges by both the local and the remote system) tend to discourage network usage. This problem could be solved by the expansion of the network to include additional user sites in the state, as the network developers envisioned. 4e1b

B. Lessons Learned 4e2

The main lesson to be learned from the MERIT experience is that organizational and managerial problems can frequently overshadow technical problems in the development of a computer network. 4e2a

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B. Special Vocabulary 4f2

CC - Communications Computer, the PDP-11 based front-end computer which provides a common network interface for host systems. 4f2a

MERIT - Michigan Educational Research Triad 4f2b

MICIS - Michigan Interuniversity Committee on Information Systems 4f2c

TUCC 5

I. Introduction 5a

TUCC is an example of a successful cooperative venture in regional networking by independent and autonomous universities. 5a1

II. Network Identification and General Description 5b

A. Sponsoring Organization 5b1

The Triangle Universities Computation Center is a non-profit corporation which is owned by the three universities who cooperatively sponsored its establishment -- Duke University, North Carolina State University and the University of North Carolina at Chapel Hill. 5b1a

B. Purpose/mission of Network 5b2

The network has three primary goals: 5b2a

1. To provide each of the institutions with adequate computational facilities as economically as possible; 5b2a1

2. To minimize the number of systems programing personnel needed; and 5b2a2

3. To foster greater cooperation in the exchange of systems, programs and ideas among the three universities. 5b2a3

Services include educational, research and administrative computing services for the three major universities, about fifty smaller schools and several research laboratories. 5b2b

C. Status and Topology 5b3

TUCC is essentially a centralized, homogeneous network comprising a central service node (IBM 370/165), three primary job source nodes (IBM 360/75, IBM 360/40, IBM 360/40), 23 secondary job source nodes (leased line Data 100s, UCC 1200s, IBM 1130s, IBM 2780s, and leased and dial line IBM 2770s) and about 125 tertiary job source nodes (64 dial or leased lines for Teletype 33 ASRs, IBM 1050s, UCC 1035s, etc.). Figures 1 and 2 illustrate respectively the topology and geography of the network. 5b3a

Services to the TUCC user community include both remote job entry (RJE) and interactive processing. Thruput has grown from about 10,000 jobs per month in 1967 to about 80,000 jobs per month in 1972. (This increase in thruput was accomplished by hardware upgrades during the period). At the present time about 8000 different individual users are being served directly. 5b3b

D. Technology Summary 5b4

TUCC operates a 2-megabyte, telecommunications-oriented IBM 370/165 using OS/360-MVT/HASP and supporting a wide variety of terminals (see Figure 3). 5b4a

The three universities are connected to the TUCC by means of Telpak A (40.8 K baud) circuits which connect the universities' primary remote batch terminals to the central facility. In addition, over 50 educational institutions are linked to the TUCC by a variety of medium and low speed lines which cover the state and extend as far as Elizabeth City, Wilmington and Ashville. 5b4b

All local node computers are of the same manufacture as the central facility, and provide local computing services and teleprocessing services (from the central facility). None of the local nodes provide computing services for remote users at this time, but plans for such service are under way. 5b4c

III. Network Organization 5c

A. Structure and Extent 5c1

The network is characterized by an organization which provides both for centralization of certain functions and the retention of freedom and authority by the individual computing centers to operate in the academic environment. 5c1a

TUCC Organization 5c1b

The TUCC Corporation is governed by a board of directors whose nine members represent the three major universities. The three members from each university represent the administration, computer science instruction and computer users. The board members are appointed by the executive officers of each institution. The board mets once a month to act on matters of general policy. Other attendees to board meetings are the President and Director of TUCC, the Associate Director and System Manager, the Campus Computation Center directors and the Director of NCES (see section C below). Most question are decided by simple majority vote of the board, except that questions of "fundamental importance" are decided by each university delegation casting a single vote. Questions of "fundamental importance" include selection of the TUCC President, the annual budget and major equipment decisions. 5c1b1

TUCC Staff 5c1c

The central staff organization is shown in figure 2. 5c1c1

Systems Programming Section 5c1c2

This section is responsible for development, testing, integration and implementation of all TUCC and manufacturers' system software. The section is headed by a systems manager who is also the primary technical liaison between the campus computation centers and the manufacturers' field and systems engineering organization. The systems manager serves as an Associate Director of TUCC. 5c1c2a

Information Services Section 5c1c3

This group is responsible for the collection and dissemination of documentation to users, campus center staff, directors and the Board of Directors. Most documents are prepared throughout the network organization, including the documentation services section. These documents are edited, approved and published by this section. The section is also responsible for maintaining the program library, for documentation standards, for public relations and visitor liaison, for a periodic newsletter and for general interest brochures. 5c1c3a

Development Section 5c1c4

This group is concerned with generation of new versions of the operating system, maintenance of the manufacturer supplied operating system, designing and programming of software interfaces between TUCC-written programs and the operating system, and creation of utility programs needed in the TUCC environment. The group is also responsible for design, programming and installation of monitors, statistics gathering programs for performance evaluation, and for the evaluation of overall systems performance. 5c1c4a

Teleprocessing Section 5c1c5

The primary responsibility of this section is maintenance of the teleprocessing software. It maintains current knowledge of all terminals and plans and acquires new communications hardware as required. The teleprocessing manager also acts as a consultant to the campus centers and to individual users. 5c1c5a

Operations Section 5c1c6

This section is concerned with the day-by-day operationsof the computer room. It also maintains the systems accounting records and prepares programs on systems usage, efficiency and turnaround statistics. It provides liaison with manufacturers' field engineers and with the campus computation center operations managers. It is also responsible for security. 5c1c6a

B. Functions Performed 5c2

1. Planning 5c2a

Campus Center Directors' Meetings 5c2a1

Once per month the campus computer center directors meet with the TUCC director, systems manager, and director of information services, primarily to discuss operational policies and procedures. Charging policies and changes to the billing algorithm are among the topics determined at the directors' meeting. 5c2a1a

Systems Programmers Meeting 5c2a2

The TUCC systems manager and the systems programmers of the central staff and of the universities meet monthly to discuss plans for new systems additions and/or modifications. 5c2a2a

2. Installation 5c2b

As described in IIIA above, all planning and control over equipment installation at TUCC is performed by the central management. Each university's computer center management performs these functions for their own center. 5c2b1

3. Operations 5c2c

Each university computer center is autonomous and is operated by its own staff. The TUCC is operated by a separate staff reporting to the central management. 5c2c1

4. User Services 5c2d

C. Interfaces (relationships with other organizations) 5c3

The North Carolina Educational Computing Service (NCES) was created as a state agency by the Board of Higher Education in 1969. (NCES is the successor of the North Carolina Computer Orientation Project (NCCOP) which began in 1966). Its mission is to provide educational services to institutions throughout the state. NCES provides technical support and consulting to small users. This includes computing services (terminals, communications and computer time) as well as technical support (information services, technical assistance to users, specialized software and documentation). 5c3a

The director of NCES represents his organization at TUCC board meetings in a non-voting capacity, and also attends meetings of the computer center directors. Close geographic co-location (in different wings of the same building) help intercommunications between the two staffs, although the organizations are totally independent. 5c3a1

The NCES staff includes both state supported and project supported positions. Nine positions are state supported: the director, his secretary, administrative assistant for curriculum development, manager of user services, three computing consultants, an information services officer and a business officer. Grant supported positions include curriculum development manager, programmer for curriculum development (half-time) and systems programmer (half-time). 5c3a2

The main function of the staff is the increase and improvement of involvement of the participating schools in computing. Two full time and one half-time "circuit riders" and a manager of user services deal directly with the needs of the outlying institutions. Schools are visited as needed and geographically close visits are usualy coordinated. Consulting services are assisted by in-WATS telephone lines and personal contacts of remote users at workshops or through visits to the central facility. Data lines can also be used for voice transmission when not otherwise in use. Some use is being made of inquiries being sent by terminal communications to the central computer to be answered by the central staff. 5c3a3

IV. Financial and Legal Concerns 5d

A. Capitalization 5d1

Initial grants were received from NSF and from the North Carolina Board of Science and Technology, in whose Research Triangle Park building TUCC was located. These funds, along with the contributions from the founding universities, served to establish TUCC. 5d1a

B. Accounting 5d2

The accounting system for TUCC is based on a wholesaler-retailer concept. TUCC is a wholesaler of computing services, including machine cycles, operating system, programming languages and application programs, a documentation service, and management. The TUCC wholesale service specifically does not include typical user services -- debugging, contract programming, etc. Nor does it include user level billing nor curriculum development. Rather, these services are provided for their constituents by the campus computation centers and NCES, which are retailers for the TUCC Network. 5d2a

The wholesaler-retailer concept can also be seen in the financial and service relationships. Every two years the founding universities negotiate with each other and with TUCC to establish a minimum financial commitment from each to the net budgeted TUCC costs. Then, on an annual basis the founding universities and TUCC negotiate to establish the TUCC machine configuration, each university's computing resource share, and the cost to each university. This negotiation includes adoption of an operating budget. Computing resource shares are stated as a percentage of the total resource each day. 5d2b

Each of the three universities and NCES currently pay 25% of the TUCC budgeted operating costs and are each entitled to equal amounts of service. A scheduling algorithm with a "usage leveling capability" allocates resources to the institution which has used the least so far. Each institution funds its own computer facility and communications lines. Each institution bills local users based on payments made to TUCC and on detailed usage statistics collected at the central computer. 5d2c

TUCC charges a wholesale rate to the three universities which is a little lower than the rate charged to NCES. The justification for this procedure is the fact that the income from the universities is guaranteed while the income from the NCES is less certain. Both the computing centers and the NCES levy additional charges on the local user to cover local computing center costs and the costs of the additional NCES central staff. 5d2d

C. Tariffs 5d3

Since the TUCC network does not extend outside the state of North Carolina, intrastate tariffs apply for all communications facilities. Standard Bell System services are utilized for wideband and voice grade circuits. 5d3a

D. Regulation 5d4

No direct Federal or state regulations apply to the TUCC network. However, the state of North Carolina can exert influence over the network through the Board of Higher Education. 5d4a

E. Security 5d5

No special attention has been given to security in the TUCC network beyond those measures normally found in a third-generation operating system for the control of access to files. 5d5a

V. Conclusions 5e

A. Summary of Problems 5e1

Administrative Data Processing 5e1a

TUCC has for some time been handling the full range of administrative data processing for two NCECS universities and is beginning to do so for other NCECS schools. The primary reason that this application lags behind instructional applications in the NCECS schools is simply that grant support, which stimulated development of the instructional applications, has been absent for administrative applications. However, the success of the two pioneers has already begun to spread among the others. 5e1a1

With the three larger universities there is a greater reluctance to shift their administrative data processing to TUCC, although Duke has already accomplished this for their student record processing. One problem which must be overcome to complete this evolution and allow these universities to spend administrative computing funds on the more economic TUCC machine is the administrators' reluctance to give up a machine on which he can exercise direct priority pressure. The present approach to this problem is to extend to allocation and scheduling algorithms to guarantee a portion of the central machine to each founding university's administrative data processing needs. This would probably require additional computing resource at TUCC. 5e1a2

Hardware Homogeneity 5e1b

While not a real problem at present, it would appear that TUCC has locked itself into IBM compatible systems. This has simplified the development of the network by permitting compatibility problems to be ignored, but it may restrict the alternatives for future growth. 5e1b1

B. Lessons Learned 5e2

1. User Services 5e2a

A very important lesson that was learned is that personal communication must exist and be kept alive at all levels. 5e2a1

"It is amazing how misinformation can spread if there does not exist a vigilant system for keeping people informed... Experience has shown us that if we relax ..., then little things that may go wrong may sometimes be magnified completly out of proportion to their importance and begin to become a source of irritation at some point in the system. The central facility must therefore have a high coefficient of sensitivity to the needs of all users."(Davis, p. 4-1-2) 5e2a1a

The earliest recognition of this fact was the hiring, at the time of the formation of TUCC, of a Manager of Information Services at TUCC. His responsibility is the documenting of all operating systems, services and policies. An elaborate system of memoranda series with distributions to various relevant groups was developed. This lesson also explains the "circuit riders" who were employed by NCCOP (now NCECS) to regularly assist its client colleges. 5e2a2

2. Wholesaler-Retailer Concept 5e2b

TUCC's implementation of the wholesaler-retailer concept (as explained in section IV-above) was designed as a mechanism for the administrative protection of the interests of the three founding universities and the NCECS schools. 5e2b1

Because each of the universities and NCECS is guaranteed a minimum percentage of utilization of the central machine (in effect, a virtual machine for each), they have the assurance that they can take care of their users' needs as would be the case with totally independent facilities. The scheduling algorithm also allows each to define and administer quite flexible, independent priority schemes. 5e2b1a

Since the local centers and NCECS are the retailers of all computer services, whether produced locally or purchased on a wholesale basic from TUCC, they are not in competition with TUCC. Users are also able to turn to local personnel for all required services, and receive a single bill. 5e2b1b

There are several structural devices which serve to protect the interests of both the wholesaler and the retailers. At the policy making level this protection is afforded by the Board of Directors, which is appointed by the Chancellors of the three founding universities. Typically each university allocates its representatives to include its business interests, its computer science instructional interests, and its other computer user interests. The University Computer Center Directors sit with the board whether or not they are members, as do the Director of NCECS and the President of TUCC. An example of the policy level function of the Board is their determination, based on TUCC management recommendations, of computing service rates for NCECS and other TUCC users. (Williams, 1972) 5e2b2

At the operational level there are two important groups, both normally meeting each month. The Campus Computation Center Directors' meeting includes the indicated people plus the Director of NCECS and the President, the Systems Manager, and the Assistant to the Director of TUCC. The System Programmers' meeting includes representatives of the three universities, NCECS and TUCC. In addition, each of the universities has the usual campus computing committees. 5e2b3

3. Neutrality of Site 5e2c

The neutral location of the central computer is felt to be "one of the chief factors contributing to the political stability of TUCC." (Brooks, et. al.) An earlier unsuccessful experience with a computer jointly owned by NCSU and UNC-CH, but located at Chapel Hill, had shown that "the psychological and political consequences of location could not be tele-processed away." It is recognized that a neutral location requires extra cost, but this is felt to be "an indespensible expense." 5e2c1

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B. Special Vocabulary 5f2

NCCOP - North Carolina Computer Orientation Project 5f2a

NCECS - North Carolina Educational Computing Service 5f2b

TUCC - Triangle Universities Computation Center 5f2c

Oregon State Regional Network 6

I. Introduction 6a

The Oregon State Regional Network is representative of a large number of centralized "star" networks serving a regional clientele. 6a1

II. Network Identification and General Description 6b

A. Sponsoring Organization 6b1

Oregon State University and the National Science Foundation 6b1a

B. Purpose/mission of Network 6b2

The regional network was established in connection with a two-year project with National Science Foundation support to develop and appraise instructional uses of computational facilities provided through computer terminals on-line to a central computer facility. The objectives of the project were: 6b2a

1. To provide faculty and students at the participating colleges with computing resources available through terminals which have direct access to a central computing facility. 6b2a1

2. To develop special instructional programs and materials suitable for regular as well as "short" courses in the use of computers in an educational environment. 6b2a2

3. To appraise the usefulness in instructional programs of the facilities offered with reference to the instructional needs of each institution. 6b2a3

C. Status and Topology 6b3

The system now supports a network of more than 200 remote terminals with approximately 75 terminals active concurrently. Approximately 35 terminals are located at other universities and colleges of the network. The network serves instructional, administrative and research aplications, and may be reaching saturation. Acquisition of new computing hardware is being contemplated at the present time. 6b3a

D. Technology Summary 6b4

The Oregon State University Regional Computer Network consists of a central computing facility at the Oregon State University campus in Corwallis, Oregon, which serves some sixteen institutions of higher learning in Oregon. The central facility runs in a time-sharing mode under a special operating system developed at Oregon State University. Remote users are connected to the central facility by low speed teletype lines. 6b4a

The principal resource at the computation center is a CDC 3300 with a memory capacity of 98K 24-bit words. Peripheral devices include a card reader and punch, line printer, four magnetic tape units, five magnetic disc units, a 200 million character mass storage disc unit, 16 CRTs, a plotter and a PDP-8 minicomputer which serves as a communications front end. The PDP-8 also serves as a telephone line interface for 180 remote terminals. During 1972 remote batch capability was added using card readers and line printers. 6b4b

The operating system, OS-3 (Oregon State Open Shop Operating System) was designed and implemented by the Oregon State Computer Center. It permits time sharing operation in a variety of languages, including ALGOL, FORTRAN, BASIC, OSCAR (a conversational language for all types of users), EDIT (a file editing language), and others. 6b4c

III. Network Organization 6c

A. Structure and Extent 6c1

The organization of the network is embedded in the organization of the regional computer center. Special organizational elements, exclusively concerned with network operations are a regional coordinator who reports to the regional computing center director, a regional steering committee, and campus coordinators resident on the individual campuses. Close liaison is maintained with the Teaching Research Division, an arm of the Chancellor's Office, which represents all institutions of the Oregon State System of Higher Education. 6c1a

Computer Center Director 6c1b

The regional computing facility is under the direct supervision of a central administrative officer, the computer center director. He has the authority to enforce adherence to established procedures, observation of priorities, and conformance to established schedules. The director is assisted by a steering committee. 6c1b1

Steering Committee 6c1c

The regional steering committee considers policy matters affecting regional projects, terminal end users, and recommends action to the regional coordinator and the computer center director. The committee helps to maintain uniformity and workability of operation and services, where this is in the interest of participating institutions. It acts as a developer of procedures for network users. It is responsive to all network participants and considers the effects of all actions on local centers. Members are elected to the steering committee by the participating schools. 6c1c1

Campus Coordinators 6c1d

The campus coordinator acts as the manager of instructional computing on his individual campus. He needs to have a knowledge of available computing facilities and of specific campus computing needs. He works closely with all users and coordinates interdiciplinary request and problems. This assignment is considered to require at least half time availability of the designated faculty member. Specific functions of the campus coordinator are: 6c1d1

Coordinate use of remote terminals with local facilities; 6c1d1a

Act as campus-wide focal point for utilization, dissemination and facilitation of instructional and research uses of the regional computing facilities on his campus; 6c1d1b

Serve as a member of the local institution computer committee; 6c1d1c

Facilitate training for faculty; 6c1d1d

Coordinate remote regional facility maintenance, regional staff visits and workshops; 6c1d1e

Attend regional conferences; 6c1d1f

Report development of computer-related curriculum material and other documentation to regional project coordinator; 6c1d1g

Prepare and coordinate interim and annual reports regarding institutional participation in the network; 6c1d1h

Report news items to regional newsletter editor; 6c1d1i

Be aware of all projects involving curriculum development teachers, curriculum writers, consultants and learning and evaluation specialists; 6c1d1j

Participate in local budget recomendations involving utilization of regional facilities on his campus. 6c1d1k

The final project report recommended that the campus coordinator report to either the dean of instruction or the dean of administration. It was also suggested that on some campuses it would be beneficial for the Campus Coordinator to have an advisory committee to assist him in making decisions relating to the allocation of resources. 6c1d2

B. Functions Performed 6c2

1. Planning 6c2a

The emphasis during the initial portion of the project was on three items: 1) developing useful and reliable services; 2) assisting individuals and classes to become fully cognizant of the services and how they could be used; and 3) a preliminary exploration of the curricular changes brought about by the introduction of the facilities. The emphasis throughout the last year of the project was on the development and evaluation of techniques and materials relating to the role of computers in the academic environment. 6c2a1

2. Installation 6c2b

The time-sharing computer facility of the OSU Computer Center has been the basic computational resource of the network. Access to the center is through remote terminals located at each of the participating colleges. Under the grant they wre provided with terminals, communications costs, computer time, and consulting services. The installation requirements for this type of arrangement are minimal. 6c2b1

3. Operations 6c2c

4. User Services 6c2d

C. Interfaces (relationships with other organizations) 6c3

The regional computing center has worked closely in the past with the Teaching Research Division, an arm of the Chancellor's office which represents all institutions of higher learning in the Oregon State System. This division is concerned with inprovements in the teaching procedures at various levels of instruction. The division has assisted in two areas: 1) direct assistance to faculty in courses using computers, and 2) evaluation of user reaction, utilization patterns, and impact of the computer on instruction. 6c3a

IV. Financial and Legal Concerns 6d

A. Capitalization 6d1

The National Science Foundation, through its Office of Computing Activities has funded 20 regional computing activities during the period 1968-1969. One of the first three such grants made was to Oregon State University in 1968 in cooperation with six other colleges in Oregon. The principal investigator under the grant was Dr. Larry C. Hunter of OSU. This grant has since expired, and current network activities are self-supporting. Campus computer center operations are supported by the local university budget. The regional center is supported by state funds and usage charges. 6d1a

B. Accounting 6d2

Because of the "star" configuration of the network, accounting was not a problem. All users maintained accounts in the central machine at OSU and were billed (or charged against their portion of the grant) from there. 6d2a

C. Tariffs 6d3

Since all participants of the network were located within the state of Oregon, intrastate tariffs applied for all telephone lines used. The network was configured as a "star" or single central timesharing system with remote users, so there were no other issues related to tariffs. 6d3a

D. Regulation 6d4

The network was regulated in part by the National Science Foundations by the terms of its grant and in part by the Chancellor's Office of the State of Oregon. Only institutions of higher learning in Oregon could participate. 6d4a

E. Security 6d5

The only security controls in the system are provided by the log-on sequence of the central time-sharing system. 6d5a

V. Conclusions 6e

A. Summary of Problems 6e1

B. Lessons Learned 6e2

Annexes 6f

A. Bibliography 6f1

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B. Special Vocabulary 6f2

OS-3 - Oregon State Open Shop Operating System 6f2a

OSCAR - Oregon State Conversational Aid to Research 6f2b

TYMNET 7

I. Introduction 7a

TYMNET is a distributed national network of heterogeneous computers operated for profit by a major time-sharing company. The continued operations of this network serves to demonstrate that such facilities are commercially viable. 7a1

II. Network Identification and General Description 7b

A. Sponsoring Organization 7b1

Tymeshare, Inc., with headquarters in Cupertino, California, was formed in 1966 as a commercial time sharing company. It has grown to a company with annual sales of some $16 million and about 300 employees, making it the largest independent in the time sharing field. The total number of individual users of Tymshare services is in excess of 10,000, and they represent over 150 separate organizations. 7b1a

B. Purpose/mission of Network 7b2

TYMNET exists primarily to make available the commercial timesharing services of Tymeshare, Inc., although the capabilities of the communications network itself have been marketed separately to customers wishing to connect their own terminals to their own computers. The network is designed for interactive terminal to computer communications, although computer to computer connections are possible. 7b2a

C. Status and Topology 7b3

The network has been operational since 1966 as a commercial service. It is presently serving over two thousand interactive users (800 simultaneously) in over 70 cities throughout the United States and Europe (Paris, France). 7b3a

The network serves to interconnect approximately 30 host computer systems and contains some 80 communications nodes. Figure 1 illustrates an abbreviated topological map of the network. 7b3b

D. Technology Summary 7b4

The network consists of approximately 80 minicomputers (Varian 620/i) called TYMSATs interconnected by common carrier voice grade facilities. The TYMSATs serve in two different capacities, to connect host systems and terminals to the network. 7b4a

The "base" TYMSAT is responsible for acting as both a message switching computer in the communications network and as an interface to the network for host or service computers. 7b4a1

When the service computer is one of those generally supported by Tymshare (such as an XDS 940, SIGMA 7 or DEC PDP-10), the TYMSAT has been programmed as a communications controller replacing the standard components for that function. 7b4a1a

Computers of a type not employed by Tymshare have thus far been interfaced to the net through their standard communications controller (e.g., IBM 270X for an IBM 360 or 370) so that the TYMSAT appears as a complex of terminals to the controller. 7b4a1b

The base TYMSATs are each connected to a service computer in a one-to-one fashion (approximately thirty throughout the country) and to one another either directly or through an intermediate base TYMSAT in a multiple ring or distributed manner. The circuits used are either 2400 or 4800 bps synchronous, full-duplex, private leased lines. 7b4a1c

The "remote" TYMSATs act as store-and-forward computers and as concentrators for user terminals. In addition, some remote TYMSATs with added hardware and software can suport hardwired terminals in the 600 to 1200 baud range. Each is capable of supporting up to thirty-one asynchronous, full-duplex modems allowing for terminal speeds in the 110 to 300 bps range. 7b4a2

The remote TYMSAT can identify a terminal (baud rate and carriage return delay time) by the first character typed. It is possible to allow a terminal to connect with two different baud rates for input and output. In addition, ASCII conversion is provided for non-standard terminals and echoing if the user terminal is operating in echo-plex mode. 7b4a2a

The remote TYMSATs are connected to the base TYMSATs and thus the service computers through a ring configuration whereby a circuit passes through a number of remote TYMSATs and one base TYMSAT. Store-and-forward techniques are used to exchange information between any remote TYMSAT and any base TYMSAT. The circuits connecting the remote TYMSATs are again 2400 and 4800 bps asynchronous, full-duplex, private leased lines. 7b4a2b

Blocks are transmitted through the network over full-duplex virtual circuits. These circuits are established at log-in time and exist for the duration of the connection. These circuits are established by software in the TYMSATs which associate an input channel with the appropriate output channel at each switching point. 7b4b

A circuit is established by the "supervisor in active mode" (Sam). When a user connects to TYMNET, he is originally communicating with the Sam, which, after the appropriate exchange of information, will establish a circuit from that user's terminal to the desired service computer by selecting the proper TYMSATs to complete the virtual circuit. 7b4b1

The "supervisor in active mode" is so named because it is a function which can be taken over by backup supervisors in the event of failure. A backup supervisor will become active by detecting a failure, polling the TYMSATs to get network status information, and assuuming the active role. This sequence does not disturb users on processors other than the one whose supervisor failed. 7b4b2

It should be noted that in the event of a processor failure, its base TYMSAT can still function in the role of a network store-and-forward computer. Since virtual circuits are established and fixed for the duration of processor connections, recovery from a physical line failure is not as clean. When a line fails, users communicating through virtual circuits using that line in their definition must reconnect. 7b4b3

III. Network Organization 7c

A. Structure and Extent 7c1

B. Functions Performed 7c2

1. Planning 7c2a

The network is privately managed in its entirety, and all planning for its growth is done by the Tymshare, Inc. corporate staff. The network topology, however, has not been laid out following any specific design strategy, but has just grown in response to customer needs and the business expected in certain areas. 7c2a1

2. Installation 7c2b

All matters relating to installation (such as leasing phone lines and the delivery and attachment of TYMSATs) are handled by Tymshare, Inc. as part of the usage contract with the customer. 7c2b1

As usage grows and bottlenecks occur, two main courses of action are taken by Tymshare. As an interim step, the "preferred routing" definitions for some terminals can be changed, so as to reroute data and thus relieve the bottleneck. Also, additional leased lines can be ordered; it normally takes about six weeks to obtain such lines. The ring structure of the network provides considerable flexibility in the management of the physical network. 7c2b2

3. Operations 7c2c

The network is controlled by a Network Supervisory System. This is a control program that is resident in four host computers. Currently, two of these host computers are at Cupertino, California, one is at Englewood Cliffs, New Jersey, and one is at Paris, France. However, only one of the programs is in control of the network. The other three have a "pecking order" for taking over control of the network, in case the active supervisor shows any sign of not being able to handle the job. If the network should become segmented, such as transmission across the Atlantic disrupted, then each segment can be run independently until communications have been reestablished. 7c2c1

The network has proved to be very reliable, with an average number of failures of only 1.4 for the TYMSATs. Preventative maintenance is performed once per year on the TYMSATs. 7c2c2

4. User Services 7c2d

Tymshare, Inc. has an extensive organization of marketing representatives throughout the country who also continue to provide service to customers after they contract to use the network. The company offers many proprietary software packages for use on the network, and is continuing to develop more. 7c2d1

As a profit-making company, it is reasonable to assume that Tymshare will be quite responsive to user needs. For example, remote batch service is not presently offered, but will probably be added when user demands dictate. 7c2d2

C. Interfaces (relationships with other organizations) 7c3

IV. Financial and Legal Concerns 7d

A. Capitalization 7d1

Tymshare, Inc. is a for-profit corporation capitalized by the sale of stock to private investors. 7d1a

B. Accounting 7d2

Tymnet can and is being used in several ways. The principal use is for providing customers with time sharing services, both computing services and application packages. The network allows a customer to use a specific resource, such as a particular data file, that may be located at a Tymshare computing center on the other side of the country. In addition, the network allows Tymshare to make "rolling use" of its resources by diverting peak loads occurring at particular hours of the day to computers located in other time zones. 7d2a

Another use of the network is where the customer has both a computer and terminals connected to the network, and the Tymshare computers do some of the processing. Data files may be exchanged between a user's computer and Tymshare computers as required. 7d2b

Still another way to use the network is by a joint use arrangement, which is allowed under Federal Communications Commission (FCC) Tariff 260. In this type of usage, the customer contracts for a specified percentage of the Tymnet capacity -- say 1% averaged over a one month period -- for communicating between the customer's terminals and the customer's computer. In this instance, the Tymshare host computers are involved to set up the call routing and to guarantee their stability, but not to process data. An agreement is signed with the Telephone Company whereby it bills the company for the specified percentage of the communications charges. In addition, Tymshare bills the customer for its "value added" services. 7d2c

C. Tariffs 7d3

D. Regulation 7d4

Aside from tariffs (discussed above) and the normal laws affecting all private businesses, TYMNET is not regulated. 7d4a

E. Security 7d5

V. Conclusions 7e

A. Summary of Problems 7e1

B. Lessons Learned 7e2

Annexes 7f

A. Bibliography 7f1

Beere, M. P. and N. C. Sullivan, "Tymnet, a serendipitous evolution," <IEEE Transactions on Communications>, June 1972, Part 2; pp. 511-515. 7f1a

Tymes, L. R., "Tymnet, a terminal oriented communications network," <Proceedings of the 1971 SJCC>, AFIPS Press: Montvale, N pp. 211-216. 7f1b

B. Special Vocabulary 7f2

TYMSAT - a miniprocessor based on the Varian 620/i which acts as a store-and-forward switch and an interface for terminals and computer systems to the network 7f2a

7f2b

8

I. Introduction 8a

The approach to network management taken in this report has been positive, rather than normative. Nevertheless, it is possible to draw some conclusions simply from observing which of several different approaches have been successful. This is the essence of the comparative approach to management. While the conclusions which will be drawn here are not intended to be definitive, they do seem to be indicative of how successful network management is performed. It is in this spirit that they are offered. 8a1

II. Network Identification and General Description 8b

A. Sponsoring Organization 8b1

B. Purpose/mission of Network 8b2

It does seem clear that for continued success a network must have a real purpose other than just research into the technology of networks. Networks which are faced with real needs to satisfy are more likely to succeed than networks which would hardly be missed were they to fail. 8b2a

C. Status and Topology 8b3

There does not appear to be a minimum critical size for achieving success in a network. In fact, growth seems to bring with it more stringent requirements in such areas as user services for achieving success. 8b3a

Topology is important only in that shared facilities be fairly available to all those contributing to their maintenance. Geographic neutrality has been found (in the case of TUCC, for example) to help emphasize this point. 8b3b

D. Technology Summary 8b4

The particular technology employed in constructing a network does not appear to be critical to the success or failure of the network. Speed of lines, routing strategies and similar factors seem not to be significant. Reliability, however, is significant. The conclusion appears to be that users will adjust their requirements to whatever type and level of service is offered, but they must be confident of receiving this service when it is desired if the network is to be successful. 8b4a

III. Network Organization 8c

A. Structure and Extent 8c1

B. Functions Performed 8c2

1. Planning 8c2a

2. Installation 8c2b

The installation of equipment in a well-managed network will be accomplished in a non-disruptive manner and on a timely basis. This can only result from orderly planning, as discussed above. None of the networks surveyed appeared to be deficient in this area. 8c2b1

3. Operations 8c2c

4. User Services 8c2d

C. Interfaces (relationships with other organizations) 8c3

IV. Financial and Legal Concerns 8d

A. Capitalization 8d1

The first conclusion to be drawn in this area is that networks require substantial capital, both for the development required and to underwrite the operation of the network while usage is still very light. Since usage may take some time to grow, as users gain both familiarity and confidence in the system, the initial capitalization should be adequate to cover at least two years of operation. 8d1a

We comment elsewhere in these conclusions that a commitment from users to the success of the network may be a key element in achieving success, especially in a non-commercial network. In this vein, it seems likely that a significant contribution to the network's capitalization by these users would go a long way towards encouraging this commitment. A network in which the users have little to lose in the event of failure is that much likelier to fail. 8d1b

B. Accounting 8d2

Herzog (1973) discusses the accounting problems which must be faced when a network is constructed to interconnect a number of autonomous sites. He bases his discussion on the wholesale/retail concept espoused by Grobstein and Uhlig

(1972). The users, of course, are anxious about the prices they must pay for service. The wholesalers (e.g., autonomous university computing centers), whose planning and budgeting experience is dominated by the history of pre-network days, are afraid that some of the income they have anticipated will be diverted to other wholesalers. This potential diversion threatens the budgetary itegrity of each wholesaler and results in real anxiety. 8d2a

Herzog suggests that in the long run, usage patterns can be incorporated in the budgetary and planing process, thereby reducing the problem to the traditional one of matching the expected and actual income. At the start, however, a cooperating group seking to obtain the benefits of a network must find a mechanism to overcome this anxiety. Using the total flow of resources across the network as a measure of success, he suggests that the ideal would be to have a large but balancing flow. A zero differential flow by definition avoids the cited anxiety. However, as Herzog recognizes, it is unrealistic and short-sighted to expect that this ideal will be met. 8d2b

(It could, of course, be met by administrative fiat, but this would create an unstable situation of unsatisfied demand which would be difficult to perpetuate). 8d2b1

In MERIT's case, relief was sought and obtained from the universities' administrations to pledge funds from sources other than computing budgets to cover imbalances. This removed a serious potential deterrent to network utilization. To arrive at his resolution, however, required a careful review of existing internal organizational policies. 8d2c

C. Tariffs 8d3

D. Regulation 8d4

E. Security 8d5

Security is an issue which has been conveniently ignored by most networks, but which will have to be faced by many of them eventually. Security may sem to be of little importance in an academic environment, but even there may be found instances of sensitive files which require adequate protection from examination and tampering (e.g., personnel files, files of student grades). Networks which offer service commercially have the responsibility to develop measures to protect their customers'' sensitive information. 8d5a

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Roberts, Lawrence G. "Network rationale: a 5-year reevaluation." <Compcon73>, pp. 3-5. 8f1f

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B. Special Vocabulary 8f2

Centralized Network - A network with a topology such that all nodes are connected to a single node. 8f2a

Circuit Switching - The establishment of a physical circuit between nodes prior to the start of transmission. 8f2b

Communications Computer - A computer that acts as the interface between another computer or a terminal and a communications link. 8f2c

Decentralized Network - A distributed network of centralized sub-networks. 8f2d

Distributed Network - A network in which the majority of nodes are not directly connected to a majority of the other nodes. 8f2e

Front-end Computer - See Communications Computer. 8f2f

Host Computer - A network computer acting as a service node. 8f2g

Link - A communications path between two nodes. 8f2h

Network- 8f2i

1) An interconnected or interrelated group of nodes; 8f2i1

2) In connection with a disciplinary or problem oriented qualifier, the combination of material, documentation and human resources that are united by design to achieve certain objectives. (E.g., a science information network). 8f2i2

Node - A point of convergence of communication paths in a network. 8f2j

Process - A systematic sequence of operations to produce a specified result. 8f2k

Protocol - A formal set of conventions governing the format and relative timing of message exchange between two communicating processes. 8f2l

Regional Network - A network whose nodes are confined to a specified geographical area. 8f2m

Remote Job Entry - The mode of operation that allows input of a batch job by a card reader at a remote site and receipt of output by a line printer or card punch at the remote site. 8f2n

Resource - Any capability or service available to users, such as computational power, brain power, programs, data files, storage capacity, or a combination of these. 8f2o

Resource Sharing - The joint use of resources on a network by a number of dispersed users. 8f2p

RJE - see Remote Job entry. 8f2q

Server Node - A node primarily providing network resources. 8f2r

Store and Forward - Pertaining to communications where a message is received, stored until ready for output, and then retransmitted. 8f2s

Terminal - A point in a system or communication network at which data can enter or exit. 8f2t

Request for Comments on Network Management Survey

(J16814) 25-MAY-73 12:21; Title: Author(s): Ira W. Cotton/IWC;
Distribution: /SDC2 JI RMD; Sub-Collections: NIC; Clerk: IWC;
Origin: <NBS-TIP>NSF-COTTON.NLS;1, 25-MAY-73 09:13 IWC ;

16814 Distribution
Steve D. Crocker, Jean Iseli, Robert M. Dunn,

Peter Kirstein is already on the NMG distribution list. 1

16815 Distribution
Marcia Lynn Keeney,

(J16815) 25-MAY-73 12:19; Title: Author(s): William E. Naylor/WEN;
Distribution: /MLK; Sub-Collections: NIC; Clerk: WEN;

RFC 518
NIC 16817

Nancy Vaughan Jake Feinler
UCSB-MOD75 SRI-ARC
June 19, 1973

1

ARPANET ACCOUNTS 1a

This RFC is being issued in response to numerous requests for information on opening an account at a given site on the ARPAnet. If you have any changes or additions, please send them to Jake Feinler (ident JAKE for the NIC Journal, FEINLER@SRI-ARC for sndmsg) before July 15, 1973 for inclusion in the next Resource Notebook (NIC 6740). 1b

JAKE/kk 1c

1d

ASS Group Members' Network Mail Boxes

(J16817) 27-JUN-73 17:47; Title: Author(s): Elizabeth J. (Jake) Feinler/JAKE ; Distribution: /SA ; Sub-Collections: NIC ; Clerk: KIRK ;

Dear Faithful Journal System,
Sorry for the recent pain I will not again INTENTIONALLY submit messages that are "too long", but of course I can't guarantee that I won't occasionally do it by mistake. If I get the "center dot simulated" warning while submitting a MESSAGE, I can, of course, not continue with the submission process; however, in such cases, is there any easy way to not completely lose all the typing I've just gone through? (I don't mind if you treat answering this as a quite low priority function)
Regards,
Alex McKenzie 1

16820 Distribution
J. D. Hopper,

(J16820) 25-MAY-73 13:05; Title: Author(s): Alex A. McKenzie/AAM;
Distribution: /JDH; Sub-Collections: NIC; Clerk: AAM;

16821

did you ever get my message ?

16821 Distribution
Keith N. Sandum,

(J16821) 25-MAY-73 12:46; Author(s): Jonathan B. Postel/JBP;
Distribution: /KNS; Sub-Collections: NIC; Clerk: JBP;

Journal Design Team Meeting

There will be a meeting of the Journal Design Team next week, scheduled tentatively for 3 PM Thursday 31 May. let me know if you can't make it, and I'll reschedule it. Please have read Ray Tomlinson's spec for his new READMAIL subsystem, and we'll discuss it in light of our attempt to provide compatibility between SNDMSG and the Journal. --Jim 1

16822 Distribution
James E. (Jim) White, Richard W. Watson, J. D. Hopper, Diane S. Kaye, Walt Bass, L. Peter Deutsch,

Journal Design Team Meeting

(J16822) 25-MAY-73 13:05; Title: Author(s): James E. (Jim) White/JEW; Distribution: /JDDT; Sub-Collections: SRI-ARC JDDT; Clerk: JEW;

The Last Straw

I understand that global changes to the NLS command language are currently being spec-ed, and that these changes are apt to be implemented in the very near future. The following is a word of caution. 1

Probably everyone at ARC is aware (to some extent or another) that TNLS has had an extremely poor reputation around the Network community (I'm speaking primarily of systems programmers -- the old NWG). People around the Net have been exposed to TNLS for quite awhile, and more or less forced (by necessity) to use it in conducting dialog with other Network implementors. The learning process has been long and frustrating, and many people wouldn't give you two cents for NLS. I'm not sure whether their feelings are well founded or not, but that's not the point. The point is that, as I see it, patience with NLS is wearing thin in spots around the Net. 2

The recent addition of terse prompts throughout the TNLS command language illicited reasonably nasty remarks from some people with whom I've talked, a couple of whom made a point of calling me about it. 3

I suggest that if some of these people log in one morning and find implemented the kind of command languages changes that are now being discussed, it may be the last straw. You just can't expect users to put up with a tool that's so lacking in stability. 4

I'm not suggesting that command language changes shouldn't be made; I too am aware of the need for them. I'm simply making a strong plea that some serious thought be given to 'breaking it gently' to the Network community. Things that might help are: 5

(1) an RFC describing our intent, presenting our proposed specs, and requesting criticisms (all the discussion that goes on within ARC may ease the change for us, but all that's transparent to the rest of the world). 5a

(2) An RFC announcing the change (well in advance). 5b

(3) Modifying NLS so that, for a time, it informs the user that the command language has changed, and gives him the option of using the old one (i.e., NLS would load a backup SAV file for the user) (I understand what users running on two different copies of NLS would do to the load average). At some point after the change was installed, it would become irreversible and the command language option would go away). 5c

16823 Distribution

Richard W. Watson, Don I. Andrews,
Judy D. Cooke, Marcia Lynn Keeney, Carol B. Guilbault, Susan R. Lee, Elizabeth K. Michael, Charles F. Dornbush, Elizabeth J. (Jake) Feinler, Augmentation Research Handbook, Kirk E. Kelley, N. Dean Meyer, Kay F. Byrd, James E. (Jim) White, Diane S. Kaye, Paul Rech, Michael D. Kudlick, Ferg R. Ferguson, Linda L. Lane, Marilyn F. Auerbach, Walt Bass, Douglas C. Engelbart, Beauregard A. Hardeman, Martin E. Hardy, J. D. Hopper, Charles H. Irby, Mil E. Jernigan, Harvey G. Lehtman, Jeanne B. North, James C. Norton, William H. Paxton, Jeffrey C. Peters, Jake Ratliff, Edwin K. Van De Riet, Dirk H. Van Nouhuys, Kenneth E. (Ken) Victor, Donald C. (Smokey) Wallace

The Last Straw

(J16823) 25-MAY-73 14:08; Title: Author(s): James E. (Jim) White/JEW; Distribution: /SRI-ARC; Sub-Collections: SRI-ARC; Clerk: JEW; Origin: <WHITE>SYNMSG.NLS;3, 25-MAY-73 14:00 JEW ;

16824

An experimental user allocation scheme by group accounts has been implemented 27-MAY-73 that affects only local and RADC users. Each user is assigned to a specific group (the details of assignment will be availble soon). Your ability to log in and stay in the system will be determined by system usage by others both within and outside your group and the number of online users allowed for your group at different times of the day. 1

If the number of members of your group logged in to the system is less than allowed, you may log in as normal. However, as the number of online users allowed for any group changes during the day (according to some predefined schedule), users whose group allocation is reduced may be moved onto OFFQUOTA status on a last-in, first-out basis. 2

If the number of members of your group logged in to the system is the maximum allowed, you may log in only if some other group is not at quota. When you log in you will get the message: 3

OFFQUOTA LOGIN: (TYPE "OFFQUOTA" FOR HELP) 3a

Typing "OFFQUOTA" causes the system to print a description of offquota status. 3a1

OFFQUOTA status means that you may be autologged out of the system if a member of any group currently under quota logs in to the system. 3b

Users on OFFQUOTA status are bumped off the system on a "last-in, first-out" basis and issued a message warning AUTOLOGOUT in five minutes. 3b1

IF YOU ARE STILL OFFQUOTA AUTOLOGOUT WILL OCCUR AT "time-date" 3b1a

A user on OFFQUOTA status may be moved to ONQUOTA status (i.e., not subject to autologout) when his group becomes under quota. 3c

If you try to log in and all groups are at quota, you will get the message: 4

NO NEW LOGINS ALLOWED 4a

An "express login" feature has been added which allows you to access the system (regardless of the number of online users) for 5 minutes after which you will receive an AUTOLOGOUT. Express login requires the TENEX command: 5

@ELOG (proceed as with normal login) 5a

In addition, the Tenex JOBSTAT command will reflect your current PRIORITY status and a new (Tenex) command GROUPSTAT tells you the status of your group. 6

```
@GROUPSTAT CR                                                6a

USERGROUP NAME
allowed = x, actual = x
user          connect     cpu     tty     status
.
.
.                                                            6b
```

16824 Distribution

Richard W. Watson, Don I. Andrews, Rome Air Development Center (ISIM)
,
Judy D. Cooke, Marcia Lynn Keeney, Carol B. Guilbault, Susan R. Lee, Elizabeth K. Michael, Charles F. Dornbush, Elizabeth J. (Jake) Feinler, Augmentation Research Handbook, Kirk E. Kelley, N. Dean Meyer, Kay F. Byrd, James E. (Jim) White, Diane S. Kaye, Paul Rech, Michael D. Kudlick, Ferg R. Ferguson, Linda L. Lane, Marilyn F. Auerbach, Walt Bass, Douglas C. Engelbart, Beauregard A. Hardeman, Martin E. Hardy, J. D. Hopper, Charles H. Irby, Mil E. Jernigan, Harvey G. Lehtman, Jeanne B. North, James C. Norton, William H. Paxton, Jeffrey C. Peters, Jake Ratliff, Edwin K. Van De Riet, Dirk H. Van Nouhuys, Kenneth E. (Ken) Victor, Donald C. (Smokey) Wallace

(J16824) 25-MAY-73 16:08; Author(s): Marilyn F. Auerbach/MFA;
Distribution: /SRI-ARC RADC; Sub-Collections: SRI-ARC RADC; Clerk: MFA;
Origin: <AUERBACH>MESS.NLS;10, 25-MAY-73 15:59 MFA ;

Yet Another Substitute Command

As a result of the command language discussions of May 24, a new Substitute command has been implemented in the XNLS system. This should approximate the final form of the command (hopefully).

Yet another Substitute command 1

A new form of the Substitute command has been implemented in the experimental (xnls) system. This flavor has the "IN" clause as part of the initial command specification (preceeding the specification of the substitution pairs). The prompting has been improved in the TNLS version of the command. Try this one, you may actually like it. (I tend to like this form the best of all recent flavors). 1a

16826 Distribution

Richard W. Watson, Michael D. Kudlick, Elizabeth K. Michael, Diane S. Kaye, Charles H. Irby, James C. Norton, Marilyn F. Auerbach, Jeanne B. North, Elizabeth K. Michael, James E. (Jim) White, Beauregard A. Hardeman, Kirk E. Kelley, Yet Another Substitute Command

(J16826) 25-MAY-73 15:39; Title: Author(s): Charles F. Dornbush/CFD;
Distribution: /RWW MDK EKM DSK CHI JCN MFA JBN EKM JEW BAH KIRK;
Sub-Collections: SRI-ARC; Clerk: CFD;

Plans for TNLS Courses in June

June 4- 8 1

Local TNLS Course, running every afternoon. 1a

Tea chers: MFA, DVN,MDK 1a1

JCN maybe in Rome the 10th and 11th, little conflict with local course since it is in the afternoon. 1b

June 11-15 2

Course for two or three people in the ARPA office, 2a

Teachers: JCN + DVN+ SRL . 2a1

June 18-25 3

Course All week at BB&N in Cambridge, 3a

Teachers: MFA + DVN . 3a1

June 27 -29 4

Course 28-30th ANTS in Urbana, 4a

Teachers: MFA + MDK . 4a1

16827 Distribution

Michael D. Kudlick, Marilyn F. Auerbach, James C. Norton, Richard W. Watson, Paul Rech, Susan R. Lee, Nancy J. Neigus, Mil E. Jernigan, Jeanne B. North, Plans for TNLS Courses in June

(J16827) 25-MAY-73 17:16; Title: Author(s): Dirk H. Van Nouhuys/DVN;
Distribution: /MDK MFA JCN RWW PR SRL NJN MEJ JBN(for arpa nes);
Sub-Collections: NIC SRI-ARC; Clerk: DVN;
Origin: <VANNOUHUYS>WHOWHERE.NLS;1, 25-MAY-73 09:41 DVN ;

Response to (16823,): Command Language CHanges--User Introduction

Thanks for your comments in (16823,). They are well taken and should be used as we proceed to implement (I assume we will) the changes being contemplated. I'm not at all comfortable with the rush "get it up before we train more users" idea. There is a meeting next week where we must figure out what is the best way to change... and what the changes have to be. Keep pushing. Jim 1

16829 Distribution
James E. (Jim) White, Richard W. Watson, Charles H. Irby, Charles F. Dornbush,

Response to (16823,): Command Language CHanges--User Introduction

(J16829) 25-MAY-73 18:23; Title: Author(s): James C. Norton/JCN;
Distribution: /JEW RWW CHI CFD; Sub-Collections: SRI-ARC; Clerk: JCN;

How to read the Proposal for an NLS Information Retrieval System.

The general response to my proposed Information Retrieval System indicates either everyone is too polite to tell me their feelings or they really have not had time to wade through the lengthy document. If the second is the case, it indicates a lack of understanding in how to read a document with that structure. I apologize for writting a document in a new format proposed by that document without providing a key to understanding the format. I have included a preface describing how to get the information you want out of the file without having to wade through that which is superfluous to you. Also, there is a command syntax change to fit in the new command language proposed by CHI. 1

16831 Distribution
Jean Iseli,

How to read the Proposal for an NLS Information Retrieval System.

(J16831) 27-MAY-73 02:33; Title: Author(s): Kirk E. Kelley/KIRK ;
Distribution: /JI ; Sub-Collections: SRI-ARC; Clerk: KIRK ;

How to read the Proposal for an NLS Information Retrieval System.

This file is located in <Kelley, File, 0:wny>

How to read the Proposal for an NLS Information Retrieval System.

The general response to my proposed Information Retrieval System indicates either everyone is too polite to tell me their feelings or they really have not had time to wade through the lengthy document. If the second is the case, it indicates a lack of understanding in how to read a document with that structure. I apologize for writting a document in a new format proposed by that document without providing a key to understanding the format. I have included a preface describing how to get the information you want out of the file without having to wade through that which is superfluous to you. Also, there is a command syntax change to fit in the new command language proposed by CHI. 1

16833 Distribution
Jean Iseli,

How to read the Proposal for an NLS Information Retrieval System.

(J16833) 28-MAY-73 11:57; Title: Author(s): Kirk E. Kelley/KIRK ;
Distribution: /JI ; Sub-Collections: SRI-ARC; Clerk: KIRK ;

RLL 28-MAY-73 13:08 16834

just some notes

1. in response to your journal item (16461,) of 16 May 1973: 1

All is well and understood re 1a

goto identification submode 1a1

goto exec command 1a2

subsystems like readmail 1a3

undelivered mail 1a4

the sndmsg mail was eventually delivered to Bob Thomas. the BBN computer was down for several days when i originally sent the message. 1a4a

sendprint operation except 1a5

the line control seems off. any suggestions? 1a5a

your guess at .2e4a was right. 1a6

I would like the capability to print say, the 3rd and 4th level of plex . for example, consider the following plex 1a6a

.1
.1a .1a1 .1a1a .1a1b
.1a2 .1a2a .1a2b .1a3 .1a3a .1a4 .1b .1b1 .1b1a
.1b1b 1a6a1

I would like to print statements .1a1 .1a2 .1a3 .1a4 only. that is the 3rd level relative to .1 or 2nd level relative to .1a or 1st level relative to .1a1 . perhaps one could also specify several mid levels to be printed in a manner similar to the 'b' viewspec. 1a6b

the phantom file most probably WAS due to exiting nls via a control c. this explains a lot - thanks. 1a7

2. Concerning the undelevered journal mail: 2

perhaps your (16461,) was not put into my rll.nls file because i had no (journal) branch at that time. I have since put such a branch. 2a

Obviously I found your journal mail. I looked at your file jcn.nls and journal author branch. 2b

Are there any other branches that I should include in my rll.nls file? Not sure which ones in your file were just for convenience and which were necessary. 2c

** Regarding the trouble I had getting into SRI-ARC on Friday and Saturday night 25 and 26 May 1973 : 3

On both occasions I was at home using the T I silent 700 terminal with uppercase only. After the usual @log 2, logger, and r t open a bell rang. No header information was printed(ie. tenex .....sri-arc...)and no character was accepted (i tried all the letters and numbers as well as control a, b , c, ...z. Each gave a bell with no echoing of character. Tried several times on both nights. Went into BBN facility to look at host stats. SRI was up. Went back to sri-arc. still no luck. Tried log 66 (SRI-AI) and no problems, Tried Utah and USC(Saturday night only and sent you a message),all with no problems. Finally got into sri-arc did my work and signed off. Just for kicks tried immediately to get back after tr close and same bell problem. Found no dificulty today, Sunday 27 May. Will be on tonight(sunday) and if get same probem will sendmsg via USC.. 3a

*** some comments on the new prompts 4

The prompt 'l:' for viewspecs and leveladj should be changed to put a space before the 'l'' or 'v' . now we have the following '.4v: ' to mean address .4 and prompt 'v:' 4a

***just learned from jean iseli of mitre that the problem I was having with the bell after the t r open was a tenex exec one and it has been fixed. 5

***also 27-MAY-73 21:27 I am having trouble with spurious control x's in nls and rubouts in exec level. jean thinks it is my t i terminaal coupler. the problem however seems to have cleared up in the last 5 minutes. Have you experienced anything like this before? 6

$ $ 27-MAY-73 21:32 I recall that there are two idents for communicating bugs and suggestions. Am i right that 'bugs' is one and 'np' the other? Exactly what kind of stuff does one send 'np' and is ther any format for either? Do you want me to continue to send you suggestions and bugs or just use the special idents? 7

16834 Distribution
James C. Norton,

just some notes

(J16834) 28-MAY-73 13:08; Title: Author(s): Robert N. Lieberman/RLL;
Distribution: /JCN; Sub-Collections: NIC; Clerk: RLL;

Network Monitor Woes

The problem again being experienced with the Net (i.e., getting bells after connection) is (in reponse to Jim Norton's question) unrelated to TIPs, since the same results are achieved with TELNET. 1

We saw this problem with 1.29, 1.31 ran clean for a long time, now the problem crops up again. The situation cannot, to my knowledge, be reproduced at will. Fairly hard to find therefore. 2

I have no handle on the problem whatsoever; talked to BBN about it many moons ago -- no concrete help there. BBN doesn't experience this problem; never has as far as I know. 3

IT'S UNFATHOMABLE TO ME THAT BASIC, NET-RELATED MONITOR CODE DOESN'T FLY BY NOW (AFTER HOW MANY YEARS)? VIRTUALLY IMPOSSIBLE TO DO DEVELOPMENT WITHOUT SOME HOPE OF DISMISSING THIS KIND OF NONSENSE. 4

Will collaborate with Smokey to pursue this thing next time it's spotted (no doubt it won't be long). May require stopping the system. 5

Jim White
Please forgive the frustration. 5a

16836 Distribution
James C. Norton, Donald C. (Smokey) Wallace, Kenneth E. (Ken) Victor, Richard W. Watson, Michael D. Kudlick,

Network Monitor Woes

(J16836) 29-MAY-73 00:01; Title: Author(s): James E. (Jim) White/JEW; Distribution: /JCN DCW KEV RWW MDK; Sub-Collections: SRI-ARC; Clerk: JEW;
Origin: <WHITE>MADMSG.NLS;3, 28-MAY-73 23:58 JEW ;

Superwatch Graphs for Week of 5/21/73

TIME PLOT OF AVERAGE NUMBER OF GO JOBS FOR THE WEEK OF 5/21/73
x axis labeled in units of hr:min, x unit =1800 sec. 1

```
6.3
5.6
4.9                        *
4.2                     *  **
3.5                   * *****
2.8                  ********** ***
2.1                  ****************        ****
1.4                 *****************   **   *******
0.7                **********************************
0.0 *************************************************
    +'''''''''+'''''''''+'''''''''+'''''''''+''''''''
    0:00      5:00     10:00     15:00     20:00
```

1a

TIME PLOT OF AVERAGE IDLE TIME FOR THE WEEK OF 5/21/73
x axis labeled in units of hr:min, x unit = 1800 sec. 2

```
94.8
86.9     *** **
79.0     ********
71.1     ********  *
63.2    ************
55.3   *************
47.4   **************                      *
39.5   **************                  *   *
31.6   ***************                 **  ***    **
23.7  ****************                **** ***** * ***
15.8 ******************         * * * ***************
 7.9 ******************** **  ************************
 0.0 *************************************************
     +'''''''''+'''''''''+'''''''''+'''''''''+''''''''
     0:00      5:00     10:00     15:00     20:00
```

2a

Superwatch Graphs for Week of 5/21/73

TIME PLOT OF AVERAGE PER CENT OF CPU TIME CHARGED TO USER ACCOUNTS
FOR WEEK OF 5/21/73
x axis labeled in units of hr:min, x unit = 1800 sec. 3

```
74.4
68.2
62.0                        **
55.8                   * ******  * *    **    *  *  *
49.6                  ********** *****  **   *****  *
43.4                  *****************  ** *********
37.2                 ****************** *** *********
31.0                 ********************************
24.8   *            **********************************
18.6 * *            **********************************
12.4 ****        *************************************
 6.2 ****       **************************************
 0.0 *************************************************
     +'''''''''+'''''''''+'''''''''+'''''''''+''''''''
     0:00      5:00     10:00     15:00     20:00
```

3a

TIME PLOT OF AVERAGE NUMBER OF NETWORK USERS FOR THE WEEK OF 5/21/73
x axis labeled in units of hr:min, x unit = 1800 sec. 4

```
9                        *
8                  *     *
7                ***    ***
6                ***   ******
5              ******  *******
4             ****************
3             ******************
2            *********************    *    ****  *
1   *****   **************************************
0 *************************************************
  +'''''''''+'''''''''+'''''''''+'''''''''+''''''''
  0:00      5:00     10:00     15:00     20:00
```

4a

Superwatch Graphs for Week of 5/21/73

TIME PLOT OF AVERAGE PER CENT OF SYSTEM USED IN DNLS FOR WEEK OF 5/21/73
x axis labeled in units of hr:min, x unit = 1800 sec. 5

```
12.6                  * *       * **
11.2                  ****      * **
 9.8                  ****  **  ****
 8.4                  ***** ********
 7.0                  ****************
 5.6                  ****************  *     *  *
 4.2                 ****************** *  ** ****
 2.8                 *****************************
 1.4  **             **********************************
 0.0 ************************************************
     +'''''''''+'''''''''+'''''''''+'''''''''+'''''''
     0:00      5:00     10:00     15:00     20:00                5a
```

TIME PLOT OF AVERAGE NUMBER OF USERS FOR THE WEEK OF 5/21/73
x axis labeled in units of hr:min, x unit = 1800 sec. 6

```
16                       **
15                  *    **
14                  ** *****
13                  ********  ******
12                  ******** *******
11                  ****************
10                  ****************
 9                 *****************
 8                 ******************
 7                 ******************
 6                ********************
 5               ***********************    *******
 4              ************************** ********
 3             ************************************
 2   ****     **************************************
 1 *******    **************************************
 0 *************************************************
   +'''''''''+'''''''''+'''''''''+'''''''''+''''''''
   0:00      5:00     10:00     15:00     20:00                  6a
```

16837 Distribution

James C. Norton, Richard W. Watson, Douglas C. Engelbart, Paul Rech, Donald C. (Smokey) Wallace, Jeffrey C. Peters, Dirk H. Van Nouhuys, Elizabeth J. (Jake) Feinler, Charles F. Dornbush, Kirk E. Kelley, Duane L. Stone,

Superwatch Graphs for Week of 5/21/73

(J16837) 29-MAY-73 10:19; Title: Author(s): Susan R. Lee/SRL;
Distribution: /JCN RWW DCE PR DCW JCP DVN JAKE CFD KIRK DLS;
Sub-Collections: SRI-ARC; Clerk: SRL;
Origin: <LEE>WEEK5/21GRAPHS.NLS;2, 29-MAY-73 10:15 SRL ;