Network Working Group   J. F. Heafner
Request for Comments: 164   Rand
NIC 6778

                MINUTES OF NETWORK WORKING GROUP MEETING
                        5/16 through 5/19/71

                              Preface

These notes are for reference and recall by those in attendance of
the NWG meetings. No attempt has been made toward completeness to
make this an understandable document for those not in attendance.

The notes are ordered chronologically. You may notice discrepancies
for particular schedules and tasks within the notes; the
discrepancies represent a revision of those schedules and tasks, thus
those dates given more recent in time are assumed to apply.

If you detect any gross errors in this report, please make
corrections via the accepted NIC procedures.

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                    I. SUNDAY EVENING SESSION (5/10/71)

INTRODUCTION OF ATTENDEES

    Attendees introduced themselves and stated their affiliation. The
    following list includes persons attending any of the sessions.

    SITE   NAME

    AMES-ILLIAC   John McConnell

    AMES-67   Wayne Hathaway

    ARPA   Bruce Dolan
                                  Cordell Green
                                  Larry Roberts

    BBN-NCC   Will Crowther
                                  Frank Hart
                                  Robert Kahn
                                  Alex McKenzie

    Carnegie   William Broadley
                                  H. Van Zoeren

    Case   Patrick Foulk

    CCA   Richard Winter

    Dept. Comm., Canada   Terry Shepard

    EDUCOM   Henry Chauncey
                                  John LeGates

    Harvard   R. Metcalfe
                                  R. Sundberg

    IBM Research   Douglas McKay

    Illinois-CAC   Jack Bouknight
                                  G. R. Grossman
                                  Jim Madden

    Lincoln Labs   Richard Kalin
                                  Joel Winett

Merit   Al Cocanower
                               Brian S. Read

Merit-Univ. Mich.   W. Scott Gerstenberger

MIT-DM   Abhay Bhushan
                               Robert Fleischer
                               Albert Vezza

MIT-MULTICS   J. C. R. Licklider
                               Mike Padlipsky

Mitre   P. Karp
                               David Wood
                               Gene Raichelson

NBS   G. Lindamood
                               T. N. Pyke

RADC   Tom Lawrence
                               Bob Walker

Rand   E. F. Harslem
                               J. F. Heafner

Raytheon   T. O'Sullivan

SDC   Robert Long
                               Arie Shoshani

SRI-ARC-NIC   Charles Irby
                               John Melvin
                               R. W. Watson

Stony Brook   Ralph Akkoyunlu
                               Art Bernstein
                               M. Inam Ul Haq
                               Richard Schantz

Univ. of Chicago   R. Ashenhurst

UCLA-CCN   Robert Braden
                               Steve Wolfe

             UCLA-NMC   Vint Cerf
                                          Steve Crocker
                                          Ari Ollikainen
                                          John Postel
                                          Rollin Weeks

             UCSB   Steve Lynch
                                          Jim White

             U. K.   Eric Foxley

             Univ. of London   Peter Kirstein

             Univ. of Mo.   Dan Garigan

             Univ. of Penna.   Don Bernard

             Univ. of Waterloo   Don Cowan

SITE STATUS REPORTS

    The following are summaries of reports given by affiliates of the
    indicated sites.

    UCLA-Sigma 7

        o   NCP (document 1) and user/server TELNET-like protocol have
             been operational for three months.

        o   NCP (RFC #107) will be implemented by June 1.

        o   TELNET will be implemented within one month of official
             specification.

        o   Have been and will continue to gather Network measurements.

        o   Will use UCSB file protocol in conjunction with above.

     UCLA-CCN

        o   Local hardware has been connected to IMP.

        o   NCP (RFC #107) 70% complete.

        o   NCP (RFC #107) and NETRJS will be in production on JULY 1.

        o   Draft of NETCRT will be issued as RFC soon.

    o   They can offer APL and are looking for interested users.

    UCSB

    o   UCSB is a service center; 360/75 + 2314 storage.

    o   NCP (doc. 1) operational since mid-October 1970.

    o   NCP (RFC #107) operational and verified remotely.

    o   Services currently offered:
              1) UCSB on-line system
              2) RJE/RJ0
              3) file system
              4) local interfaces to net via F0RTRAN, PL/1, etc.

    o   Short range plans:
              1) DRS implementation and experimental service
              2) Interested in APL
              3) Distributed data base experiment with SRI

    SRI-ARC/NIC

    o   Now running NCP (doc. 1) in TENEX.

    o   NCP (RFC #107) will be installed when BBN releases it.

    o   They are currently examining and tuning TENEX parameters and
            resolving interface difficulties.

    o   Stage 0 plans include initial work with West Coast sites to
            gain experience, in using NIC, with respect to response
            times, traffic loads. This will initially look like TENEX to
            a user. Later, this will appear as a virtual machine to
            remote users via a special NIC subsystem.

    SRI-AI (reported by SRI-ARC personnel)

    o   Configuration includes PDP-10, TENEX, high-speed drum, robot.

    o   Probable Network connection in July.

    o   Software includes various theorem-proving mechanisms.

    o   Interested in working on the above over the Network.

RAND

o   Current configuration includes 360/65, 1800, IMP, video
     graphics system.

o   NCP (RFC #107) in 360/65 in daily production use in
     conjunction with UCSB.

o   Network Services Program (NSP) used in above features:
          1) dynamic access to local files
          2) access to video consoles
          3) access to NCP
          4) UCSB RJE/RJ0 protocol
          5) UCLA NETRJS protocol (not operational)
          6) Logger and TELNET-like protocols.

o   PDP-10 to be connected into Net (directly to IMP) in about
     two months -- will eventually run TENEX and be a service
     center.

o   Short range software development includes TELNET and DRS.

o   Will continue to provide production support for Climate
     Dynamics.

o   Hardware is 360/65 connected to Honeywell 516 connected to
     IMP.

o   NCP (doc. 1) verified with Rand.

SDC

o   360/65 runs Adept timesharing, has 10 users, can do protocols
     from a user process.

o   NCP (RFC #107) will be coded by end of month.

o   Logger fairly close to being checked out.

o   Will have TELNET similar to RFC #137 by June 1; will offer it
     by 20 August.

   o   SDC not meant to be a general service; will allow 1 to 4
        users; can use Adept to run a job.

   o   Experimentation plans include:
        1) Voice I/O will use Net to communicate with speech
           researchers (will respond to specific programs only)
        2) Eventually graphic I/O
        3) Man/machine synergism
        4) Network data management
        5) Network resources Notebook use and update.

ILLINOIS-CAC

   o   IMP works.

   o   Will use B5500 on campus since B6500 doesn't work.

   o   Will link to PDP-11 at Paoli for I4 software development --
        not a general link for everyone.

AMES

   o   Probably will be two separate nodes ILLIAC and 360/67.

   o   Plans are in rumor stage.

   o   Plan TIP by end of summer to gain access to I4 simulator.

   o   Duplex 360/67 will be regular host node.

   o   Are looking for an NCP implementer.

   o   Will use other services; laser store and UCSB.

   o   Their general research includes an interest in Network
        accounting and management.

   o   Will go onto Net as soon as possible to ILLINOIS.

   o   Will go on via TIP if it can support two nodes.

   o   Will define Net protocol for interactive graphics for I4.

   o   Plan to get on Net before I4 comes up.

CCA

o   CCA is responsible for data computer project.

o   It is special purpose computer with large storage device.

o   Data computer (PDP-10 and laser memory) should be viewed as
        one black box.

o   Will have two ports -- high-speed to I4 and low-speed to IMP.

o   Data language and data will pass over ports. This will
        include requests of files and portions of files, update,
        manipulation, and transformation of data. It will not
        include number crunching. Only access to the laser store
        will be through the black box data computer.

o   Hardware and communications are specified.

o   Data computer services are beginning to be defined, (600
        questionnaires were sent out, 10 responses were received).
        With regard to services please call Dick Winter on (617)
        491-3670. Dick wishes to hear from any potential user.

o   Laser store is one trillion bits of on-line storage packaged
        in 40 packs containing 10 mylar strips each. Strips are kept
        in a carousel that can be rotated and mounted in 10 seconds.
        Access to any track is a maximum of 400 ms.

o   Laser will arrive at CCA in early 1972 and move in late '72.
        Services to laser while located at CCA will be offered.

o   CCA will send out plans (as feasible) as RFCs.

  CASE WESTERN

o   Hardware has been built (PDP-10) and starting to test it.

  CARNEGIE

o   Hardware includes PDP-10 240K 36-bit words, TTY, etc.

o   Currently using DEC monitor.

o   Will modify Harvard's version of the monitor.

HARVARD

   o   Hardware includes PDP-10 with PDP-1 as graphics devices
        handler.

   o   Hardware is up, talking back and forth.

   o   NCP (RFC #107) for PDP-10 will be completed by the end of the
        month.

   o   PDP-10 has 48K 36-bit words; expect more core after July;
        will then make NCP resident.

   o   Interested in file transfer, graphics, extensible languages,
        experiments of distributed processes.

IBM RESEARCH

   o   IBM will buy an IMP, now negotiating it.

   o   They are designing new concept of Networking.

   o   They will become an active node with either a 67 or a 91.
        The candidate 91 now has 300-400K.

RADC

   o   TIP is scheduled for delivery in October.

   o   They will provide local access to the SRI on-line system.

   o   They are interested in the July graphics meeting sponsored by
        MIT. (Al Vezza)

MIT DM AND MULTICS

   o   GE-645 runs MULTICS: PDP-10 is for dynamic modeling of
        graphics systems.

   o   NCP (RFC #107) on PDP-10 by end of week.

   o   Logger on PDP-10 available by 15 June.

   o   NCP (RFC #107) available on MULTICS by 11 June.

   o   Logger and TELNET available on MULTICS by first week of July.

o   They have been conducting file transfer experiments of
     simplified ASCII transfers (not RFC #114).

o   Interests include:
     1) File transfers
     2) E & S processing to IMLAC and ARDS formats
     3) DRS service.

LINCOLN

o   Three connections are planned.

o   360/67 has NCP, logger, TELNET, and some file transfer
     protocol.

o   TX-2 NCP is being developed. An interim NCP is working with
     file transfer experiments, error detection and correction.

o   They are experiencing hardware difficulties with the third
     connection.

o   360/67 has been running NCP (doc. 1) and a TELNET-like
     protocol since 1 March. UCLA and Rand have logged in. The
     TELNET-like protocol supports ASCII and EBCDIC.

o   NCP (RFC #107), TELNET, and logger will be operational on 67
     by 1 July.

BBN-NCC

o   NCC is responsible for maintaining the subnet and interfacing
     with Honeywell and AT&T. They are planning a mechanism for
     repair of the Net from their homes. The subnet has
     experienced a 98% up time.

o   An operational 316 version of the IMP has been hooked into
     the Net since February. It is a production item at 1/2 cost
     of 516; the IMP programs are identical.

o   The 316 will be incorporated into the TIP. The multi-line
     controller has been fabricated and is being debugged. A
     common language for the TIP has been developed. TIP will be
     delivered to NASA Ames on 1 August. The TIP will handle 64
     lines up to 19.2K bits. BBN is still shaking down the kinds
     of terminals that will be compatible (will be bit serial at
     least). They are working with sites to determine terminal
     requirements.

o   The resource notebook has been compiled and distributed.
        Twelve of 19 sites are included in the notebook. SDC has
        since reported. Stanford, SRI/AI, MIT/DM, UTAH, Carnegie,
        LL/67 have not provided an entry. BBN again made a call for
        responses and asked that each site stay up-to-date. A
        comment was made regarding the Notebook that a mechanism is
        needed for a) date of information, b) complaints of
        information, c) reporting that advertised procedures do not
        work.

o   TIP delivery for the rest of the year is to the following
        five sites: Ames, Mitre, Rome, ETAC in Washington, D.C., and
        NBS.

o   BBN has been studying performance of Network to learn ways to
        improve it. An earlier Rand RFC reported a very low rate for
        a total Network experiment -- Rand re-ran the experiment to
        examine just the subnet performance and reported the subnet
        rate to be in the 13-15K bit range for that test. MIT/DM has
        reported a 5KB rate that will be examined further. BBN made
        a general offer to the Net community to phone NCC in the
        event that such measurements are taken and low data rates are
        discovered.

o   The BBN-Honeywell relationship is a straightforward
        maintenance contract that includes P.M. and other problems
        which arise. BBN stated that a 24-hour delay in service
        would be unusually long. BBN would like to be kept informed
        of views and opinions of the Honeywell service. BBN asks
        that each site keep a maintenance log and copy it to Marty
        Thrope at BBN.

   BBN/TENEX (reported by BBN/NCC)

o   BBN has a three-host IMP that includes NCC and two PDP-10s.
        One 10 is for operational use, the other for experimentation.

o   Software for the PDP-10 is TENEX.

o   They are interested in getting involved in Network
        experimentation.

   MITRE

o   Expect TIP delivery in September.

o   Now using PDP-10 at BBN.

     o   Will work on sample data management system using UCSB file
              storage.

   NBS

     o   Expect TIP delivery in December.

     o   Have selected PDP-11 as host; ready by December.

     o   Will build from the U. of Illinois operating system.

     o   Contemplating attaching their UNIVAC 1108 to Network.

     o   Will provide experimental access to Network for services:
              1) measurement (performance)
              2) graphics
              3) personal communication
              4) lab automation
              5) support NBS with services appropriate
              6) provide local hardcopy from PDP-11.

   ETAC (Environmental Technical Application Center

     o   ETAC, located in the Washington area, is a branch of Global
              Weather Service.

     o   Air Weather Service in Omaha, Nebraska, has seven 1108s
              providing weather data; one will be connected to Net to
              provide daily weather information to ETAC in Washington.

     o   ETAC has 1401 and 7040 in Washington to produce summaries for
              longer range use; the 7040 may go on the Network.

   AIR FORCE SITES (reported by ARPA)

     o   To export technology to other regions, two Air Force sites
              (Oklahoma City, Oklahoma, and Sacramento, California) will
              temporarily join the ARPA Net to talk only to each other in
              an operation to parallel their AUTODIN connection. If it
              materializes, they will run for the first six months of '72
              but probably won't continue. The motivation is to examine
              the Net ideas for developing a wholly autonomous network in
              three or four years.

OTHER REPORTS

   DEPT. COMM., CANADA

          The Canadian Government wishes to optimize the use of all
          computers in Canada.

          They now have a banking network.

          They are interested in a small net for universities.

          Their largest problem is the size of the country in relation
          to the sparseness of population.

   U. OF CHICAGO

          The University of Chicago has no current time schedule but
          they have definite ideas about what they wish to accomplish
          and they are seeking funding. They are applying to NSF to
          support a local net on campus for lab automation. They have
          good people and good equipment; the idea is to make it
          coherent.

          Their interest in the ARPA Network is to make shared software
          available to their people and to a limited extent, make local
          services available to other ARPA nodes. Their proposed host
          is a PDP-11 to the mini computers and a second host (PDP-10)
          as a big software engine to make data available to the mini
          computers. The PDP-10 and PDP-11 will perhaps be linked
          together. They also expect to get a TIP to provide remote
          number crunching for their people.

   UNITED KINGDOM

          They have proposed three main machines and three terminal
          nodes. They have in mind the 906A, approximately the 360/75
          in power.

          Their Post Office also has plans for a digital network in the
          distant future.

   MERIT

   MERIT-UNIV. MICH.

          Most of the bugs are out of the hardware.

          Most of the software is written.

Will have PDP-11s by the end of the summer that are capable
of transmission from one to another.

They will need and are now studying a TELNET-like protocol.

They are concerned with orderly communication of the two
processors; will later become concerned about process-process
communication.

EDUCOM

EDUCOM involves 100 major universities including most of
those now in the ARPA Network. For two years, they have been
running a network without wires. They assume the ARPA
Network can resolve the technical issues. They are looking
into marketing, contracts, documenting, etc., for running the
network. They have conducted a survey of 70 universities,
polled about their interests in the ARPA network: 60 of 70
are interested, 14 have money and are ready to become sites.

RAYTHEON

They will access the Net through the four Boston nodes.

Their interests include:
 1) experiments of file transfer conversions.
 2) indexing behavioral data to allow one to search an index
    to see if the body of data of interest is within the
    Network.

MISCELLANEOUS TOPICS

Graphics

   Al Vezza will host a July meeting of a small group interested in
   Network graphics. The price of admission is a sincere interest,
   working background, and a prepared talk.

NCP Protocols

   A new official document will replace document 1 and RFC #107;
   implementation should not be held up because of the absence of this
   new document.

   The long range protocol committee chaired by Carnegie has been
   disbanded.

IMLAC Users Group

   A quick survey was taken to determine which sites had or planned to
   get an IMLAC. The plan is to form an IMLAC users group. The
   following sites have or plan to get one: UCLA-S7, AMES-67, BBN,
   SRI-ARC, Stanford, MIT-DM, MIT-MULTICS, Mitre, Case, Raytheon, U. of
   Illinois.

Official Document Formats

   The notion of a functional document was suggested, one of which would
   be the document of official protocols with divisions of levels of
   protocols.

II.   MONDAY MORNING SESSION (5/17/71)

NETWORK INFORMATION CENTER

Plans for NIC

   Two activities are planned for this summer, off-line mail and on-line
   access. The off-line service will continue after the on-line service
   has come into being. Plans for getting on the Net via PDP-10
   (replaced XDS-940) are almost complete. Response times for display
   use are marginal.

   The activities will be developed in stages. Stage 0 (June 18) NIC
   will work with West Coast sites. This will involve providing NLS
   facilities to allow people to create messages with initial delivery
   as hardcopy, etc., with automatic generation of catalog entry and NIC
   #. This system has been used locally for about a month. Stage 1
   (August 2) NIC will be open to the Net community as a whole. Remote
   users will come in directly to the on-line system and will have on-
   line access to the catalog. Users will be trained either at SRI or
   at their own sites before coming on. Four to eight concurrent
   terminals will be supported. Stage 2 will include file transfer
   protocol, on-line delivery of messages, remote editing of SRI-located
   text. Prior to stage 0, a course will be offered (on June 16, 17)
   for UCLA, Rand, SDC, UCSB, Ames, and RADC for the use of Stage 0.
   The second group of users (after stage 0) will use NIC to do their
   own site documentation.

Concepts & Recommendations for Documentation

   The NIC # is a unique "name" for reference -- it has no other
   meaning. Other numbering schema such as RFC numbers will eventually
   go away. However, the subgroups, such as RFCs, will remain.
   Appropriate set manipulators will be provided for assisting in
   storage and retrieval.

   The notion of functional documents was introduced (see RFC #115).
   This is to be a document whose purpose is reasonably stable over
   time. It can have subdocuments that change more frequently. A
   current list of functional documents includes the NIC Catalog,
   Directory of People, Resources Notebook, Protocols, and Site
   Facilities (one for each site).

   The mechanism of documentation is the responsibility of NIC; the
   document contents are the responsibility of the author. There are
   two cases of document revision; replace part of the document and
   replace the entire document. In general, NIC would like the document

to be re-issued in its entirety with a new NIC # rather than issuing
errata. The functional documents are in looseleaf form, new pages
can be issued with the same number and a revision date.

Documents are reproduced and mailed to site liaisons 24-48 hours
after receipt. They are mailed to station agents on a weekly basis.
When mailing is handled directly by a site, a copy of the document
and a distribution list should also be sent to NIC. In the past, NIC
has supplied abstracts of documents for the catalog; NIC requests
that the authors include an abstract.

TELNET

The purpose of TELNET is to provide an immediate mechanism for
communication between keyboard terminals and serving processes, with
sufficient platform for later expansion and sophistication.

Tom O'Sullivan described TELNET as delineated in RFC #137. (Later in
these NWG meetings, Tom issued RFC #158, a new TELNET protocol.)
After the description, many issues and questions were raised, viz.,
can TELNET expect "recovery" from NCP, 128 vs. 256 character set, DLE
+ 7-bit code vs. high-order bit on, should protocol extend service
beyond what level consoles see, human factors, if information is
available at second level should it be passed to TELNET, TWX-like
service from NIC, mailbox protocol, etc.

In large part, these issues were raised but not resolved. It was
agreed that an RFC would be forthcoming (RFC #158, published later at
the meetings) followed by a functional document.

III. MONDAY AFTERNOON SESSION (5/17/71)

FILE TRANSFER PROTOCOL (RFC #114)

   The file transfer protocol (RFC #114) was described. See also RFC
   #133 and RFC #141.

   A simplified version of RFC #114 is being implemented by MIT/DM and
   MIT/MULTICS in order to: 1) allow Dynamic Modeling access to MULTICS
   file storage facility and 2) conduct a pilot project to gain
   understanding of such protocols.

   It was noted that RFC #114 was not simple enough to implement for
   TIPs.

   A group was formed to meet Wednesday morning for more discussion and
   to exactly define the problems. The group would include
   representatives from UCLA, UCSB, BBN, MIT, Rand, SRI, Harvard.

FILE PROTOCOL STATUS REPORT

   UCSB described the status of RFC #122, A Simple Minded File System,
   as an operational program; not a proposal. The basic concepts of the
   file system were described; the design objective was to provide a
   simple service quickly.

   Currently one 2314 drive and pack is available. At most four drives
   will be made available during the next year. It is also not clear
   how long space will remain available. The storage is currently free.

   Sites that will use the file system are Mitre, via BBN, UCLA, SRI,
   and Raytheon via one of the Boston hosts.

MISCELLANEOUS TOPICS

Sockets

   Socket name structure was briefly discussed. Relevant RFCs that were
   mentioned were 1) RFC #129 whose purpose was to describe socket
   structures enumerated at the February NWG meetings, and 2) RFC #147,
   a recently proposed structure.

   It was pointed out that there was a definite need to reduce the
   socket length from 32 to 16 bits (a TIP storage problem) regardless
   of its structure.

A committee (Bob Metcalfe, Chairman with Abhay Bhushan and Joel
Winett) was appointed to produce a report in two weeks. The
committee is to address the following three issues:

    1) is a socket structure needed
    2) are more than 16 bits needed
    3) what procedures are recommended for managing socket numbers.

Initial Connection Protocol

  Race conditions and time out problems were elucidated. See RFC #123,
  127, and 151.

  A committee (chaired by Jon Postel and including Steve Wolfe, Eric
  Harslem, and Arie Shoshani) was appointed to clean up the ICP
  specification.

Testing and Validation

  Sites wishing a remote partner to exchange NCP, TELNET, and logger
  protocols can contact Rand. Rand was to collect status information
  before and during these exercises. Information was to be forwarded
  to Alex McKenzie to maintain and update status reports. (NOTE: A
  later steering committee decision reflects on the way in which this
  information is gathered, however. Rand is still available for
  testing and validation.)

IV.   MONDAY EVENING SESSION (5/17/71)

NOTE: Minutes of this session were kindly prepared by Bob Walker,
RADC.

OPERATING SYSTEMS AND NETWORKS

An attempt was made to study the ARPA Networks from an academic point
of view. An analogy was drawn on the basis that the ARPA Network
with its hosts and protocols is in a sense an "operating system" and
that a study of what makes a good operating system might help define
what makes a good ARPA Network.

Professor Art J. Bernstein of Stony Brook gave a presentation
abstracting what he considered to be the features of a flexible
operating system, the techniques for obtaining such; and when
appropriate, a discussion of those aspects where a difference in
techniques is required between dealing with an internal operating
system and dealing with a network.

The features of a flexible operating system were cited as: (1) a
flexible file structure, (2) a process hierarchy, and (3) an
interprocess communication facility (IPC). The terminology and
techniques described to obtain these three features were essentially
those developed for the MULTICS system.

A file structure capability was defined in terms of hierarchy of
directories, tree names, active file table, hold count, known file
table, and reference number.

A process hierarchy was discussed in terms of father-son relationship
and a father-node spawning a son node, creating an entry in the known
file table and assigning resources, all embodied in the SPAWN
primitive. Implementation of primitives as time independent was
stressed as being crucial to Network activity whereas not necessarily
so for an internal operating system. This lead into the concept
subcontracting process, where executive type functions are treated on
the same basis as user processes and as such are swappable. The
"link process" was then described as the interface mechanism between
two cooperating machines.

Interprocess communication was discussed in terms of channels, status
return and software interrupts. Appropriate primitives were defined
in detail as well as control type problems.

The discussion then went to file handling and a specification of the required primitives and thence to directory handling, specification of related primitives, and the mechanics of directory handling, specifically the outstanding operation entry table in the executive.

After a short recess, Bob Metcalfe gave a presentation from the ARPA Network point of view with reference to various points of Professor Bernstein's presentation. He noted the all pervasive tree structure in Bernstein's presentation which appears to be most efficient to internal operating systems (i.e., file system, process hierarchy, etc.), but that the ARPA Network is not a tree structure but rather a directed graph and that we should be careful not to impose tree structure thinking on a directed graph type situation.

A number of questions and problem areas were elicited from the group and listed on the blackboard:
   1) How much does the operating system need to know about the
      Network to get how much and vice versa?
   2) Degree of transparency to the user?
   3) "Optimal" resource allocation on the Network?
   4) Autonomy versus centralization of control.
   5) Resiliency.

The group discussed the need for a committee on Theory, how it should function, how often should they meet, requirements for attendance, etc. Dave Walden was mentioned as a possible organizer of a related effort. Bob Metcalfe agreed to chair such a committee.

V.   TUESDAY MORNING SESSION (5/18/71)

DRS WORKING GROUP MEETING WITH OPEN ATTENDANCE

    The purpose of the Data Reconfiguration Service meeting was to
    resolve several lingering syntax and semantics issues and also to
    receive comments and discuss the DRS with the entire Net community.

    A brief overview of the DRS (see RFC #138) was given.

    Remaining technical issues were resolved. An implementation
    specification (replacing RFC #138) will be issued soon.

    Initial implementers and users were polled for schedules and initial
    experiments, results are shown below.

    MIT   No dates currently provided
    U. of Ill. One or two months will be required to reformat from remote
               formats to GOULD printer; also conversion of ARDS to
               COMPUTEC strings.
    UCSB   Implementation of service in two months; will provide
               system forms for remote TTY-like devices to access UCSB
               on-line system.
    MITRE   Will compare performance of DRS to current software of
               UCSB file experiment.
    Rand   implement service by September; initial use to specify
               UCSB RJE/RJ0 and UCLA NETRJS formats for local users.
    UCLA   will have a compiler of forms within one month unless
               serious difficulties arise.

DATA MANAGEMENT ON COMPUTER NETWORKS

    SDC presented RFC #144 (see also RFC #146). Arie Shoshani presented
    considerations and approaches that can be taken to achieve data
    sharing. The considerations were common language, sharing of
    existing data, evolutionary/revolutionary, future and use facility,
    further development, implementation, and speed.

    Approaches given were:
          1) centralized
              a) new data only
              b) existing data
          2) standardized data
          3) integrated - common languages + interfaces
              a) interface on different nodes
              b) interface on service node
              c) Data Reconfiguration Service
          4) Unified

Dick Winter described the CCA approach. With several data computers
it becomes decentralized. All data computers have identical hardware
and software. Their objective is to dispose and restructure data
throughout the Net to optimize its use, i.e., relocate it close to
where it is used most heavily. For small files of wide interest
multiple copies can be maintained.

Dr. Roberts commented that with respect to the Network, no
distance/cost relationship exists if data is retrieved more than one
link away. The reason for putting files in several places is
reliability. He views the CCA approach as a Net-level language, thus
the unified approach. Also the natural language approach is suitable
as a research project but not suitable for data management for real
Net experiments.

CCA will present a proposal of data language at the next NWG meeting.

OPEN DISCUSSION ON DATA MANAGEMENT

This time period was initially allocated to the description of a
particular data management system being constructed by Mitre. It
became, in fact, an open discussion of general principles and
requirements for data management in the Network. The following were
among the most recurrent comments made.

1. DRS, file protocol, and data management should be examined in a
    comprehensive way.

2. Important considerations of data management are to allow users to
    define and restructure files logically, to move towards
    transparency of the Net, and to move toward natural language.

3. A data management system should include functions for define,
    access, manipulate, analyze, store of files. For example, the
    data computer doesn't do formatting for output (like an RPG), it
    can take a number of conditions and do conditional retrieval but
    not RPG.

4. A data management system could be developed in stages where a)
    the user explicitly moves data around the Net, b) the user
    specifies the location but the access is integrated
    automatically, c) location is maintained by the service.

5. An area should be defined between file handling and application
    specific manipulation, and the area should be treated in a system
    wide way.

6. The super file (too large for any one individual to economically
    own) never came up before but it is reasonable for the Net.
    However it is just one use and there still will be need of many
    10^9 files.

7. Privacy and security criteria should be applied at output rather
    than input, which is an argument for having processing capability
    at the location of the file.

8. Dr. Roberts indicated that the things that are important are what
    things are on the Net, and what things are there to say. The
    structure depends on what there is to say. Thus, one should
    concentrate on the language and not the structure.

9. The data management system can be viewed as having two parts: 1)
    the request, 2) the response and format. On the response side
    (operand side) there is the taxonomy of data types and a template
    of data followed by the data. A template is a string in which
    data types or their descriptions are given with knowledge of
    iteration, recursion, and data types. On the request (operator)
    side, templates can be used to precisely specify the data to be
    retrieved, assuming the structure of the file is already
    specified.

10. The disposition and request are over structures to the response.

A small group was established to continue discussion on data
management.

VI.   TUESDAY EVENING SESSION (5/18/71)

TERMINAL IMP

The TIP can either be configured with 1) one host and two phone lines
or 2) three phone lines. Interfaces will provide 19.2KB to lowest
TTY speeds for each line. It can handle various terminals and
devices.

Normally the user speaks through the TIP but a primitive language
exists for talking to the TIP. Commands will exist to do the
particular protocols such as logger. Other commands will be present
for terminate on line feed, on character, now, on nth char., at end
of message, i.e., class of things to determine when message is sent.
There is another class to determine echoing. Device rates can be set
up. The serving site can also set up command such as capturing a
printer.

The TIP is currently trying to comply with all second and third level
protocols such as TELNET, file transfer (when defined).

Current plans are that the TIP cannot be reloaded through the
Network.

When new terminals are added, BBN will supply the TIP routines as
part of the service.

The TIP is intended to be used for RJE, terminal to process, and
later tape to tape. The TIP is intended to be a switch rather than
an operating system, under the assumption that power will reside in
terminals and service centers.

The program limits the bandwidth -- the sum of input and output is
100KB.

Potential for TIP delivery is about one every three weeks after
August. An upper figure for the TIP is $100K; the leasable terms are
$40K/yr. for three years plus a residual of $5K to own it, with a
two-year minimum. This was designed as an alternate method of
purchase.

"COMMENTS BY DR. ROBERTS"

The major cost benefit in the near term to getting on the Network
will be to use other physical systems to access new resources. It
will be a number of years before people enter the Network in order to
get rid of machines or to boost CPU usage.

Regarding future Network growth, the University of California has
proposed to enter seven universities into the Network. We should
have the data and program sharing protocols fixed by that time. ETAC
will be working on the past 10 years weather in 10^11 store. NCAR
will be trading time (a 6600 and a 7600) with them and with ILLIAC;
use is restricted to weather work. January or February are probable
dates. This will be a third cross country connection through UTAH
perhaps (second is via Omaha weather). SC will be added in March or
April '72 for picture processing. England will join about February '
72. There are other plans to tie in Mexico, France, Israel,
Australia, Japan, Hawaii, Canada, etc. that could possibly all happen
in '72.

With regard to operating the Network, ARPA will not operate it
indefinitely. One plan is to have AT&T operate it since they can
legally sell the services; this will not come about soon. A
commercial organization (not a common carrier) can only operate the
Net under Government sponsorship. The current plan is to have BBN
run the Net as a service for the Government; this will be settled
within the coming year.

On the question of resources, setting up contracts with the service
people at each site to get one agent to ship money for various
subcontracts is a basic legal framework; for ARPA purposes it is
sufficient to have only one connection with each site.

On software development, the NCP progress has been extremely poor and
slow. The second iteration should have been defined by now from
experiences with the first. Towards the end of the year a new
protocol should be defined to last for a couple of years. Accounting
and billing protocol should also be defined. The NCP protocol is
getting to be a critical problem -- everyone should be complete and
consistent with the current protocol by July 1. Without it, there
will be serious problems of bringing new people onto the Net. For
example, the I4 and the laser store will be on the Net by March or
April of '72 with serious people wanting to use it (80% of its use
will be remote). By early '72 the Net must be a solid working
entity.

The question of profit making time-sharing companies on the Net
depends on whether or not AT&T takes over Net operations.

The capital arrangement for non-ARPA users to be on the Net is as
follows. A federal agency can donate $76K and get a TIP. Non-
federal agencies can pay $36K per year for the TIP for three years
plus the $5K residual to own it. ARPA will not decide casually to
allow non-federal agencies on.

Regarding software support services, documentation will be upgraded
so all sites need not keep complete NIC documentation (except service
sites). In service centers it makes sense to add one or two
personnel to work on net service programs, work with users, etc., if
needed. Research centers will now have to concern themselves with
reliability, integrity, and problems of access.

Regarding the charging mechanism for the data computer, the 10^12
store cost one million, plus the cost of the PDP-10; thus 10^-4
cents/bit is reasonable for permanent storage. The rate for short
term storage strips (like two weeks) will be about the same. If
medium term storage is needed, a rate will be worked out. ARPA will
pay for this storage as backup for the sites.

The on-lineness of NIC is very important for initial use, but we must
have something better than TTY or CRT. The Net is cheaper than the
mails. (Electrostatic hard-copy devices were briefly mentioned).

Regarding new developments for AI symbolic processing, a plan hatched
by Alan Kay is to have lots of processor, lots of core and a big
switch with the capability of serving users in the Net. It is to
provide low cost core space (economics of processing are not known).
This may become associated with some experimental hardware
development facility since the desire is to be able to build new
architecture in a reasonable amount of time. It should be 10 to 100
times faster than the PDP-10 with earliest delivery in '73.

The speech effort is on the order of three million per year. The
concern now is to be able to tie together pieces at various sites for
comparative evaluation. The cross-testing can have an impact on the
researcher, but everybody must maintain compatible interfaces.

The climatology program is for predicting future long-range climate
of the World that comes about by perturbations. Various sites are
involved at various levels and it is hard to get these people to big
computers, to the data bases, and with each other. The Network
provides their total communication path with the I4. Direct and
effective use of the Network can be made without much more of an
investment; the Rand/UCSB work is a good example.

                   VII.   WEDNESDAY MORNING SESSION (5/19/71)

This session began with discussion of file transfer protocol, led by
Abhay Bhusan. It was decided that the current file transfer protocol
should be parsed into two pieces -- a data transfer protocol front-
end that could be used for file transfer and other protocols, and the
file mechanism protocol. This problem was referred to the committee
which met for the remainder of the day to specify the data transfer
and file protocols. An RFC will be forth-coming, describing these
protocols.

The data management group met in parallel Wednesday. An RFC will be
forthcoming on their results.

            VIII.   WEDNESDAY EVENING SESSION (5/19/71)

   The following information was summarized by Steve Crocker.

Committees	Publication Date	Approval Date
ICP - Postel	5/27	6/3
File Transfer - Bhusan	6/7	---
Data Mgmnt. - McKay	(7/21)	---
Socket Struc. - Metcalfe	6/22	---
Telnet - O'Sullivan	5/19	6/10
Theory - Metcalfe	---	---
DRS - Heafner	6/1	---
Graphics - Vezza	(7/18)	---

   The following inputs were provided to Steve Crocker on implementation
   dates of NCP (RFC #107) and TELNET (RFC #158).

Service Hosts	NCP + TELNET
CCN	7/1
LL/67	6/15
SRI/NIC	(6/18)
MIT/MULTICS	7/1
BBN/10X	?
UCSB/75	Up

__Host__	NCP (RFC #107)	TELNET (RFC #158)
UCLA/S7	6/1	6/15
Rand	Up	6/15
Utah	Up	6/15
U. of Ill.	7/1	7/1
Harvard	?	?
MIT/DM	5/25	6/25

   The following inputs were provided to Steve Crocker on schedules for
   current and pending work.

Users	Tasks
Mitre	data management in progress
Raytheon	data sharing (August)
NBS	PDP-11 via low-speed phone line (July)

          BBN   validation of resource notebook
                                 (July 15)

          UCLA   data store, retrieval, reduction
                                 (July 1)

          DM/MULTICS/Harvard   graphics, file transfer (July 1)

          Ames/67   I4 simulator (July 15)
                                 climate with UCSB (now)
                                 climate with UCLA (July 1)
                                 DRS (September)
                                 SRI/NIC (August)
                                 LL LISP (?)

          LL   TX2 speech data
                                 TX2 data transfer (now)
                                 TSP compiler (September)

          U. of Ill.   remote use (July 1)
                                 link to Paoli (July 1)

Miscellaneous Issues

   Alex McKenzie will generate the NCP functional document in one month
   as an experiment.

   Service documents to be sent to NIC include normal user documentation
   you would use at the site plus special conventions (if any) for
   remote users. Read RFC #115 and RFC #118.

NWG Organization

   There is some concern over the size of the NWG. Its functions and
   reorganization were discussed. Nothing definitive resulted
   immediately. It was suggested by Steve Crocker that another NWG
   meeting would be held in August.

   Dr. Roberts and Steve Crocker created a steering committee to examine
   this and other problems. More will be said about the steering
   committee by Steve Crocker, at a later date.

       [This RFC was put into machine readable form for entry]
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