Request for Assistance in Evaluating the New Command Language

Everyone please read this.

Request for Assistance in Evaluating the New Command Language

The new command language will be in use by everyone at ARC within the next few weeks. As one part of an analysis of the new language, we would like to collect initial reactions, problems, likes, dislikes, and generally any comment that comes to mind, no matter how trivial.   1

Our hope is that this will: 2

    1) Give us a basis for analyzing the user's reactions and therefore the effectiveness of the new language, and   2a

    2) Prepare Operations for the kinds of problems to expect when the new language comes up on the utility.   2b

In order to make this process as simple as possible we are suggesting the following ways of conveying your reactions: 3

    1) Sndmsg to LEE, or   3a

    2) Send journal message to ident - NEWNLS, or   3b

    3) Jot your comments on paper as you work and leave in my in-box, or   3c

    4) Any other method which is convenient for you.   3d

Several people have already begun using the new language and more will probably begin to use it before it becomes generally available. For this reason comments are welcome at any time.   4

The two existing journal idents, BUGS and NP will still be available, but to avoid duplication and confusion between features and bugs all problems related to the new command language should be reported via NEWNLS until further notice. Kirk and I will review incoming comments and distribute them to the appropriate places.   5

Comments sent via NEWNLS in the journal will arrive in <analysis>nnls and comments received by other means will be recorded in that file also. Anyone who is curious to see what is being reported can read that file.   6

If there are any questions about this project, please see me.   7

20637 Distribution
   Donald C. (Smokey) Wallace, Richard W. Watson, Don I. Andrews,
   James H. Bair, A. Jim Blum, Meredith(Reddy) E. Dively, Jeanne M.
   Leavitt, Rodney A. Bondurant, Jeanne M. Beck, Mark Alexander Beach,
   Judy D. Cooke, Marcia Lynn Keeney, Carol B. Guilbault, Susan R. Lee,
   Elizabeth K. Michael, Charles F. Dornbush, Elizabeth J. (Jake)
   Feinler, Kirk E. Kelley, N. Dean Meyer, James E. [Jim] White, Diane
   S. Kaye, Paul Rech, Michael D. Kudlick, Ferg R. Ferguson, 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, Jeffrey C. Peters, Jake Ratliff, Edwin K. Van De
   Riet, Dirk H. Van Nouhuys, Kenneth E. (Ken) Victor

1

Request for Assistance in Evaluating the New Command Language

(J20637) 29-NOV-73 14:39;   Title: Author(s): Susan R. Lee/SRL;
Distribution: /SRI-ARC; Sub-Collections: SRI-ARC; Clerk: SRL;
Origin: <LEE>CLANG.NLS;4, 29-NOV-73 13:05 SRL ;

Analysis of the response to the Utility

Response to -- IJOURNAL, 20173, 1:w) "What is Analysis Going to do
about the Utility?" SRL 12-NOV-73

   Some discussion ensued, however, it was not productive. We are at
the point, however, that some discussions are necessary about (1) the
kinds of instruments that should be employed and thce time frame
given a whole range of contingencies, (2) what level of interaction
should be persued between analysis people and utility staff, (3) the
manpower resources that are available and (4) tha constituency of the
population.
I think that it is imperative we meet to discuss thase questions. If
there are no responses to this, I will assume agreemant and will set
up a meeting next week.   1

20638 Distribution
   James C. Norton, Susan R. Lee, Paul Rech, Dirk H. Van Nouhuys,
   Richard W. Watson,

Analysis of the response to the Utility

(J20638)   29-NOV-73 14:47;   Title: Author(s): James H. Bair/JHB;
Distribution: /JCN SRL PR DVN RWW(info); Sub-Collections: SRI-ARC;
Clerk: JHB;

oldmail at isi

mark,
when are you going to clean up your old and
new mail at isi?

john   1

20639 Distribution
    Mark C. Krilanovich,

oldmail at isi

(J20639)   29-NOV-73 15:06;   Title: Author(s): John R. Pickens/JRP;
Distribution: /MCK; Sub-Collections: NIC; Clerk: JRP;

Passing Problems with SENDPRINT

Steve,
I don't know anything about SENDPRINT, so I have sent this message to
Smokey Wallace (DCW) who recently modified it, and Jim Bair (JHB) who
also knows a little about it. Your journal item (IJOURNAL, 20594,)
pointed out some very difficult problems that I have never
experienced because I have never used SENDPRINT. I hope one of these
people can help you.   1

Passing Problems with SENDPRINT

(J20640)   29-NOV-73 15:13;   Title: Author(s): Kirk E. Kelley/KIRK;
Distribution: /SRW DCW JHB; Sub-Collections: SRI-ARC; Clerk: KIRK;

-------   1

Date: 29-NOV-73 1713-PST   2

From: NORTON at SRI-ARC   3

Re: ARPA and the Allocation Bug   4

cc: perry at USC-ISI, arpa, norton   5

- - - -   6

John: It now appears that the bug is gone..but I want to know if you
gents don't think so. We found an obscure problem..etc etc as these
situations always seem to end. I have just finished having 4 arpa
jobs logged in   and with no activity for 20 minutes...not moved to
offquota and not logged off..in a heavy load period..soooooo I think
it's ok.   Let me know if not   Jim   7

-------   8

                                                                          9

20641 Distribution
James C. Norton,

(J20641) 30-NOV-73 00:46;   Title: Author(s): James C. Norton/JCN ;
Distribution: /JCN ; Sub-Collections: SRI-ARC; Clerk: JCN;

NOV 18-24, 1973: A WEEK IN REVIEW

WEEKLY ANALYSIS REPORT: 1

                                                                            2

WEEK: NOV 18 - 24, 1973 (24 HOURS/DAY)   3

                                                                            4

TOTAL SYSTEM CPU: 49.676   5

                                                                            6

(ARC)	CPU HRS	CON HRS	CPU/CON	% SYS	CON/CPU:1	
						6a
						6a1
(DOC)						6a2
(JMB)	.643	19.195	.033	1.294	29.852	6a2a
(NDM)	.793	23.972	.033	1.596	30.230	6a2b
CAT	3.189	4.553	.700	6.420	1.428	6a2c
DOCB	-	-	-	-	-	6a2d
DOCUM	.201	12.373	.016	.405	61.557	6a2e
	-----	-----		-----		6a2f
TOTAL	4.826	60.093	.080	9.715		6a2g
						6a2h
(FAC)						6a3
(RAB)	-	-	-	-	-	6a3a
(MEH)	.668	17.694	.038	1.345	26.488	6a3b
(JCP)	1.752	30.423	.058	3.527	17.365	6a3c
(JR)	-	-	-	-	-	6a3d
(EKV)	-	-	-	-	-	6a3e
OPRATR	1.950	34.003	.057	3.925	17.437	5a3f
	-----	-----		-----		6a3g

TOTAL	4.370	82.120	.053	8.797		6a3h
						6a3i
(NIC)						6a4
(JDC)	.096	3.293	.029	.193	34.302	6a4a
(EJF)	.459	14.903	.031	.924	32.468	6a4b
(CBG)	.002	.039	.051	.004	19.500	6a4c
(MDK)	.437	9.009	.049	.880	20.616	6a4d
(MLK)	.114	5.613	.020	.229	49.237	6a4e
(JBN)	.374	19.877	.019	.753	53.147	6a4f
NETINFO	-	-	-	-	-	6a4g
NIC-WORK	-	-	-	-	-	6a4h
	-----	-----		-----		6a4i
TOTAL	1.482	52.734	.028	2.983		6a4j
						6a4k
(PRO)						6a5
(DIA)	.126	6.194	.020	.254	49.159	6a5a
(CFD)	2.072	40.086	.052	4.171	19.347	6a5b
(WRF)	.428	28.109	.015	.862	65.675	6a5c
(JDH)	.137	6.777	.020	.276	49.467	6a5d
(CHI)	.717	14.296	.050	1.443	19.939	6a5e
(DSK)	.166	5.008	.033	.334	30.169	6a5f
(HGL)	.894	17.844	.050	1.800	19.960	6a5g
(EKM)	1.049	34.002	.031	2.112	32.414	6a5h
(KEV)	1.905	34.038	.056	3.835	17.868	6a5i
(DCW)	.672	17.138	.039	1.353	25.503	6a5j

(JEW)	1.018	18.964	.054	2.049	18.629	6a5k
	-----	-----		-----		6a5l
TOTAL	9.184	222.456	.041	18.489		6a5m
						6a5n
(PSO)						6a6
(JML)	.069	4.341	.016	.139	62.913	6a6a
(BAH)	.974	18.838	.052	1.961	19.341	6a6b
(MEJ)	1.446	113.461	.013	2.911	78.465	6a6c
(KIR)	1.193	38.398	.031	2.402	32.186	6a6d
	-----	-----		-----		6a6e
TOTAL	3.682	175.038	.021	7.413		6a6f
						6a6g
(STA)						6a7
(JRB)	.028	.871	.032	.056	31.107	6a7a
(DCE)	.117	6.148	.019	.236	52.547	6a7b
(SRL)	.111	3.251	.034	.223	29.288	6a7c
(JCN)	.093	3.532	.026	.187	37.973	6a7d
(DVN)	.691	18.943	.036	1.391	27.414	6a7e
(PR)	.221	8.622	.026	.445	39.014	6a7f
(RWW)	.352	12.061	.029	.709	34.264	6a7g
	-----	-----		-----		6a7h
TOTAL	1.613	53.428	.030	3.247		6a7i
						6a7j

(GROUP) TOTALS   6a8

GROUP   CPU HRS   CON HRS   CPU/CON   % SYS   6a8a

6a8b

(DOC)	4.826	60.093	.080	9.715	6a8c
(FAC)	4.370	82.120	.053	8.797	6a8d
(NIC)	1.482	52.734	.028	2.983	6a8e
(PRO)	9.184	222.456	.041	18.489	6a8f
(PSO)	3.682	175.038	.021	7.413	6a8g
(STA)	1.613	53.428	.030	3.247	6a8h
	-----	-----		-----	6a8i
TOTAL	25.157	645.869	.039	50.644	6a8j

6a8k

(STATS)   6a9

HIGHEST CPU: CFD 2.072 hrs   LOWEST CPU: JHB   .028
hrs   6a9a

HIGHEST CON: MEJ113.461 hrs   LOWEST CON: SRL   3.251
hrs   6a9b

HIGHEST CPU/CON: JCP   .058   HIGHEST CON/CPU:1: MEJ
78.465   6a9c

6a9d

	CPU HRS	CON HRS	CPU/CON	% SYS	CON/CPU:1	
						6b
(NET)						6c
						6c1
TOTAL	9.621	348.859	.028	19.368	36.260	6c2
						6c3
TOP FIVE						6c4
--------						6c5
GUEST	3.376	74.253	.045	6.796	21.994	6c6

MITRE-TIP	.947	62.987	.015	1.906	66.512	6c7
UCSB	.801	22.448	.036	1.512	28.025	6c8
UK-ICS	.726	26.842	.027	1.451	36.972	6c9
UCLA-NMC	.714	17.540	.041	1.437	24.566	6c10
	-----	-----		-----		6c11
TOTAL	6.564	204.070	.032	13.212		6c12
						6c13
(SYS)						6d
SYSTEM	6.546	323.388	.020	13.178	50.000	6d1
PRINTER	4.473	216.447	.021	9.004	48.390	6d2
BACKGROUND	1.588	108.213	.015	3.197	68.144	6d3
	-----	-----		-----		6d4
TOTAL	12.607	648.048	.019	25.379		6d5
(WOR)						6e
						6e1
ENERGY	.003	.084	.036	.006	28.000	6e2
GILBERT	-	-	-	-	-	6e3
JIMB	.008	.495	.016	.016	61.875	6e4
MARRAH	-	-	-	-	-	6e5
	-----	-----		-----		6e6
TOTAL	.011	.579	.019	.022		6e7
						6e8
(XOX)						6f
						6f1
DEUTSCH	.007	.093	.075	.014	13.286	6f2

NOV 18-24, 1973: A WEEK IN REVIEW

MITCHELL	.027	1.111	.024	.054	41.148	6f3
SATTERTHWAITE	.112	6.471	.017	.225	57.777	6f4
	-----	-----		-----		6f5
TOTAL	.146	7.675	.019	.293		6f6
						6f7

(RAD)   6g

                                                                       6g1

NAME	CPU HRS	CON HRS	CPU/CON	% SYS	CON/CPU:1	DIR	
							6g2
							6g3
BERGS	.226	9.652	.023	.455	42.708	45	6g4
CARRIER	.219	11.885	.018	.441	54.269	25	6g5
CAVAN	.044	1.866	.024	.089	42.409	126	6g6
DAUGHTRY	.022	.718	.031	.044	32.636	76	6g7
IUORN	.115	6.046	.019	.232	52.574	39	6g8
KENNE	.364	11.842	.031	.733	32.533	73	6g9
LAFORGE	.008	.495	.016	.016	61.875	17	6g10
LANON	.082	4.937	.017	.165	50.207	89	6g11
LAWRE	.277	7.336	.038	.558	26.484	78	6g12
LIUZZI	.082	4.371	.019	.165	53.305	16	6g13
MCNAM	.008	.593	.013	.016	74.125	121	6g14
PANAR	.101	5.111	.020	.203	50.604	140	6g15
RADC	.007	.180	.039	.014	25.714	79	6g16
RZEPK	.159	10.207	.016	.320	64.195	116	6g17
STONE	.329	13.989	.024	.662	42.520	243	6g18
THAYE	.024	.429	.056	.048	17.875	51	6g19

TOMAI	.065	2.557	.025	.131	39.338	29	6g20
	-----	-----		-----		-----	6g21
TOTAL	2.132	92.214	.023	4.292		1363.000	6g22
(PER CENT TOTAL DISK CAPACITY)						2.805%	6g23
							6g24

7

20642 Distribution

Susan R. Lee, Beauregard A. Hardeman, Douglas C. Engelbart, Don I. Andrews, Charles F. Dornbush, Elizabeth J. (Jake) Feinler, Martin E. Hardy, J. D. Hopper, Charles H. Irby, Mil E. Jernigan, Diane S. Kaye, Kirk E. Kelley, Michael D. Kudlick, Elizabeth K. Michael, Jeanne B. North, James C. Norton, Jeffrey C. Peters, Paul Rech, Dirk H. Van Nouhuys, Kenneth E. (Ken) Victor, Donald C. (Smokey) Wallace, Richard W. Watson, James E. (Jim) White, Duane L. Stone, Thomas F. Lawrence, James H. Bair, L. Peter Deutsch, James G. Mitchell,

1

NOV 18-24, 1973: A WEEK IN REVIEW

(J20642) 29-NOV-73 20:53; Title: Author(s): Beauregard A.
Hardeman/BAH; Distribution: /WAR; Sub-Collections: SRI-ARC WAR; Clerk:
BAH;

Summary and Comments on IR Proposal..INSTANT

This is my "instant" analysis of the INSTANT system proposed by IR in
response to Gabelman's request for a AFSC MIS.   1

SUMMARY: 2

The first 11 pages essentially say that better management of AFSC
resources is a must..particularily management of people, which
they consider to be the most important resource. It enunerates
many of the technical goodies that are state-of-the-art, and
suggests that they are minimal risk items. The combination of
these hardware and software components into a system, is
considered a more risky proposition and they believe it should be
modeled first. They mention the security problem briefly, but
offer no soloution.   2a

The next 9 pages cover the modeling of the terminal,
communications, hardware and data base aspects of the system.
Data on the information needs of AFSC managers and its flow
(direction and magnitude) would be collected and input to a model,
to determine the "best"..least cost..way of meeting the needs.   2b

The next 4 pages are the proposal. It is essentially to
interconnect key management offices within the intelligence
community of AFSC. Hq AFSC, ESD, ASD, and RADC; along with links
to TAC, SAC, and XXX.   2c

The next page covers the benifits of the INSTANT system, but in no
detail.   2d

The next 3 pages are graphs of the transmit time vs the volume
transmitted, for diferent types of data.   2e

COMMENTS: 3

The proposal lacks any substantive content. There are many
"motherhood" statements, and a lot of filler which says nothing.
It is clearly a Xerox-cut-and-paste operation, which leaves one
with the impression that little thought was given to the content,
its organization or flow.   3a

The proposal implies that the productivity of the RDT&E personnel
can best be increaed by managing them better. No thought is given
to directly helping the working level individual.   3b

The proposal centers around the modeling capability; to the extent
that one is left with the impression that IR has a model, and are
seeking to apply it somewhere. Maybe this is an offshoot of the
Informatics model that they once tried to sell to the Dept. of
Agriculture.   3c

The proposal assumes that the information needs and flow can be
discovered in sufficient detail to allow modeling of the entire
system. There is no provision for unstructured information, nor
is mention made of how the data is going to get into the system.   3d

The proposal mentions the secuity problem, says there is no really
acceptable soloution to it, and then proceeds to recommend Phase I
implementation within the intelligence community...a group loaded
with security hangups.   3e

The proposal indicates that the INSTANT system would pay for
itself by "reducing AFSC overhead costs", but the origins of these
reductions are not made clear.   3f

The table of contents promises a section on costs, but there was
no indication in the copy I had of the manpower, dollar, time or
facility resources necessary to bring INSTANT into being.   3g

20645 Distribution
Frank J. Tomaini, John L. McNamara, Roberta J. Carrier, Richard H.
Thayer, Edmund J. Kennedy, Roger B. Panara, Joe P. Cavano, David L.
Daughtry,

(J20645) 30-NOV-73 06:16;   Title: Author(s): Duane L. Stone/DLS;
Distribution: /FJT JLM RJC RHT2 EJK RBP JPC DLD2; Sub-Collections: RADC;
Clerk: DLS;
Origin: <STONE>INSTANT.NLS;1, 30-NOV-73 06:11 DLS ;

DAUGHTRY's Directory....RADC

Jim I talked to you here earlier about my initials file. The problem
is   two-fold. First, I lost all the information in Bethke's old
file and I need it for guidance in some work I was doing (I refer to
bethke's initials file)...Secondly, since creation of the directory
in my name I   have not recieved any JOURNAK mail at all. AKW
experts here think that I may not be in the RADC group. Please fix
the two problems for me as soon as you can. Thanks ... Dave Daughtry   1

20646 Distribution
    James H. Bair, David L. Daughtry,

DAUGHTRY's Directory....RADC

(J20646)   30-NOV-73 06:54;   Title: Author(s): David L. Daughtry/DLD2;
Distribution: /JHB DLD2; Sub-Collections: NIC; Clerk: DLD2;

DAUGHTRY's directory

I have been given a directory in my name. Kindly send messages and
journal maail to me using initials "DLD2. For some reason I have not
gotten any journal since creation of the direectory. If i have not
responded to requests then now you have the reason. I askked Jim
Bair to fix the problem. Dave Daughtry   1

20647 Distribution

Larry M. Lombardo, Anna A. Cafarelli, Roberta J. Carrier, Donna R. Robilotta, David L. Daughtry, Richard H. Thayer, Frank J. Tomaini, Mike A. Wingfield, Edmund J. Kennedy, Ray A. Liuzzi, John W. Johnson, Donald Van Alstine, Dean F. Bergstrom, William P. Bethke, Frank S. LaMonica, William E. Rzepka, Rocco F. Iuorno, Frank P. Sliwa, Thomas J. Bucciero, Robert E. Doane, David A. Luther, Roger B. Panara, John L. McNamara, Joe P. Cavano, Duane L. Stone, Marcelle D. Petell, Josephine R. Stellato, Robert K. Walker, Thomas F. Lawrence, James H. Bair,

DAUGHTRY's directory

(J20647)   30-NOV-73 06:59;   Title: Author(s): David L. Daughtry/DLD2;
Distribution: /RADC; Sub-Collections: NIC RADC; Clerk: DLD2;

PLEASE SEND US A COPY OF THE NEW TNLS USERS' GUIDE. 1

20648 Distribution
    Marcia Lynn Keeney,

NEW TNLS USERS' GUIDE

(J20648)   30-NOV-73 06:59;   Title: Author(s): Laura E. Gould/LEG;
Distribution: /MLK; Sub-Collections: NIC; Clerk: LEG;

memo to LHD

10:15 Fri.-from PF to Larry Day-   I spoke to Mr. Spitz (the guy
from France) and he would like to talk about teleconferencing with
you , Mike and me. I'll try to arrange for a demo. of conf. TV but we
will spend most of the time talking about comp. and TV conferencing,
in general. He comes in from Toronto at 12 noon so he'll be arriving
at Belmont at 12:30 or so and we'll go out to lunch and then return
to a conference room here. Please confirm whether you will be
available from 1200 hrs to 1700 hrs on Wed. Dec. 5.   1

20649 Distribution
    Lawrence H. Day,

memo to LHD

(J20649)   30-NOV-73 07:29;   Title: Author(s): Michael T.
Bedford/MIKE; Distribution: /LHD; Sub-Collections: NIC; Clerk: MIKE;

database format suggestion

KIRK Duplicate words in the HELP syntax branch.
Where ever the name of a syntax statement is the same as the first
word in the syntax, the name should not be duplicated. The
convention of using "<NULL> <EOL>" delimiters in the SYNTAX branch
should only be for those statements where the first word is not the
same as the name for that statement. In all cases where the first
word in the syntax is also the proper name for that statement, the
delimiters should be "<NULL> <SP>".   1

20650 Distribution
    Jeanne M. Beck,

database format suggestion

(J20650)   30-NOV-73 09:06;   Title: Author(s): Kirk E. Kelley/KIRK;
Distribution: /JMB; Sub-Collections: SRI-ARC; Clerk: KIRK;

Left over compile branch from programs

This function branch has been deleted from programs subsystem. Since
the Set Filter command in editor will replace it, I thought whoever
was doing that command might want to look at this branch. (Actually,
I just hated to delete it.)

Left over compile branch from programs

Content analyzer:
Allows you to specify a Content Analyzer pattern to be compiled and
instituted as the current Content Analyzer filter.   1

   syntax
   ##<syntax compile content: D>##   1a

   example
   ##<Example Compile Content: D>##   1b

   effects
   You may address a pattern in a file, or type it in. If you
   address it, the pattern must begin with the first visible after
   the ADDRESS and is read up to the semi-colon. When this command
   is executed, the pattern specified is compiled into the buffer,
   its name is put on the stack, and it is instituted as the Content
   Analyzer filter. REPEAT and INSERT = Command Accept.   1c

      buffer
      ##<concepts buffer>##   1c1

      programming
      ##<programming>##   1c2

      Content analyzer
      ##<concepts Content>##   1c3

   Compiling
   ##<concepts Compiling>##   1d

20651 Distribution
Jeanne M. Beck, Dirk H. Van Nouhuys,

Left over compile branch from programs

(J20651) 30-NOV-73 09:55;   Title: Author(s): Kirk E. Kelley/KIRK;
Distribution: /JMB DVN; Sub-Collections: SRI-ARC; Clerk: KIRK;

NETWORK MANAGEMENT SURVEY

by

Ira W. Cotton

Institute for Computer Sciences & Technology

National Bureau of Standards

Washington, D. C.   20234

Foreword

This report is one of a series of publications
produced by the Institute for Computer Sciences and
Technology, National Bureau of Standards, under Grant
AG-350 from the National Science Foundation.

This grant supports a broad program of
investigation into the foundations of computer
networking in support of scientific and related
educational efforts.

A listing of completed and planned publications
produced by the Institute under this grant follows:

1. "Primary Issues in User Needs"
   D. W. Fife
   Chapter 10 in <Networks for Research and
Education:
       Sharing of Computer and Information Resources
       Nationwide>
   MIT Press, Cambridge, Massachusetts
   Expected Publication: October 1973

2. "Some Technical Considerations for Improved
       Service to Computer Users"
   T. N. Pyke, Jr.
   COMPCON 1973
   Seventh Annual IEEE Computer Society
       International Conference

3. "Computer Networking Technology - A
       State of the Art Review"
   T. N. Pyke, Jr. and R. P. Blanc
   COMPUTER Magazine
   Computer Society of the IEEE
   August, 1973

4. "Review of Network Management Problems and
Issues"
   A. J. Neumann
   October, 1973
   NBS Technical Note No. 795

5. "Annotated Bibliography of the Literature on
      Resource Sharing Computer Networks"
   R. P. Blanc, I. W. Cotton, T. N. Pyke, Jr.
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Acknowledgements

Network Management Survey

Ira W. Cotton

This report presents some of the results of a study of
management practices in different computer networks.
Five networks were chosen as typical of different
approaches to network implementation and management:
Defense Advanced Research Projects Agency (ARPA)
Network, MERIT Network, Triangle Universities
Computation Center (TUCC), Oregon State Regional
Network and Tymnet, a commercial network. A common
format is employed to survey each network. While the
report is not intended to be prescriptive, some
empirical observations are presented for each topic
covered.

Key Words: Computer network; network;
           network management; management

Introduction

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

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.

   The ARPA network is a large distributed network of
   autonomous, heterogeneous computer systems. It has
   focused on the development of network technology and

resource-sharing techniques, rather than
organizational problems.

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.

TUCC is another regional network, but with
homogeneous computers and a larger number of
participating institutions. TUCC has also given
considerable attention to organizational issues.

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

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).

Information for this report was gathered from primary
and secondary literature sources, from telephone and
on-site interviews, and by iterative review of this
document by representatives of the networks covered.
In some cases the information presented here will
already be out of date by the time this report is
published, so rapidly are these networks developing.

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 surveys 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.

Some comments are probably in order regarding the use
of the term "successful" with reference to the networks

surveyed.   In the author's view, success is measured by
the satisfaction and acceptance of the network and its
facilities by its users.   This should translate to the
continued existence of the network, and in most cases
to growth.   Used in this sense, the term transcends
mere technical accomplishments.   A network which
performs adequately in the technical sense but which
fails to satisfy user needs can not be considered
successful.

Table 1. Organization of Each Survey

I. Introduction

II. Network Identification and General Description
    A. Sponsoring Organization
    B. Purpose/mission of Network
    C. Status and Topology
    D. Technology Summary
    E. Future Plans

III. Network Organization
    A. Structure and Extent
    B. Functions Performed
       1. Planning
       2. Installation
       3. Operations
       4. User Services
    C. Interfaces (relationships with other
    organizations)

IV. Financial and Legal Concerns
    A. Capitalization
    B. Accounting
    C. Regulation
    D. Security

V. Conclusions
    A. Summary of Problems
    B. Lessons Learned

Annexes
    A. Bibliography
    B. Special Vocabulary

I. Introduction

The ARPA Network is characteristic of large
decentralized networks of autonomous computer
systems. Its continued 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.

II. Network Identification and General Description

A. Sponsoring Organization

The network is sponsored by the Defense Advanced
Research Projects Agency (ARPA), an agency of
the Department of Defense concerned with
research and development in areas of advanced
technology.

B. Purpose/mission of Network

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

The network currently supports many
ARPA-sponsored research programs by providing
access to resources not available locally.

C. Status and Topology

The network has been operational since mid-1971.
Figures 1 and 2 illustrate respectively the
recent geography and topology of the network .
The network currently includes over 30 sites
with over 40 independent computer systems
connected.

Reliability of the various network components
varies widely. Currently the communications
subnet of Interface Message Processors (IMPs)
and circuits has extremely high reliability,
with only occasional outages for particular IMPs
or circuits. Since most nodes are connected to
at least two other nodes, the outage of a single
circuit does not disturb network operation. The

service sites are generally less reliable than
the subnet, although the statistics vary widely
from site to site.

D. Technology Summary

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 neighboring IMPs by
means of dedicated 50kb communications 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 may
follow different routes. The destination IMP
will reassemble the message and deliver it to
the proper host.

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.

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.

E. Future Plans

The ARPA network continues to grow at a rate of
about one site per month. It has been extended
into Hawaii and Europe via satellite links.
Network traffic has been growing at an
exponential rate for some time. The main
technical work includes redesign of the present
IMPs, development of mini-computer front ends to
IMPs for remote job entry and private line
interfaces, and the continued refinement of the
protocols. Organizationally, the network is
turning its attention to improving
resource-sharing facilities.

III. Network Organization

A. Structure and Extent

Figure 3 illustrates the present organizational
structure for the network.

The Advanced Research Projects Agency (ARPA) of
the Department of Defense initially conceived
and funded the network, and presently directs
its operation through the Information Processing
Techniques Directorate. ARPA is not a large
agency, serving primarily as a granting agency,
and only several people spend their full time on
network activities.

ARPA has turned 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 services and as
the central liaison point for the Defense
Commercial Communications Office and the common
carriers (see below, III-B-1), Bolt Beranek and
Newman, Network Analysis Corporation, and
prospective new users.

Bolt Beranek and Newman (BBN) of Cambridge,
Massachusetts, 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, through RML, 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.

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 the IMPs and TIPs, and are responsible for
maintenance.

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

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

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. 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. 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. The NIC staff will remain
at SRI, as will the responsibility for further
developments in these areas.

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.

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

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. Each site has a Technical 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.

The "network facilitators" were an informal
commitee of experienced users who proselytized
and attempted to solve network problems for
users. This group was in existence for about a
year, after which it disappeared. The
performance of this type of function has since
been delegated to a group at the Mitre
Corporation under contract to ARPA. Mitre

publishes a network newsletter, responds to user
inquiries and provides various kinds of
assistance.

Other groups that are in a sense "network
facilitators" are these special and general
interest groups:

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

B. Functions Performed

1. Planning

Network growth is controlled by the
sponsoring agency, ARPA. However, Karp
(1973) indicates that the first 15 sites were
ARPA research facilities selected for their
expertise in software and system design
rather than for the computer resources they
could provide. Subsequent sites have
provided both additional resources and users
of these resources. There does not appear to
be any fixed or published policy for
determining what sites are to be added.
Network growth is presently limited by the
rate at which Honeywell and BBN can supply
IMPs (about 1 per month).

When a new site is selected, 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.

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 through
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.

2. Installation

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 (NCP). 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.

Bolt Beranek and Newman coordinates 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.

3. Operations

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 comunications
circuits.

For diagnostic and control purposes, BBN
operates a special host system in Cambridge,
Massachusetts, 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.

The maintenance function, which may involve
several organizations including the Bell
System, Honeywell, BBN and the local host,
appears complicated, but is handled
efficiently't. The Network Control Center is
very effective in diagnosing failures and
coordinating maintenance among the various
groups involved.

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.

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.

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. However,
these problems are recognized and new and
improved protocols are being constructed and
tested by various contractors.

4. User Services

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.

The Network Facilitators Group was an
informal committee of experienced personnel
at various sites around the country who
organized to promote network utilization.
This informal group has since been replaced
by a group at the Mitre Corporation who have
an ARPA contract to assist network users.

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.

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 helped at selected
user sites, but because of the informality of
their organization and because they were not
located at all sites they were not a general
solution. Mitre has been at work on their
user assistance task for too brief a period
to be evaluated. The NIC has not provided a
general solution to the documentation
problem, since they do not attempt to
distribute all the documentation needed to
run at a particular site nor to enforce any
documentation standards.

C. Interfaces (relationships with other
organizations)

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
ARPA network is presently functioning as a
marketplace for the sale of computer time to the
network community.

ARPA has indicated on several occasions that it
does not intend to operate the network
indefinitely and has already turned over daily
operation to another governmental organization
(RML). Various options for converting the
network to commercial operation have been
considered, but none have been considered
feasible. It remains to be seen what the future
of the network will be.

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 and 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).

Finally, ARPA does seem interested in

investigating the means and the difficulties of
connecting to other networks. Many members of
the ARPANET community participate in the
International Network Working Group, originally
an ARPA-sponsored initiative which is now a
working group under IFIP with international
participation. The purpose of the group is to
develop inter-network protocols and to mount
some international experiments.

IV. Financial and Legal Concerns

A. Capitalization

The network was funded by ARPA, so
capitalization is provided through research
grants. 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 many of
the newer sites are users who are paying for
their own.

B. Accounting

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.

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 recognized to be less than
satisfactory, and a committee of principal
investigators is currently trying to develop a
network-wide accounting scheme.

C. Regulation

No commercial users or non-research commercial
servers are currently permitted on the network.
As a research activity sponsored by the
Department of Defense, the network is not
subject to regulation by other government
agencies (e.g., the FCC).

The wideband communications circuits used in the
subnet are leased by ARPA through the Defense
Department at bulk (TELPAK D) rates. These
rates represent considerable economies of scale
for large data communications users.

D. Security

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.
There is no checking on the origin of messages
to insure that they agree with the
identification given in a logon sequence.

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.

V. Conclusions

A. Summary of Problems

Start-up Requirements - Fabrication of the IMP
interface and coding of the Network Control
Program have been major obstacles to new hosts
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 researcher to user. However, a mitigating
factor may be the inventory of interfaces and
NCPs which have already been constructed.

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
published figures are derived from loading
factors which have never been realized (although
traffic has been growing at an exponential
rate). 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 with a view to
reducing overhead.

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.

Heterogeneity - While some facilities (such as
TELNET, network mail and file transfer protocol)
have been provided to permit common operation on
hosts of different types, the problem has not
been solved in general. Executive level
commands are all different for different
machines, text editors are different, log-on
procedures are different, etc. This is a
difficulty which networks have only exacerbated
by making additional systems available to
potential users.

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 leaves room for improvement.

Protocols - Lack of particular protocols such as
graphics and remote job entry has cut off
potential usage in some cases. This problem
will be resolved as these protocols become
better developed and are made generally
available.

B. Lessons Learned

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. Large numbers
of users depend on the network now for their
day-to-day work. 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.

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

The network seems also to have been most useful in
offering services when the differences between host
systems have been bridged automaticaly by the
network. For example, perhaps the most successful
service has been the TELNET, which has permitted a
wide range of terminals to operate more or less
identically on many different host systems. The
resources for which this type of standardization
has not been performed have been less successful in
attracting wide utilization. Additional work in
this area seems indicated.

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B. Special Vocabulary

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

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.

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

Message - A logical unit of data exchange
between processes.

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

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

I. Introduction

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 have permitted
attention to be focused on the managerial problems
of the network.

II. Network Identification and General Description

A. Sponsoring Organization

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 sponsors
the network.

B. Purpose/mission of Network

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, knowledge about and solutions to the
problems of network operation in an established
educational computing environment.

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.

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

The Michigan State University computer (CDC

6500) is unusually fast and therefore
well-suited to large, compute-bound jobs.

The Wayne State University Computer Center,
using duplex IBM 370/67 hardware running the
MTS timesharing system, has developed a
special competence in administrative data
processing.

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.

C. Status and Topology

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 monthly 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.

D. Technology Summary

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.

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:

   1. Data set interface

   2. Automatic calling unit and multiplexor
   interface

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

   4. CDC 6500 interface (for one host system)

The data set interfaces are designed to transfer
entire messages over the telephone 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.

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.

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 and minimizing the amount of
the host's network support software.

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.

E. Future Plans

The MERIT network continues to serve the three
participating universities. There is
consideration for a remote version of the
communications computer to allow terminals to
access the network directly (without there being
a local host) so as to be able to offer service
to other institutions in the region. Work is
underway to extend the communications computer
software to allow the routing of messages in a
less-than-fully connected network.

III. Network Organization

A. Structure and Extent

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

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.

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

   1. Educational and promotional;

   2. Research and technical development of the
   network; and

   3. Financial administration.

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.

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 essentially 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.

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. At the peak of activities,
approximately the equivalent of 12 full-time
engineers and systems programmers were 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.

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.

B. Functions Performed

1. Planning

   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.

   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.

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.

2. Installation

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.

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

3. Operations

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

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.

4. User Services

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

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 facility's documentation
and is responsible for issuing notices
reflecting any significant changes.

C. Interfaces (relationships with other
organizations)

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.

IV. Financial and Legal Concerns

A. Capitalization

The Merit Computer Network was 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.

B. Accounting

The Director and the Joint Executive Committee
of MERIT have focused much attention on 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.

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.

C. Regulation

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.

Communications between sites in the MERIT
Computer Network currently utilize a
pre-existing, inter-university, voice-grade
telephone network.

D. Security

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.

V. Conclusions

A. Summary of Problems

The developers of the MERIT network have had to
face all the problems faced by developers of
other networks of heterogeneous computers (e.g.,
ARPA). The most publicized problems have been
in non-technical areas. However, the
development of a processor which offers a common
interface to the network from the specialized
interface requirements of each host machine was
a non-trivial effort. Similarly, the
development of the necessary control software
for each of the host systems had to be
undertaken. By and large the major technical
difficulties have been overcome, although some
peculiarities remain to be ironed out. [For
example, terminals behave according to the
system to which they are physically connected,
not the system which they may be using, as in
the ARPA network).

Perhaps the most publicized non-technical issue
in 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.

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 are few compelling reasons for
extensive use of the network. Also, the double
charges for use of remote resources (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-only and direct
terminal-access sites in the state, as the
network developers envisioned.

B. Lessons Learned

One important lesson to be learned from the
MERIT experience is that organizational and
managerial problems can frequently dominate
technical problems in the development of a
computer network, and can even cast a shadow on
technically sound networks.

In the technical area, MERIT has provided
additional evidence as to the soundness of using
an intermediate communications computer to
mediate between the standard operations of the
network and the peculiarities of each host.

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B. Special Vocabulary

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

MERIT - Michigan Educational Research Triad

MICIS - Michigan Interuniversity Committee on
Information Systems

Triangle Universities Computation Center (TUCC)

I. Introduction

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

II. Network Identification and General Description

A. Sponsoring Organization

The Triangle Universities Computation Center is
a not-for-profit corporation which is owned by
the three universities who cooperatively
sponsored its establishment -- Duke University
at Durham, North Carolina State University at
Raleigh and the University of North Carolina at
Chapel Hill.

B. Purpose/mission of Network

The network has three primary goals:

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

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

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

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

C. Status and Topology

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 370/135), 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.

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.

D. Technology Summary

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

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 TUCC by a variety of medium and low
speed lines which cover the state and extend as
far as Elizabeth City, Wilmington and Ashville.

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).   Except in
special circumstances, none of the local nodes
provide computing services for remote users at
this time, but the Hasp-to-Hasp software in use
allows for such services to be provided if and
when desired.

E. Future Plans

TUCC continues to serve its participating
institutions.   Hardware and software adjustments
are made as required to insure adequate capacity
to meet their processing demand.   Immediate
emphasis is on 'improving interactive services
(primarily but not exclusively via TSO) and
services for large data base processing

including university administrative data
processing.

III. Network Organization

A. Structure and Extent

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.

TUCC Organization

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 meets 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 NCECS
(see section C below). Most questions 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.

TUCC Staff

The central staff organization is shown in
figure 4.

Systems Programming Section

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.

Information Services Section

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.

Development Section

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.

Teleprocessing Section

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.

Operations Section

This section is concerned with the
day-by-day operations of 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.

B. Functions Performed

1. Planning

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

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.

2. Installation

As described in III.A 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 its own center.

3. Operations

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

4. User Services

Considerable attention has been devoted
throughout the TUCC organization to the
provision of adequate user services.
Although there is some information
dissemination from the central organization
in the form of regular newsletters and an
extensive documentation system, the
wholesaler-retailer organization insures that
most user services are provided by the local
computer center. This facilitates user
access to these services and insures
responsiveness on the part of the providers.

In the case of the small institutions served
by NCECS, these services are provided by
"circuit riders" who visit the schools on a
regular basis. Schools are visited as needed
and geographically close visits are usually
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.

C. Interfaces (relationships with other
organizations)

The North Carolina Educational Computing Service
(NCECS) was created as a state agency by the
Board of Higher Education in 1969. (NCECS 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.
NCECS 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).

The director of NCECS 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.

The NCECS 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).

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, as explained
above (III-B-4).

IV. Financial and Legal Concerns

A. Capitalization

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 payments for services from the founding
universities, served to establish TUCC.

B. Accounting

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 or curriculum development.
Rather, these services are provided for their
constituents by the campus computation centers
and NCECS, which are retailers for the TUCC
Network.

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.

Each of the three universities and NCECS
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 all of its costs,
including payments made to TUCC, and on detailed
usage statistics collected at the central
computer.

The budget negotiation described above results
in an effective wholesale rate to the three
universities which is a little lower than the
wholesale rate charged to NCECS. The
justification for this procedure is the fact
that the income from the universities is
guaranteed while the income from the NCECS is
less certain. Both the computing centers and
the NCECS levy additional charges on the local
user to cover local computing center costs and
the costs of the additional NCECS central staff.

C. Regulation

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 University of North Carolina.

Since the TUCC network does not extend outside
the state of North Carolina except for
occasional dial services, intrastate tariffs
apply for most communications facilities.
Standard telephone company services are utilized
for wideband and voice grade circuits.

D. Security

In addition to those measures normally found in
a third-generation operating system for the
control of access to files, TUCC has implemented
its own data set and volume password systems as
well as locally developed encrypting programs
and operator procedures.

V. Conclusions

A. Summary of Problems

Administrative Data Processing

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.

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' (understandable) reluctance
to give up a machine on which he can exercise
direct priority pressure. The present
approach to this problem is to extend the
allocation and scheduling algorithm to
guarantee a portion of the central machine to
each founding university's administrative
data processing needs. Another problem is
the development of confidence in the
available back-up resources. It would
probably require additional computing
resources at TUCC if this option is elected
by any of the universities.

Hardware Homogeneity

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.

B. Lessons Learned

1. User Services

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

"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 completely 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)

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.

2. Wholesaler-Retailer Concept

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.

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.

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.

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)

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.

3. Neutrality of Site

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."

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B. Special Vocabulary

NCCOP - North Carolina Computer Orientation
Project

NCECS - North Carolina Educational Computing
Service

TUCC - Triangle Universities Computation Center

Oregon State Regional Network

I. Introduction

The Oregon State Regional Network is representative of the large number of centralized "star" networks serving a regional clientele. It was organized to provide educational computing services to a number of geographically dispersed institutions, and is not concerned with research into the technology of networking.

II. Network Identification and General Description

A. Sponsoring Organization

The network was sponsored by Oregon State University with support from the National Science Foundation.

B. Purpose/mission of Network

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:

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.

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.

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

C. Status and Topology

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.

D. Technology Summary

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.

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.

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.

E. Future Plans

The regional network described here was an
experiment of fixed duration and limited to
academic computing. The State Department of
Higher Education is currently considering a

proposal to establish a computing consortium
among all nine of the institutions of higher
learning in the state and to establish and
develop a computer network to serve both
academic and administrative needs. It would be
structured similar to the regional network, with
a central facility and staff at OSU and remote
stations at the other participating sites.

III. Network Organization

A. Structure and Extent

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.

Computer Center Director

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.

Steering Committee

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.

Campus Coordinators

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 requests 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:

Coordinate use of remote terminals with
local facilities;

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

Serve as a member of the local institution
computer committee;

Facilitate training for faculty;

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

Attend regional conferences;

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

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

Report news items to regional newsletter
editor;

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

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

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.

B. Functions Performed

1. Planning

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.

2. Installation

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
were provided with terminals, communications
costs, computer time, and consulting

services. The installation requirements for
this type of arrangement are minimal.

3. Operations

Because of the star configuration of the
network, operational concerns specific to the
network are minimal. The center is operated
as any other large multiprogrammed center
serving interactive users.

4. User Services

User services have primarily been provided by
three means: publications, seminars and
personal interaction.

Publications include manuals for all services
available as well as a computer center
newsletter published on a regular and timely
basis. These are necessary but not
sufficient to the success of the project.

In an effort to promote the use of the
network, a series of conferences were held at
various campuses to introduce the faculty to
some of the instructional uses that can be
made with the computer in the classroom.
Each conference lasted two days and
concentrated on a specific academic area.
The participating faculty were presented with
ten to fifteen examples of actual classroom
uses of the computer followed by an
opportunity to use the material and to modify
and adapt some of the examples into their
instruction. Whenever possible, each example
was presented by an instructor who had used
the material in his class, and Regional
Computer Center staff were on hand to help
the faculty with any problems they had in
using the terminal, the system or the
materials. The faculty attending the
conferences became very enthusiastic about
the possibilities of the computer in the
classroom. However, it was found that
without some type of follow-up the enthusiasm
wanes.

The follow-up is provided through personal

interaction. A Regional Computer Center
staff member, familiar with the academic area
and the instructional materials, visited the
participating schools during the immediate
weeks following the conference. He discussed
with the faculty who attended the conference
and other interested faculty possible
applications in their classrooms. The role
of the local campus coordinator in providing
personal assistance has already been
discussed. Within the course of one term,
following this procedure, the faculty who
have attended the conferences introduced the
computer into their classrooms on a regular
basis.

C. Interfaces (relationships with other
organizations)

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 improvements 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.

The other external relationship of interest is
with the other universities involved in the
CONDUIT project. Oregon State University,
Dartmouth College, the North Carolina Educational
Computing Service, and the Universities of Iowa
and Texas have been funded by the National
Science Foundation in a cooperative project in
educational computer usage and program exchange.
Each of these schools have developed active
computer networks and a significant base of
curriculum materials. The CONDUIT project
involves the formation of a central organization
and staffs at each of five schools to design the
procedures necessary to transport about 75
curriculum units and to implement these
procedures in the five networks. CONDUIT will
quantify this exchange process including all

costs, faculty training requirements and user
feedback.

IV. Financial and Legal Concerns

A. Capitalization

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.

B. Accounting

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.

C. Regulation

The network was regulated in part by the
National Science Foundation 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.

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.

D. Security

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

V. Conclusions

A. Summary of Problems

Due to the use of a well-known and
straightforward network design (the star
configuration) and the emphasis on providing
service rather than performing research on
networking, there were no notable technical
problems. The primary problem was in promoting
the use of the facility by those to whom it was
offered.

B. Lessons Learned

The project's final report suggested that the
success of a regional computing activity
required quick and effective methods of
communication between the remote site and the
central staff. The following general principles
were offered:

1. There must be a willingness of regional
participants to work out mutual problems, to
cooperate, to compromise if necessary, and to
consider the progress of all users.

2. A regional center should be considered a
service organization to provide services
which cannot be provided efficiently
otherwise.

3. The activities of the regional group are
under a steering committee which considers
policy matters affecting regional projects,
terminal use and users, and recommends action
to the Regional Coordinator and the Computer
Center Director.

4. The Regional Steering Committee can help
to maintain uniformity and workability of
operation and services.

6. The regional facilities and activities
should augment each schools local facilities
and services. The use of the terminals and
facilities on each campus should be under the
jurisdiction of that school and operated for
that respective school.

7. Location of regional facilities is of little concern. More important is ease of access, reliability and personal service.

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B. Special Vocabulary

OS-3 - Oregon State Open Shop Operating System

OSCAR - Oregon State Conversational Aid to Research

TYMNET

I. Introduction

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.

II. Network Identification and General Description

A. Sponsoring Organization

Tymshare, 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 $21 million and about
450 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.

B. Purpose/mission of Network

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.

C. Status and Topology

The network has been operational since 1969 as a
commercial service. It is presently serving
over ten thousand interactive users (800
simultaneously) in over 70 cities throughout the
United States and Europe (Paris, France).

The network serves to interconnect approximately
40 host computer systems and contains some 100
communications nodes in a multi-ring
configuration. Figure 1 illustrates an
abbreviated topological map of the network.

D. Technology Summary

The network consists of approximately 100
minicomputers (Varian 620/i, 620/L and
620/L-100) 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.

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. When
the service computer is one of those generally
supported by Tymshare (such as an XDS 940, IBM
370/158 7 or DEC PDP-10), the TYMSAT has been
programmed as a communications controller
replacing the standard components for that
function. 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 or 3705 for an IBM
360 or 370) so that the TYMSAT appears as a
complex of terminals to the controller.

The base TYMSATs are each connected to a service
computer in a one-to-one or one-to-two fashion
(approximately forty 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.

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
local printers 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.
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.

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 synchronous, full-duplex, private
leased lines.

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. 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.

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 assuming the
active role. This sequence does not disturb
users on processors other than the one whose
supervisor failed.

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.

E. Future Plans

Tymshare, Inc. continues to expand its network
coverage as business conditions justify. The
company is also starting to use higher-speed
lines and alternate suppliers.

III. Network Organization

A. Structure and Extent

Tymshare, Inc. is organized similarly to most
corporations which produce and market goods
nationally. They have a home office with a
central staff for planning and control in
Cupertino, California, and regional and branch
offices throughout the country and in Europe.

B. Functions Performed

1. Planning

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.

2. Installation

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.

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.

3. Operations

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 be disrupted, then each segment
can be run independently until communications
have been reestablished.

The network has proved to be very reliable,
with an average of only 1.4 failures per year
for the TYMSATs. Preventive maintenance is
performed twice per year on the TYMSATs.

4. User Services

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.

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.

C. Interfaces (relationships with other
organizations)

Since Tymshare is a company which markets
products to organizations rather than to
individual consumers, each customer represents
an interface with another organization. As
outlined below, many organizations, both private
and public, use TYMNET in a "shared" (really
"value-added") mode of operation as provided for
in FCC Tariff No. 260. Tymshare obtains
circuits from the common carriers and "shares"
the use of them with the additional network
functions sold to its customers.

Besides Tymshare itself, the National Library of
Medicine in Bethesda, Maryland, is the largest
user. With nation-wide access to their Medline
Data Base on an IBM 370/155, NLM serves more
than 200 libraries, hospitals and university
medical centers. NLM has been using the network
since February 1972.

IV. Financial and Legal Concerns

A. Capitalization

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

As listed in the 1972 Annual Report, Tymshare's
investments in computer systems and
terminal/comunication equipment were $5.05
million and $4.49 million, respectively.

B. Accounting

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.

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.

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.

TYMNET's standard price list is as follows:

Description	Monthly Charges
Each log-on to host computer	$ .50
Accumulative time connected to host for all terminals:	
0 to 500 hours	3.00/hour
next 1500 hours	2.50/hour
next 3000 hours	2.00/hour
next 5000 hours	1.50/hour
each hour over 10,000	1.00/hour
Transmission of characters between user and host computer characters	.125/1000
TYCOM-III rental (30 ports)	2150.00/month
AT&T Joint Use Charge (billed by AT&T)	7.50/Leased lines used/month
One time installation charge	1000.00

C. Regulation

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

D. Security

When a user accesses the system, a Tymsat
accepts his terminal identification and prompts
with the message PLEASE LOG IN. He is
immediately connected to the network supervisor
which checks the Master User Directory and
validates the user name and password. The
supervisor then determines which computer is
associated with that user and connects him to
the appropriate system. At that time, the
supervisor transfers control to that system and
data is transmitted directly, rather than
through a central point as in a star-type
network. Whenever he logs out, he is returned
to the network supervisor which again asks for
the log in sequence.

Users may be validated on multiple systems, in
which case they must identify the system to
which they wish to be connected at login-time.
A single user's password is the same on all
systems.

The supervisor, in maintaining records, provides
a complete chronoligical log of all events in
the network. The supervisor also permits manual
intervention and survey, including the ability
to determine how many users are connected to a
host and to determine where host users have
originated a call and which nodes they pass
through en route.

V. Conclusions

A. Summary of Problems

TYMNET continues to have a number of tecnical
problems which affect the level of service which
can be offered. No facilities for remote job
entry are presently provided, although this

service is under investigation, and synchronous
terminals cannot be supported. The capabilities
of the Varian 620's place a limit on the ability
of the network to handle much faster
communications lines than are presently in use.
The present strategy of disassembly and
reassembly of all messages at every node also
limits the capacity for handling increased
traffic. Terminal interfaces to the TYMSATs are
also bit-oriented, thus limiting the number of
terminals which a single TYMSAT Can accommodate.
Tymshare recognizes this "bit banging" to be
inefficient, and is investigating the use of
more sophisticated terminal interfaces and
message forwarding strategies.

B. Lessons Learned

Tymshare has demonstrated that value-added
networks can offer an economically viable
product.

Of equal importance, Tymshare's experience
demonstrates that a distributed network can be
adequately managed.

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B. Special Vocabulary

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

TYCOM — A modified TYMSAT which permits users'
computers to be connected to the network through
their own communications controllers.

Conclusions

I. Introduction

The approach to network management taken in this
report has been to report on management practices
as they exist, rather than to try to proscribe the
way in which they should be performed.
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.

II. Network Identification and General Description

A. Sponsoring Organization

We are concerned more here with the managing
organization than the sponsoring organization.
They may be the same, and if the sponsoring
organization really wants the network to succeed
it is better that they be the same (the absentee
landlord is never an effective manager).

For the managing organization there are two
important criteria: the organization should have
a serious stake in the success of the network
(e.g., either financial reward or the satisfying
of needs of the organization itself), and it
should have the means of exercising effective
managerial control. Viewed another way, these
criteria are simply the responsibility and
authority which should accompany the delegation
of any management task.

B. Purpose/mission of Network

It seems clear that network success, i.e., high
user satisfaction and growing demand for network
services, cannot be achieved or adequately
acertained without there being a real purpose
for the network other than just research on
networking. Networks faced with real needs to
satisfy are more likely to seriously and
realistically work out user support problems

than networks which would hardly be missed by a
significant user community.

C. Status and Topology

There does not appear to be a minimum critical
size for achieving success in user satisfaction
by a network. Indeed, growth seems to present
more stringent demands on network management
resources in such areas as user services. Thus
for research projects or experiments in
networking, small scale efforts with a
well-identified user community would seem
preferable. Nonetheless, evaluation and
measurements would have to be considered in
projecting success for an expanded operation.

Topology is important only in that shared
facilities should be equally 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.

D. Technology Summary

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 adapt
their usage modes 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.

E. Future Plans

It seems to be characteristic of networks, as
with organizations in general, that once
established they have a life of their own and
are only disestablished under unusual
circumstances. All of the networks surveyed are
continuing in operation, and indeed, are
undergoing expansion.

III. Network Organization

   A. Structure and Extent

      The main comment to be made regarding the
      structure and extent of the network management
      organization is that there SHOULD BE structure
      and extent. Networks need to be well managed to
      be successful, and a formal organization is
      preferred to an informal one in nearly all
      cases.

   B. Functions Performed

      1. Planning

         The results of the survey seem to indicate
         that centralized planning is to be preferred
         over distributed responsibilities. In
         multi-organizational ventures where the
         interests of individual parties need to be
         protected, the centralization of planning
         responsibility can be vested in a joint team
         or committee.

      2. Installation

         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.

      3. Operations

         The main comment to be made about operations
         is that the degree of reliability which must
         be built into networks is extremely high --
         95% up time is probably not good enough.
         Users must have the assurance that the system
         will be available when they need to use it.

         A large measure of this reliability is
         designed into networks through the techniques
         of redundancy and standardization.
         Redundancy, for example, insures that the
         failure of a single communications link does

not isolate any users. Standardization
provides a means to switch from processor to
processor as required. Additional efforts
along these lines are required, but these are
not, strictly speaking, operational matters.

The main requirement in the operations area
is the ability to rapidly diagnose and
respond to failures in the network. The
network control center developed for the ARPA
network is the most sophisticated example in
this survey. Such control centers serve the
multiple functions of continually monitoring
the network and diagnosing problem areas,
coordinating corrective measures, and
providing a central point to which users may
direct inquiries and complaints.

4. User Services

It is clear that the area of user services is
critical to the success of any network. It
is also clear that a wide variety of services
is required, not just good documentation.
These services include as a minimum
documentation, training, assistance on
specific problems, and a channel for
accepting user feedback (gripes).
Additional services might include network
mail and facilities for on-line
collaboration.

The experience of the networks surveyed
indicates that services are best provided by
organizations closest to the user -- e.g.,
the local retailer. This is because personal
services are required, and because a local
organization is likely to be more responsive
to the needs of local users.

C. Interfaces (relationships with other
organizations)

Because of their size, most networks must deal
with multiple organizations; indeed, this is one
of the major problems facing network management.

Certain special organizations seem likely to
affect many of the networks surveyed here.

Various standards groups are beginning to
consider the area of data networks. The
International Network Working Group was founded
following an ARPA initiative to examine means of
interconnecting different networks. Composed of
members from a large number of different data
networks around the world, the group now has
official standing as a working group under IFIP
Technical Committee 6 (data communications). An
American National Standards Task Group has also
been formed to consider all interface standards
relating to "Public Data Networks" (X3S37).
This group develops the American position for
presentation to the International Standards
Organization (ISO).

Other initiatives, such as the NSF Networking
for Science program, seem likely to promote
greater cooperation and perhaps interconnection
between networks.

IV. Financial and Legal Concerns

A. Capitalization

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.

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 more likely to fail.

B. Accounting

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
integrity of each wholesaler and results in real
anxiety.

Herzog suggests that in the long run, usage
patterns can be incorporated in the budgetary
and planning process, thereby reducing the
problem to the traditional one of matching the
expected and actual income. At the start,
however, a cooperating group seeking 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. (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).

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 this resolution, however, required a
careful review of existing internal
organizational policies.

C. Regulation

Up to the present time, most networks have been
able to avoid entanglements in tariff questions
through one means or another. However, as

networks continue to grow in size and
importance, there are likely to be tariff
decisions made which will affect networks.

There have been two major issues before the
Federal Communications Commission that have
direct bearing on computer networks and their
required data communications. These
investigations covering specialized common
carriers and the inter-dependence of computers
and communications and the resulting rulings are
often confused and considered together.
However, as Enslow has pointed out, it is
important to realize that they are separate and
distinct in their effects on both computer
networks and communications.

The major question addressed in the Specialized
Common Carrier inquiry, FCC Docket No. 18920,
was whether or not carriers other than the
presently established ones would be permitted to
offer competitive services. The FCC decision,
released in June 1971, came almost eight years
after MCI first filed for authority to construct
a Chicago to St. Louis microwave system;
however, the ruling covered all of the
applications pending before it. The
Commissioners position strongly supported free
and competitive entry into the market.

In November 1966, the FCC initiated Docket No.
16979 to examine the "Regulatory and Policy
Problems Presented by Interdependence of
Computer and Communication Services and
Facilities." Another lengthy study was required
before the Commission issued its final order in
March 1971. Although all of the items raised in
the initial inquiry were not ruled on, there
were important decisions made on the regulatory
status of publicly offered teleprocessing
services. Enslow characterized the decision in
terms of a spectrum of service offerings between
pure computing and pure communications.

  "Pure" remote computing utilizes
  communications services, but that use is only
  incidental to the primary function of the
  service. It was ruled that this service
  would be unregulated.

The other end of the spectrum is circuit
switching which requires some computation and
logical decisions to be made by the switching
processor. However, this is incidental to
the primary service which is "essentially
communications" and therefore fully subject
to regulation.

The Commission's ruling also covered message
switched service, which, though it requires more
computation, is still a "communications" service
and regulated. What the ruling did not settle
was the status of hybrid services where the
"incidental" test fails. The problem was
recognized and specified as an area in which
advisory rulings could be obtained; however, as
Enslow recognizes, the mere fact that the line
is not drawn between what is to be regulated and
what is not has already served as a deterrent to
the offering of new services.

Another regulatory issue that is often raised
when networks are discussed is the prohibition
against resale or third-party use by an
organization that has obtained service from the
regular common carriers. This is a problem;
however, Enslow suggests that it is becoming
less of a problem in the area of data
communications. One important feature of data
communications networks that distinguishes them
from private voice networks is the fact that the
service provided by the operator of the network
is usually quite different from the facility he
obtained from the common carrier. A data
communications network will usually provide
additional services to its customers such as
error correction, automatic routing, testing and
alternate routing, and other features such as
directory services. Enslow suggests the term
"Value-Added Network" or VAN to describe such
services, but he points out that the regulatory
issues relating to such networks have not yet
been resolved.

D. Security

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 seem 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.

V. Conclusions

A. Summary of Problems

The problems which have been evidenced in the
networks surveyed may be most conviently
summarized according to a number of broad
classes as follows:

Technological - These problems deal with the
difficulty of setting up a useful, usable and
reliable service for the usually remote users of
the network. The problems include the
compatibility difficulties between different
computers, both in hardware and software,
implementational difficulties, both in host
operating systems and in communications
computers, and reliability problems with all
components. Problems of this sort continue to
plague all network developers; on the other
hand, all of the networks surveyed have found
acceptable solutions to most of these problems.
Thus, technological problems do not represent
the major impediment to network success.

Operational - These problems relate to the
day-to-day managerial tasks associated with
operating a computer network. Included are all
problems related to network planning and
installation, diagnosis and maintenance, and the
delivery of user services. In general, problems
have arisen when one (or both) of the two
requirements for effective management,
responsibility and authority, have been lacking.

Financial - These problems include the costs
associated with the various network components,
and raising the necessary capital to develop and
operate a network. Networks are not inexpensive

to develop or operate, with substantial costs
arising both from hardware and software
components. Furthermore, most costs are fixed
over a given operating period, resulting in a
high sensitivity to variations in demand on the
part of network finances. A major challenge to
network developers is to reduce the overhead and
thereby the costs associated with such
components as host software specific to the
network. The communications components of
networks represent opportunities for savings
resulting from economies of scale, so another
challenge is to raise network loading to the
point where these benefits are realized.
Capitalization of the networks surveyed did not
appear to be a major problem, but it certainly
represents a barrier to entry for potential
networks, be they academic or commercial.

Legal - The legal and regulatory issues relating
to computer networks were outlined in IV.C
above. Problems in this area are more likely to
affect current and potential commercial networks
than private and/or academic networks. These
problems have hardly affected any networks up to
the present time, but with the FCC now actively
considering the issues, legal matters may become
much more of concern in the near future. The
resale of common carrier communications services
with "value-added" is a particular area likely
to be affected by any FCC ruling.

Sociological - These problems arise from the
large and diverse organization which typifies
computer networks. A large, distributed network
establishes a community of developers,
maintainers and users who must interact with
each other. The technology of the network
requires that each of these people operate in a
way in which they may not be accustomed. Users
in particular must adapt to certain constraints
of a network in order to accomplish their
desired tasks. For example, less user
assistance through personal interaction is
characteristic of networks. User assistance is
provided instead through better documentation
and on-line tutorials in automated form. To the
extent that users are unable to adapt to this

mode of operation, serious impediments to
network success may arise.

B. Lessons Learned

The overwhelming empirical lesson to be learned
from this study is that networks can and must be
managed if they are to succeed in providing
adequate levels of service to users. Computer
networks offer no exceptions to the principles
of management which apply in all other
organizations.

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B. Special Vocabulary

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

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

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

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

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

Front-end Computer - See Communications
Computer.

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

Link - A communications path between two nodes.

Network-

1) An interconnected or interrelated group of
nodes;

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).

Node - A point of convergence of comaunication
paths in a network.

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

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

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

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.

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

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

RJE - see Remote Job entry.

Server Node - A node primarily providing network
resources.

Star Network - A centralized network.

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

Sub-network - A network which is itself a
component of a larger network.

Tariff - Communications tariffs are schedules
filed by common carriers that specify the
classifications and charges for offered
facilities or types of service. Under the
Communications Act of 1934, interstate and
international tariffs are approved by the
Federal Communications Commission.

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

Network Management Survey

(J20652)   30-NOV-73 11:48;   Title: Author(s): Ira W. Cotton/IWC;
Distribution: /RLL; Sub-Collections: NIC; Clerk: IWC;

<NBS-TIP>NSF-COTTON.NLS;6, 21-NOV-73 14:07 IWC ;2, 13-JUN-73 15:12
IWC ;   1

The report is in production. In the meantime, here is a copy without illustrations.

how does this llook....any changes

to Geoff Weeks re meeting with Anderson : Nov. 29/73   1

    Thanks very much for your assistance in setting up yesterday's
meeting with Maurice Anderson of Sears.   1a

    I think the meeting went very well and I am confident that my
follow-up meeting with Mike Lutze of Anderson's group will proceed
equally smoothly.   Since Mike has been designated by Anderson as
the formal contact for future planning of our proposed joint
venture, I expect to be meeting with him next week to present our
resources and capabilities to him.   He will be able to talk first
hand with the people who will be working with me in our efforts to
assist Sears with their analysis of the current trial.   1b

    I expect to bring Shankar Sanyal(Subscriber Systems, BNR) and Paul
Deltjne (Staff Supervisor - Mgt. Science) with me to assist in the
presentation.   These two individuals will be responsible for the
work that their groups may be doing for Sears.   As such they will
be reporting to me as the official interface for this particular
venture.   1c

    As I mentioned yesterday, I will keep you fully informed of our
plans with the Sears people.   I understand your interest in
keeping on top of this situation, and I will make sure that you
are notified in advance of any meetings that our people have with
any Sears representatives.   1d

    Thank you once again for your help yesterday.   You should be proud
of your relationship with Mr. Anderson.   1e

20653 Distribution
    Lawrence H. Day,

how does this llook....any changes

(J20653) 30-NOV-73 12:04;   Title: Author(s): Michael T. Bedford/MIKE;
Distribution: /LHD; Sub-Collections: NIC; Clerk: MIKE;

Meeting about analysis of the utility

I agree we should have a meeting so we at least know what is expected
and so we are all aware of some of the problems involved in
evaluating the utility.   IT SURE IS NICE WHEN A QUESTION GETS A
RESPONSE   Thanks for the message.   1

20654 Distribution
   James H. Bair,

Meeting about analysis of the utility

(J20654)   30-NOV-73 12:58;   Title: Author(s): Susan R. Lee/SRL;
Distribution: /JHB; Sub-Collections: SRI-ARC; Clerk: SRL;

Just a note to confirm our scheduled discussion on the NIC, Monday 3
Dec at 3:00 pm,   to resolve the issues raised in
(IJOURNAL,20439,1:wy). .   1

20655 Distribution
   Douglas C. Engelbart, James C. Norton, Paul Rech, Richard W. Watson,

NIC Discussion

(J20655)   30-NOV-73 15:33;   Title: Author(s): Michael D. Kudlick/MDK;
Distribution: /DCE JCN PR RWW; Sub-Collections: SRI-ARC; Clerk: MDK;

Welcome to USING. Dave.   1

20656 Distribution
    Alan R. Hill,

(J20656)   30-NOV-73 15:42;   Title: Author(s): David H. Crocker/DHC;
Distribution: /ARH; Sub-Collections: NIC; Clerk: DHC;