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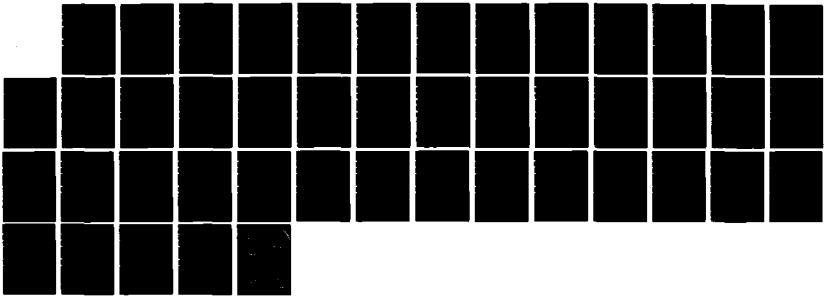

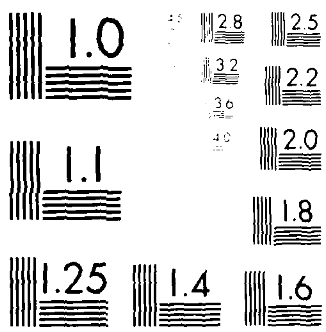

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Bethesda, Maryland 20084

MITRENET A TESTBED LOCAL
AREA NETWORK AT DTNSRDC

by

Richard Havard III

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COMPUTATION, MATHEMATICS, AND LOGISTICS DEPARTMENT
DEPARTMENTAL REPORT

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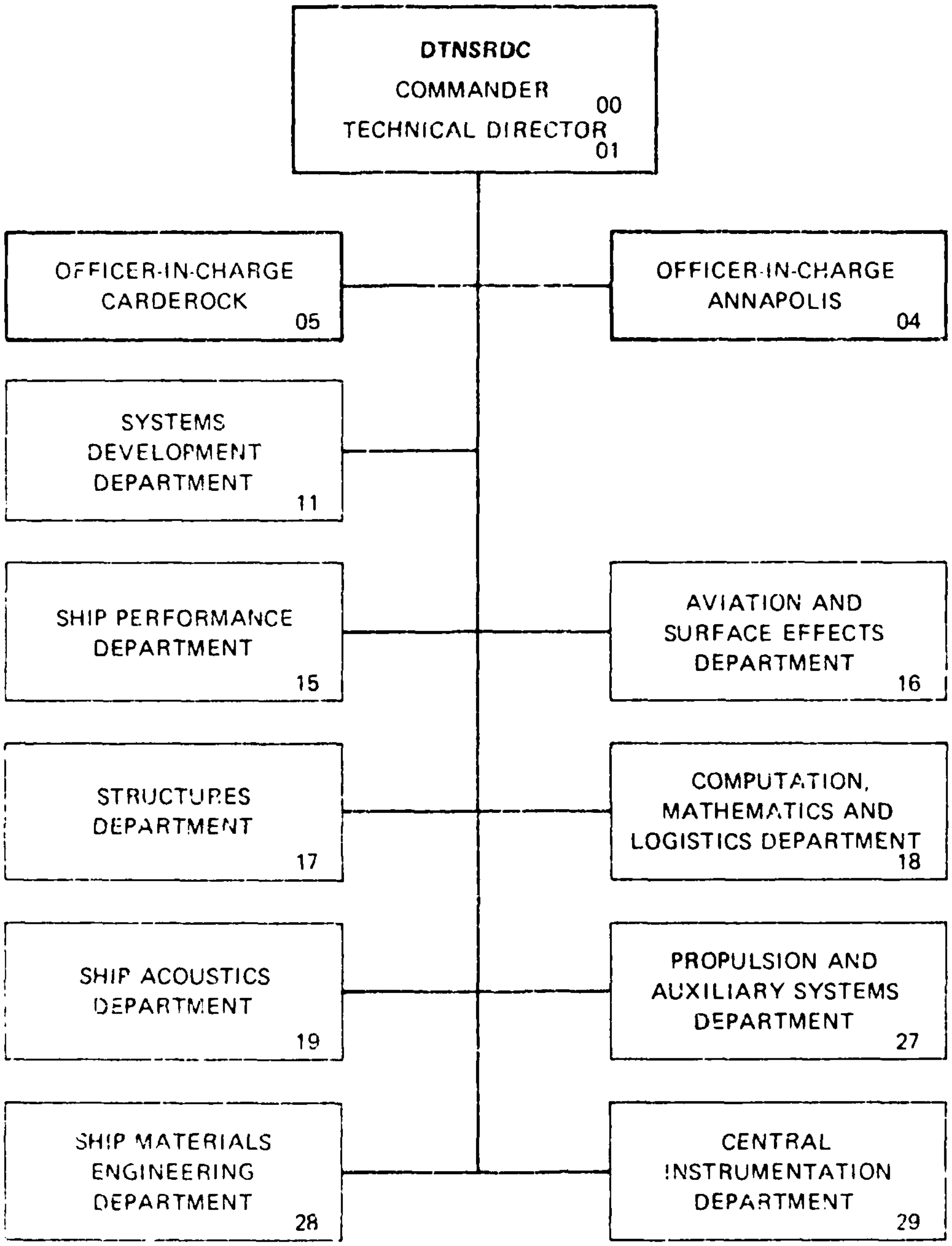
DTNSRDC/CMLD-86/11

MITRENET A TESTBED LOCAL AREA NETWORK AT DTNSRDC

MAJOR DTNSRDC ORGANIZATIONAL COMPONENTS



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DTNSRDC has established the Technical Office Automation and Communications System (TOFACS) to utilize modern office automation technologies. A pilot broadband network was installed to study the effects of a high speed network on the productivity of TOFACS. DTNSRDC installed the MITRENET Local Area Network (LAN) with the objective of experiencing the use and managment of a LAN with the intention of eventually installing a permanent, full scale LAN at DTNSRDC.

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ACRONYMS AND ABBREVIATIONS

ARPANET	The Defense Advance Research Projects Agency Network
BIU	Bus Interface Unit
CD	Collision Detection
CMOS	C Micro Operating System
CSMA	Carrier Sense Mutliple Acess
DCE	Data Communication Equipment
DDN	Defense Data Network
DIU	Host DMA Interface Unit
DTNSRDC	David Taylor Naval Ship Research and Developement Center
DMA	Direct Memory Access
EEPROM	Electrical Erasable Programmable Read Only Memory
EPROM	Erasable Programmable Read Only Memory
FTP	File Transfer Protocol
HDLC	High-Level Data Link Control
HIU	Host Interface Unit
IC	Intergrated Circuit
IEEE	Institute of Electrical and Electronic Engineers
IU	Interface Unit
IP	Internet Protocol
LAN	Local Area Network
NAP	Network Access Protocol
NCC	Network Control Center
NIU	Network Interface Unit
PROM	Programmable Read Only Memory
RAM	Random Access Memory
RCP	Remote Control Protocol
RF	Radio Frequency
SIO	Serial Input/Output
SMTP	Simple Mail Transfer Protocol

TELNET	Virtual Terminal Protocol
TCP	Transmission Control Protocol
THIU	Dial-Out Interface Unit
TIU	Terminal Interface Unit
UUCP	UNIX to UNIX Copy

ABSTRACT

DTNSRDC has established the Technical Office Automation and Communications System (TOFACS) to utilize modern office automation technologies. A pilot broadband network was installed to study the effects of a high speed network on the productivity of TOFACS. DTNSRDC installed the MITRENET Local Area Network (LAN) with the objective of experiencing the use and management of a LAN with the intention of eventually installing a permanent, full scale LAN at DTNSRDC.

INTRODUCTION

David W. Taylor Naval Ship Research and Development Center (DTNSRDC) has established the Technical Office Automation and Communications System (TOFACS) to utilize modern office automation technologies. The proliferation of TOFACS has intensified the need for data communications throughout the Center. Therefore, a means of communicating data swiftly and reliably was and is now needed. A pilot broadband network was installed to study the effect of a high speed network on the productivity of TOFACS. DTNSRDC installed the MITRENET local area network (LAN) with the objective of experiencing the use and management of a LAN with the intention of eventually installing a permanent, full scale LAN at DTNSRDC. This report is organized into four general sections:

MITRE Implementation

Present Status and Development of the Network

Conclusions and Summary

Appendices

BACKGROUND

MITRENET is a network product of MITRE CORP. There are four versions of MITRENET, three of which were developed at MITRE in Bedford, Massachusetts. The fourth and most advanced version was developed at MITRE's McLean Virginia facility. All four versions use a Network Interface Unit (NIU) or more commonly known as a BIU (Bus Interface Unit) which employs Carrier Sense Multiple Access with Collision Detection (CSMA/CD) network access techniques. The McLean version differs significantly from the previous versions in that it is based on a Z8000 microprocessor and is able to support the Department of

Defense, Transmission Control Protocol (TCP) and Internet Protocol (IP) standards. The previous versions do not support TCP or IP and have considerably less capability.

A major implementation effort of MITERNET was begun by M/A COM DCC, under contract to MITRE in 1978. This eventually became known as the INFORBUS system and is based on the z80 microprocessor. In 1981, Ideas Inc. developed a similar system for the U.S House of Representatives. The Defense Communications Agency decided to sponsor, beginning in 1980, a more powerful MITRENET-based network produced by the MITRE C3 Division at McLean, Virginia. The Zilog z8000 development board was selected as the basis for the new BIU (Bus Interface Unit) and was manufactured by Reaction Instruments, Inc. This is the MITRENET currently installed at DTNSRDC.

MITRE IMPLEMENTATION OF THE NETWORK SYSTEM

According to the MITRE report "A Testbed Local Area Network at DTNSRDC - Volume 1: LAN overview" (MTR-84W00122-01), the MITRENET at DTNSRDC uses broadband dual coaxial cable. The interface units to this LAN are z8000 based BIUs. The MITRENET follows the (Advanced Research Project Agency/Defense Data Network) protocols, these being TCP, IP, File Transfer Protocol (FTP), and TELNET. Simple Mail Transfer Protocol (SMTP), the Electronic Mail Protocol, does not support the LAN in this prototype. MITRENET employs packet switching technologies.

Terminals are connected to the network via Terminal Interface Units (TIUs) and the host computers via Host Interface Units (HIUs). The VAX-11/780 serves as the host in DTNSRDC's LAN. The host contains a UMCZ80 board (the Direct Memory Access (DMA) device) which provides the interface to the HIU. A host-to-frontend protocol, designed by MITRE Corp., is the Network Access Protocol (NAP). This protocol makes possible the interfacing of the host to the BIU.

In the initial implementation by the MITRE Corp., the MITRENET at DTNSRDC consisted of two subnetworks, Network Alpha and Network Bravo. These subnetworks will be discussed later.

The Direct Memory Access Interface Unit (DIU) is a TIU with hardware and software modifications to allow for high speed RS-422 link to a UNIBUS DMA device (UMCZ80) for Digital Equipment Corporation PDP-11 or VAX computers. Up to 25 terminals can access the host computer through the DIU simultaneously.

MITRENET NETWORK COMPONENTs

The network components of the MITRENET consist of the cable plant, the network hardware components, and network software.

Cable Plant

The LAN used at DTNSRDC is a dual coaxial cable network. The cable itself is a JT-3412 semi-rigid aluminum shielded coaxial cable (0.312 inch outside diameter). The components making up the backbone are wideband linear amplifiers, power supplies, taps (which allow devices to make network connection, and splitters (to allow cable branching). Aluminum cable (0.412 inch diameter) with sleeving to protect against weather and water is used where the LAN backbone is placed between via underground conduits or breeze-ways.

The Network uses 4-way multitap pairs situated every 50 feet along the network's aluminum distribution cable. Two BIUs can be accommodated on each of the 4-way multitap pair. Network Alpha uses 14 multitap pairs and network Bravo uses 8. A minimum of one RS-232C post can be maintained at each work location. The UNIX Operating System (UNIX BSD 4.2) is used on the Vax Host.

Network Interface Units

The general interface to the LAN is the BIU. The BIU was designed at MITRE Corporation in McLean, Virginia and was manufactured by Reaction Instruments as Model 442C NIU.

MITRE Corporation has made some modifications to the basic model 442C so that there are now 64K bytes of RAM memory and sockets for installing 32K bytes of PROM (eight 2732A EPROM chips).

The BIU is a z8002 microprocessor unit with radio frequency (RF) modems and serial input/output (SIO) ports. The RF modems modulate a carrier signal to transmit the digital information. The middle frequency of this RF modem is 39 MHz with 4 MHz bandwidth. There are four types of BIUs.

The first type of BIU is the TIU which interfaces with the terminals. The TIU has a configuration of ten RS-232C ports, with each port capable of running up to 19.2 Kbps. The TIU makes it possible for a user at a terminal to communicate with a host or another terminal. The TIU contains terminal interface software which enables a user at a terminal to connect to a specific host in the network.

The second type of BIU is the DIU, which interfaces with the host via a high-speed synchronous link from a host DMA interfacing device (the UMCZ80). The DIU acts as a frontend in the network architecture and contains software to implement its half of the MITRE-designed host-to-frontend protocol, NAP. One side of the DIU communicates to the TIU using TCP/IP protocols through the MITRENET cable and on the other side it communicates to the UMCZ80 using NAP (Network Access Protocol). Both the TIU and the DIU contain an operating system called CMOS (C Micro Operating System), and both implement the lower protocol layers TCP, IP, CSMA/CD, and HDLC (High level Data-Link Control).

The third type of BIU is the Host Interface Unit (HIU) which interfaces with the host RS-232C ports on the DH-11 or DZ-11 devices. Besides the CMOS operating system, TCP/IP, CSMA/CD and HDLC protocols, a Remote Control Process (RCP) is implemented in the HIU. The RCP provides basic network administrative functions such as resetting connections, enabling or disabling the HIU RS-232 ports, and selecting the baud rate for the RS-232 ports. The RCP can be used by someone located at a location which is remote from the HIU establishing a TCP session over the LAN to the host HIU.

The fourth type of BIU is the THIU, which utilizes TIU hardware and HIU software. Up to ten auto-dial modems can be connected to the THIU. Users on the network can dial out to the outside world. Because the THIU uses HIU software, it also uses the CMOS operating system. This means that the THIU is a TIU configured as a DCE and not a DTE. The THIU could be used to replace the HIU through the proper cable, thereby preventing some software problems in dial-out. The THIU is dedicated to connecting host computers and/or modems. User terminals cannot be attached to the THIUs or HIUs.

UMCZ80 Microprocessor.

The UMCZ80 board is a device which gives the host computer the ability to interface a NIU via high-speed link. The UMCZ80 uses a Z80 microprocessor. It is manufactured by Associated Computer Consultants and has been modification by MITRE Corporation. A UMCZ80 is installed in each of MITRENET's host's UNIBUS slot. Most of UMCZ80's software (90%) is written in C Language.

Some of the low-level software is written in z80 assembly language. MITRE maintained the UMCZ80's software by a Z80C cross compiler on a PDP 11/70 running UNIX Version 6. MITRE had purchased this cross compiler from Interactive Systems.

DMA transfer between both UMCZ80 and VAX-11/780 memories is possible since the UMCZ80 supports DMA capability.

The UMCZ80 contains 4 Kbytes of RAM and 16 Kbytes of PROM (programmable Read Only Memory). The PROMs are made of four 2732A EPROM chips that can be inserted into sockets on the UMCZ80 board. Also, 32 Kbytes of RAM located on a memory extension board can be connected to the UMCZ80 processor board by being plugged into the host's UNIBUS. The UMCZ80 uses NAP to off-load the host, thereby allowing the host to reach greater speeds.

Communications between the UMCZ80 microprocessor and z8000 DIU is implemented through the use of several interrupt service routines. For details of the UMC hardware refer to Volume V of a "A Testbed Local Area Network at DTNSRDC".

Network Software

A large part of NIU software is written in C language. This software provides the LAN's lower level protocols, the CMOS operating system, and the host-to-frontend protocol. Part of the software was written in z8002 assembly language. This software was maintained by MITRE Corp. using a Z8000 C cross compiler package running on a PDP-11/70 UNIX Version 6. These protocols are briefly described below, the details of their implementations can be found in MTR84-W00122-01. Currently, there are sets of software used in MITRENET's TIU, HIU, and DIU.

For the software residing in the host computer, the MITRENET uses NAP as a means of communication between the host's service layer protocol and the BIU's lower layer protocol.

The service software used by the VAX-11/780 consists of library subroutines which are part of each program. The job of these subroutines is to access the protocols implemented in the DIU.

Transaction software is part of the UNIX kernel and is arranged as software modules inside the Kernel.

A server program called "ltelsrv" provides users a virtual terminal connection through the DIU.

The original VAX-11/UNIX 4.1 BSD Kernel was modified by MITRE Corporation Several source files such as "nipswitch.c", "nipacs.c" and "nipio.c" with their included files were added by MITRE Corporation into the UNIX Kernel to implement the transaction layer of the software. All of the software is written in C except for a file called "niputrap.s" which was written in VAX-11 assembly language.

User parameters and data are moved from the UNIX user level to the Kernal level by using the VAX-11/780 Extended Function Code (XFC) instruction. XFC acts as an interface between the service and the transaction software.

MITRE Corporation maintained VAX Host software using Vax-b (Unix C) compiler.

Software within the host implements the high-level protocols to provide the user with network functions such as communication between terminals and file transfer. All software that resides in the host is written in the high level C language.

As mentioned earlier, part of NAP is contained in the UMCZ80 to provide speed and to off-load from the host.

NETWORK PROTOCOLS

The MITRENET software follows standard layered protocols, thus permitting a variety of devices to be connected to the network. The NAP protocol serves as the host-to-frontend protocol. MITRENET's software uses a set of commands to gain access to the LAN.

One type of network protocol is CSMA/CD. This protocol prevents collision between different transmissions traveling through the network. CSMA allows a BIU to decide weather the path is clear before going ahead and transmitting data.

Another protocol in the LAN is the IP protocol. IP provides a datagram service for transmitting data through the LAN.

The TCP protocol also is employed on the MITERNET. TCP assures a virtual circuit between two processes occurring in interconnected packet-switched networks.

The RCP protocol is designed to operate in the HIU or THIU to provide basic network administrative functions.

Users can access different hosts by utilizing the TELNET protocol. TELNET allows interoperability for asynchronous scroll mode terminals.

Users operating from a foreign host can access files and transfer files between hosts by using the FTP protocol.

PRESENT IMPLEMENTATION OF MITRENET (MAY, 1985)

TIU's

Nine on-line located in buildings: 192 (3), 9 users
191 (3), 9 users
121 (1), 4 users
17 (3), 25 users
TOTAL # OF USERS: (46)

HIU's

fiscal - vax-b
db1 - Plexus-B (2 ports), tower (1 port)
VMS - Scientific & Engineering VAX

THIU

dial-1 - DCA 355 switch (10 ports, 4 decicated high speed ports)

A burn-in station located in building 192 room 107, enables equipment to be tested before being installed on the network. The idea behind the burn-in station is to connect BIUs on-line with the the network before replacing an inoperative BIU on the network (usually a burn-in period should last anywhere from three to five days to insure a successful replacement). It is recommended that the future DTNET (David Taylor local area Network) provide a burn-in station completely separate from the production LAN because experience has shown that an improperly operating BIU can possibly bring down the entire network. Furthermore, all testing, integration, and future development can be done on a much smaller scaled model of the DTNET without risking disruption on the production LAN. The scaled model of the DTNET, or better known as a Test Bench, will insure smoother integration of components on the Network.

HARDWARE

Outside equipment located at IMS (Integrated Microcomputer Systems, Inc.), a local consulting firm formerly tasked to support the maintenance of the

MITRENET, includes 2 UMC z80 memory boards, and 2 UMC z80 controller boards. This equipment was used to build a "mini mitrenet" at IMS using a VAX 11/750 as the host computer.

All necessary hardware, i.e., BIU,s are available for use. This includes 15 TIU's, 4 HIU's, 6 DIU;s, and 2 THIU's. However, most of the BIUs are not working and extensive maintenance is being preformed to salvage an optimum number of BIUs in order to support the continuous operation of the LAN. Most of the maintenance of the hardware is preformed by in-house personnel and IMS. DTNSRDC has recently acquired a Network Analyzer to preform most of the troubleshooting in the BIU's particularly in tuning the RF-Modems. Maintenance and the problems found associated with the LAN will be discussed in more detail later.

Distribution cable for making connection to the taps on the network is available including RG-6 F-type connectors.

SOFTWARE

New HIU EPROM software is being installed in the HIU's because of a problem found in the RESET command which has been modified by IMS. Other numerous existing problems were discovered. Many of the problems have been resolved (Appendix A), such as those with the TIU, HIU, THIU, Unix Kernal and Ltelsrv, etc. Due to the limitation of funds, some problems have been investigated but not resolved such as the unreliability of the TIU-DIU connection, and difficulties with the TIU-HIU connection in reaching steady state at 9600 baud through the MITRENET.

CABLE PLANT

Network Alpha and Network Bravo have been combined into one logical LAN including buildings 193, 192, 191, 17, and 121 with a cable extension going to building 2 and 19. Building 121 cable plant has been repaired, tested and tuned by ARC Engineering. Installed at the headend in building 193 was an eight-way pair multi-tap that was needed to further develop and add-on future network resources in the controlled environment of building 193.

Network Alpha uses a VAX 11/780 and resides in building 193. The headend in the MITRENET takes signals comming from the inbound cable and amplies them onto the outbound cable. The headend resides in building 193 and consists of a signal splitter, a power combiner, a power supply, two line amplifiers, and three multitaps. One of the multitaps sits between the inbound and outbound cables and causes the inbound signal to loop to the outbound cable.

PRESENT STATUS SUMMARY

The present overall health of the network is good, running smoothly and uninterrupted except for planned shutdowns for maintenance, experimentation and development on the network. There will be, however, unplanned down-time on the network for some or all users occasionally due to a faulty TIU or HIU. In most cases the inoperative BIU need only be reset. Even without the support and maintenance from the manufacturer and with limited or nonexistent network control management the MITRENET has proven to be both useful and effective providing utility for approximately 40+ users, reliable file transfer between computer hosts and terminal devices on the network, and practical hands-on experience for government personnel who are involved with the network.

PAST EXPERIMENTS

There have been several past experiments performed on the network to demonstrate some of the capabilities of a broadband dual cable LAN.

Video Security

There was a video camera installed on the network which successfully demonstrated video surveillance on a LAN cable plant.

PA System

In October 1984 a modulator was installed in basement of building 2 with a demodulator located in building 192. Voice was successfully broadcast in buildings 191, 192 using the LAN cable plant technology with greater quality than the existing public address system.

DMA, DUAL-DMA (Direct Memory Access)

DMA is the implementation of the original network design. This newly pioneered implementation provides greater processing power at the front-end of host computers. It handles up to 13 users with only one port connection into a UMCZ80 which resides in the host. Dual DMA is an enhancement of DMA which will handle up to 26 users. Neither DMA nor dual DMA are implemented at this time because it did not prove to be reliable when in use. (NOTE: refer to

Appendix A which explains in detail the problems associated with this implementation).

PRESENT DEVELOPMENT

File Transfer

The File Transfer capability has been implemented using a TIU connected to several ports on VAX-B located in building 192 residing in the same cabinet with DIAL-1 and DB1 HIU's. This implementation will enable file transfers between all hosts on the network at a speed of 4800 baud. The file transfer implementation using the TIU has been successfully performed by IMS at their location approximately nine months ago using the KERMIT protocol. C-KERMIT will reside in public domain on host computers on the network. An inherent feature from the TIU-HOST interface connection provides the capability of a remote access to the MITRENET. Network managers can access all resources on the network to check the health and operation of the network from a remote location.

File transfers have been demonstrated successfully between Zenith 120 microcomputers, the Zenith and the Plexus, the Zenith and the VAX 11/780, the Zenith and the Apple Lisa, the Zenith and the Tower. All microcomputers use the C-Kermit File Transfer Protocol and have transferred ASCII files in all combinations of the above microcomputers with a very low error rate on the network. The MITRENET cannot however transfer binary files because it strips the eighth bit.

Expanded Resources

It is now possible to expand host resources to the network including the NALCON VAX 11/750, and by adding more ports onto the Plexus and Tower processors now existing on the network. However, each host will have its owm HIU before new users can be brought on the seperate computer devices. As of now the Plexus and Tower use the same HIU due to expiremental purposes it is impractical to use in its present configuration.

It is now possible to connect the VAX computer (original fiscal) in building 121. Several users were brought on to the MITRENET in building 121 that demonstrates the functionally and visibly expands the entire use of the network. Because of the limited number of operational and reliable Interface Units it is not recommended to bring on any more users at this time. The

MITRENET does however provide a means of data communications for users who do not have a data line or any other means of communicating with remote host computers.

The DCA 355 Data Switch has been integrated into the MITRENET utilizing a THIU going into the ST Handler (TRUNK) and connected to the TT (TTY) Handler by the Node Super Processing Module that connects directly to the TTY ports to all of the resources on the DCA 355 Network. The 355 uses a character oriented protocol to connect to the hosts. All of the processing, flow control, and handshaking is done in the PM (processing module) which is a Z80 based microprocessor board. With this configuration it appears that a greater baud rate can be achieved (9600 baud) with a very low error rate. However only one port was connected to the 355 in this way and it is unknown if this throughput can be sustained if all ten ports were connected at 9600 baud at one time. Another interesting configuration using the THIU-355 is when the baud rate is lowered in the THIU to 1200 baud. The 355 will multiplex the 1200 baud port comming from the THIU to all the different host selections that are presently configured to speed match at 1200 baud, thus that one port will contend like any other incoming port on the DCA 355 Network. In effect that one 1200 baud port from the THIU can access many more resources from one THIU as opposed to one HIU dedicated to only one Host. The software presently in the HIUs can only access one host at that address. An advantage of this configuration (THIU set at 1200 baud) a user CAN access any host NOT on the MITRENET but can access any host resource on the 355 using the MITRENET. The disadvantage is the tradeoff in slower speed at 1200 baud.

PC Server

Expirements were performed utilizing the Network as a PC Server. It is possible to interconnect different personnel computers or workstations to the MITRENET to access resources and transfer files between workstations at remote locations with some transparency to the users. The PC Server included a dedicated Zenith 120 set in the ctty mode which enables a remote user to intentionally open an HIU connection at the Servers address, and take over control of the Zenith 120's terminal. Now the user can access or share any file on that PC including transferring that file between different host computers that support the same version of C-Kermit on the MITRENET at a transfer rate of 9600 baud.

Print Server

A print server has been attempted on the MITRENET, however not totally successful. Some of the problems and difficulties are:

1) Limited hardware resources

The MITRENET does not support a Print Server. One way to implement a Print Server is to connect a TIU to the TTY ports on all or some host computers. This is not practical because "VAX-B" has limited number of TTY ports available and those ports are needed to support the population of TOFACS users. And the MITRENET has a limited number of working TIUs that are needed to support the users on the network.

2) Use of HIU as Frontend

Another approach would be to use an HIU as a frontend to the Print Server. However there is no way presently to control the handshaking in the HIU alone. The flow control cannot be managed in any way in the HIU.

3) Microcomputer as Spooler

Required hardware would be an HIU, TIU, and a microcomputer with three communication ports. A print server was developed with this configuration; a HIU connected to an Apple LISA to logon spooler, cu to tty0 out to a TIU, open third connection to source host, transfer file using C-Kermit to Apple Lisa, print file to Diablo 630 letter quality printer. This process works but is too cumbersome to use. Too many connections would have to be made on the mitrenet and the entire process is impractical to use. It is easier to use the existing TOFACS printing methods.

The MITRENET does not support a Print Server at this time, and the above mention ways are not transparent enough for any practical use.

Software

When all resources are identified, new address tables including dummy symbols with address, will be burned into the EPROM chips and installed in all the TIU's.

Hardware

Special cable adapters are needed in order to reconfigure a TIU to an HIU to further develop and expand host resources and workstations on the network. These cable adapters will circumvent the need to hard wire the SIO boards in the interface units. This will reduce the possible hardware failure and error when hard-wiring and significantly reduce the amount of time by just adding a special cable adapter to a TIU to easily convert to an HIU. There is a shortage of HIU's and the cable adapters will easily rectify this problem.

Maintenance

Most all of the maintenance required on the MITRENET is performed on the BIUs. Up until October 1984 Reaction Instruments performed all corrective maintenance on the BIUs. After October 1984 Reaction Instruments announced they would no longer manufacture, support, or perform maintenance on the BIUs. Only four minor parts may be replace in the operating area. These are the fuse, the "POWER" switch lamp, and the two front panel LED's. The following equipment (or equivalent) is required for maintenance, test and support of the Model 442c Bus Interface Unit. This equipment is utilized for alignment, calibration and testing of the modem and digital logic.

TEST EQUIPMENT

Generator Supply
Network Analyzer
Phase/Magnitude Display
Spectrum Analyzer
Digital Frequency Counter
Oscilloscope
5Vdc Supply
12Vdc Supply
50/75 ohm matching impedance pads
40db 75ohm Star-coupler

DTNSRDC has recently rented a Network Analyzer which includes the Spectrum Analyzer, Generator Supply, and Frequency counter to do the testing and alignment of the modems. The test equipment and testing is done at IMS's location in Rockville, Md. on their "mini MITRENET. All maintenance on the BIU's is now performed by government personnel and IMS. The Network Analyzer is used for modem alignment procedures, transmitter filter alignment, receiver filter alignment, receiver discriminator pre-alignment, and receiver detector

Pre-Alignment. Some of the more common problems encountered with the checking of an inoperative BIU are:

- CPU chips may be bad. This would cause the BIU to have no response at all. Would have to replace the cpu chip.
- The BIU "times-out". It is usually do to a frequency shift in the RF modem or not enough "POWER" at the transmitter or receiver end of the modem.
- Bad components in the motherboard. DTNSRDC is not equipped to troubleshoot or replace parts on the CPU board.
- No connection on any one port, but other ports are working the problem is most likely located in the SIO board.
- Any combination is likely to occur. With no spare parts the BIU's with the more serious problem would be cannibalized.

CONCLUSIONS

Like many other pioneer local area networks, the MITRENET has experienced several design problems. Since MITRENET was originally designed as an experimental network at the MITRE Corp., emphasis seemed to have been put on the demonstration of an operational network with with little attention placed on network management, software maintenance, and provisions for easy enhancement and assurances of reliability. Nevertheless, early MITRENET design strategies such as the implementation of DMA at the host with multiplexing capability has had significant impact in the LAN industry and is considered a leading step in the success of today's host-to-host LAN products.

In the following, there are problems, and several interesting issues that have been unearthed about the MITRENET.

IMMATURITY OF THE LAN INDUSTRY

Utilization of LAN in data communications has generally been oversold to the public since its emergence. LAN has been described as an easy to use communication media that enables the interconnection and communication of heterogeneous computer devices. As of today, this promise is still essentially a promise. Most off-the-shelf LAN products are still considered as in their infancy stage. Installed base and user experience on LAN products are very limited. Most of the cases, LAN implementors and users have to continuely work closely with LAN manufacturers to identify and resolve network problems that never seem to stop. As one of the early pioneers in using LANs, DTNSRDC's experience with network problems can be said as has been certainly expected. Although the provisions of remedial actions to these problems has been complicated by the fact that MITRENET is not an off-the-shelf commercial product and is not actively supported and maintained by its manufacture Mitre. However, being a research and development laboratory, taking a pioneering step of selecting a R&D oriented prototype network with state-of-art technology is one of the best ways to learn and understand the technical fundamentals involved. This is most valuable experience for future development and planning.

IN-HOUSE EXPERIENCE

Unlike off-the-shelf products, MITRENET was developed, manufactured, and maintained by a non-profit research and development oriented organization and was later developed into several different versions. The MITRENET BIUs used at DTNSRDC are basically implemented on several Original Equipment Manufacturers (OEM) Z8000 microprocessor boards. Although MITRE Corporation has made some modifications and enhancements to this board, the capability of the BIUs were limited by the available hardware design of the boards.

One of the major problems that the MITRENET facing now is the lack of both hardware and software support by the original manufacturers. Because of this, significant in-house managerial and technical support is needed to manage and maintain the network. Despite its immaturity, most network users are happy with the networking capability and services the MITRENET provides.

DEVELOPMENTAL TOOLS

The lack of adequate source codes was the most important factor that slowed down the diagnostic, development, and enhancement efforts. Most of the software that resides inside the BIUs and the UMCZ80 board are written in C language. It was impossible to modify the capability of the BIU without the source list of the software in the BIU and/or the UMCZ80. During the last year, IMS has tried to collect a complete set of source codes and developmental tools such as a compatible Z8000 C cross compiler from MITRE Corporation. Since MITRE did not keep a good collection of a working version of the source code, an incomplete set of software and compiler were received.

Apart from the source code for the networking software, several developmental equipments were required to perform the diagnostic, maintenance and enhancement tasks. These include EPROM eraser, Z80 C crosscompiler, and a certain number of EPROMS.

SUMMARY

The MITRENET Testbed Local Area Network Project design and purpose has provided government personnel with the necessary and practical hands-on experience required to successfully prepare for a more permanent, complex, and larger LAN that DTNSRDC expects to manage in the future. Government personnel and management now have the experience to foresee and isolate problems involved with local area network technology, and have a more realistic and cognizant expectation of what a local area network will provide for the Navy's R&D Laboratories. LAN technology is relatively new in the field of Data Communications, a pilot project, such as the MITRENET, was a recommended and necessary project to undertake prior to the much more complex DTNET LAN.

A lot of effort and invaluable support was performed by IMS who has done much of the technical development of this network. Because of the nature of this project the Miter Corporation was unable to support and develop the network. After several years of development the network is ready for some limited production and experimental use, and has met all expectations from the concept's original purpose, except for DMA. Even though the development of the DMA has been slow, it was originally the major part of the design and implementation of the network configuration, and least to say the most difficult to implement. Unfortunately, because of the numerous problems, and lack of tools and resources the DMA still has several bugs in it which at this time proves unreliable. It would be desirable and advantageous to further pursue the implementation of DMA of its capability and most importantly the direction of major venders implementations are using DMA. To implement DMA would require more effort by IMS and more monetary resources allocated to this project on the part of DTNSRDC. To have the DMA capability would be a precious asset for DTNSRDC, for those involved with the LAN, either directly or indirectly, in obtaining the experience, knowledge and possession of a clearly advanced technology of local area network host-to-frontend interconnection. Everything is now in place to complete a successful and reliable DMA capability on the DTNSRDC MITRENET LAN Project. IMS has now has the necessary resources (source codes and compiler programs) including a "mini" MITRENET in their Lab to direct all efforts in ironing out the bugs to make it reliable. Some of the advantages the DMA as compared to the HIU are:

- Automatically disconnects a virtual terminal connection when a user doesn't disconnect properly. The HOST-DMA connection disconnects automatically after a determined amount of idle time (usually about 15 minutes).
- The DIU provides better flow control to enable a faster data rate of 9600 baud.
- The DIU has a direct memory access into a z80 memory board which multiplexes up to 25 connections on a single cable into the z80.
- The DIU implementation solves the problem of the limited number of tty ports on the DH-11 (10 ports) that the HIU needs and the DIU hardware can now be utilized without further reconfiguration.

Other problems, even though somewhat less important, but worth mentioning are the failure of the host/HIU interconnection to run at 9600 baud, and "dirty power" in several areas of the buildings. The HOST/HIU connection when set to 9600 baud looses characters in the process. The HIU is presently set for 4800 baud and it is acceptable to operate at this speed with a low error rate. Installing power suppressors with noise filters on those TIU's that need to be reset several times a day will in most cases will rectify this problem. Also, another important problem has been uncovered is that the BIUs are heat sensitive. When the modem gets too warm the frequency shifts therefore the transmission of the signal is not recognized by some or all of the other BIUs on the network. Removing the cover sometimes helps, a small fan placed directly over the BIU works even better.

To reiterate, the MITRENET pilot project was not intended for production use. This will be the responsibility of the DTNET. If the MITRENET will not be incorporated into the DTNET, and it is very likely it won't, it can be well utilized in a limited productive mode with minimal effort in management and maintenance for accessings resources and transferring files at the higher data transmission speeds. For all intents and purposes the MITRENET Testbed Local

Area Network has provided useful experience with defining and isolating problems involved with the common, distributed interconnection of different types of host computers. This network is expected to function and provide service until the DTNET is in place.

APPENDIX A

IMS NETWORK SUPPORT

DTNSRDC NETWORK SUPPORT

When IMS started to support the MITRENET, numerous existing problems were discovered. Many of these problems have been resolved, such as those with the TIU, HIU, THIU, Unix Kernel and Ltelsrv, etc. Due to the limitation of funds, some problems have been investigated but not resolved such as the unreliability of the TIU-DIU connection, and difficulties with the TIU-HIU connection in reaching steady state at 9600 baud through the MITRENET. For the unesolved problems, IMS was able to complete the preparation of the tools used for debugging and testing, such as obtaining and fixing a Z8000 C cross complier package (to maintain the NIU software), purchasing a Z80 C cross complier package (to maintain the UMCZ80 software), purchasing an EPROM programmer, obtaining the source codes of the UMCZ80 and the NIU software from MITRE Corp. and then retrieving the source codes of the running version od software in the UMCZ80 EPROMS.

In order to facilitate IMS's ability to work on DIU problems, debug the Unix Kernel, and implement dual DMA capability, the following actions were taken:

(1) A "mini" MITRENET was installed at an IMS location with similiar configuration to DTNSRDC's MITRENET, and
(2) Conversion of MITRENET's version of UNIX Kernel from 4.1 BSD to 4.2 BSD.

IMS was successful in debugging the UNIX Kernel on 4.1 BSD UNIX and in fully implementing dual DMA capability on the 4.2 BSD UNIX Kernel.

The MITRENET problems which IMS investigated are discussed in detail in the following sections.

THE TIU PROBLEMS AND SOLUTIONS

(1) Problem 1: When a user tried to close an existing connection but type a wrong name, the port on the TIU died. The whole TIU needed to be reset in order to bring the one port back up. This problem was reported to the MITRENET project manager, Mr. Pat Marques. He contacted MITRE Corp. and they fixed the problem.

(2) Problem 2: After using the "+" command to add a new symbol to the symbol table amd then trying to use the "-" command to delete it from the symbol table, the TIU displayed a "Can't - use close/kill" message. However, when using the "c" command, the whole TIU went into the "panic" situation and entered monitor mode. Then the whole TIU died. The TIU needed to be reset in order to bring it back up. The problem was submitted to MITRE Corp. and they solved it.

THE HIU PROBLEMS AND SOLUTIONS

The software of the HIU and the THIU are the same. IMS performed tests on the THIU. The problems are discussed under the section covering THIU problems.

THE THIU PROBLEMS AND SOLUTIONS

IMS determined that the THIU could be used to replace the HIU through the proper cable, thereby preventing some software problems in dial-out. The THIU is dedicated to connecting host computers and/or modems. User terminals cannot be attached to the THIUs or HIUs.

For the hardware configuration, IMS performed tests and used a blue box for diagnostic purposes and was able to find the proper configurations. IMS determined that the THIU can be used as a HIU with the following cable configuration:

```
dH-11 ports            THIU ports
  Female                  Male
     1-----------------------1
     2-----------------------2
     3-----------------------3
     4--                   --4
       |                   |
     5-----------------------5
     7-----------------------7
     6--|                 |--6
     8--|                 |--8
    20--|                 |--20
```

(1) Problem 1: The information shown on the RCP eithe did not reflect the real status of the THIU or there was some other unknown problem. This situation was sent to MITRE and they fixed the problem.

(2) Problem 2: The ports on the THIU must be utilized in a sequence without any ports disabled in between, otherwise the port enabled (shown as disabled) can be connected but cannot be dialed-out. MITRE solved this problem.

(3) Problem 3: According to the MITRE draft working paper WP-82W000586, pages 23-31, the HIU is configured without modem control signals. However, IMS discovered that the THIU, which has modem control signals, can be used to replace the HIU without any problems. Thus the THIU is equivalent to the HIU.

(4) Problem 4: The THIU ports serve as the DCE (Data Communication Equipment). IMS conducted a test and found that the standard "NULL Modem" is able to interface with this DCE.

The configuration of this NULL modem is described as follows:

THIU		Modem	
1		1	Protection Ground
2	Xmit Data	3	Rcv Data
3	Rcv Data	2	Xmit Data
4,5	RTS, CTS	8	CD
6	DSR	20	DTR
7		7	Signal Ground
8	CD	4,5	RTS, CTS
20	DTR	6	DSR

THE DIU PROBLEMS AND SOLUTIONS

IMS suspected there were some bugs in the DIU software in the TIU to DIU connection mode. However, IMS was unable to do any tests and debugging before IMS had to prepare the tools and software available; thus, IMS had to prepare the tools such as Z8000 C cross complier package, EPROM programmer, down line loader programs, and an up-to-date version of the DIU software.

(1) Problem 1: IMS could not make any changes to the DIU software without the source code. At that time the source code of the DIU was n t available.

Solution: The source code was obtained from MITRE with the help of Pat Marques.

(2) Problem 2: There was no Z8000 C cross complier.

Solution: IMS obtained a copy of the Z8000 C cross complier package from MITRE Corp. which was written for UNIX V7. IMS converted this package to run under UNIX 4.2 BSD.

(3) Problem 3: The "Link Editor" of the Z8000 C cross complier provided by MITRE Corp. was not the correct revision. After compilation of the DIU software, IMS used a name list command "nm8k" from the Z8000 C cross complier package to obtain a symbol table of the DIU object code which said "newnm". Then IMS also ran "nm8k" to an existing copy of the MITRE Corp. produced object code from their link editor and obtained a symbol table saying "oldnm". IMS compared these two symbol tables and found that the text part and data part of the object code had different orientations.

Solution: IMS discovered that these two object codes were produced by different link editors. Another copy of the source code of the link editor which was written for UNIX V6 was obtained. IMS compared this link editor to the previous version and found a missing line in the new version.

After fixing the above problem, the "newnm" for the produced object code had a similar symbol table compared to the "oldnm".

(4) Problem 4: The source codes provided by MITRE Corp. were not the same as the revision running on the DIU. Only the object loading file provided was the same as the running revision. The object code produced from the exisitng DIU software was not identical to the existing object code. IMS might not have been the up-to-date version.

Solution: In order for IMS to debug any DIU related problem, IMS had to find the source cod of the current running DIU software. Thus the following actions were taken:

(a) IMS read the contents of the 8 DIU EPROMS in HEX format.

(b) IMS modified a MITRE Corp. furnished "download" program to produce HEX format output from the MITRE supplied DIU object code.

(c) After comparing the results of (1) and (2), IMS determined that the DIU oect code provided by MITRE Corp. was the current running version.

(d) Afterwards IMS checked the "nmnew" and "nmold" and complied the DIU software repeatedly for many times and re-created the source code of the DIU software.

(5) Problem 5: IMS identified a mistake in the Mitre documentation which gave an erroneous configuration of the UMCZ80-to-DIU cable. On page 16 of Volume IVb, "Network Access Protocol Implementation on a UMC Microcomputer", pin 19 of the 50-pin edge connector is shown connected to pin 17 instead of pin 15 of the 25-pin connector.

THE UMCZ80 PROBLEMS AND SOLUTIONS

The UMCZ80 consist of a processor board and a memory expansion board on the VAX UNIBUS. The UMCZ80 is user-programmable under Z80 assembly language and was implemented by MITRE Corp. as part of the NAP. The UMCZ80 boards talk to the VAX UNIX Kernel through VAX's UNIBUS device driver and talk to the MITRENET DIU using the NAP through the RS-422 cable.

IMS connected a UMCZ80 console to monitor the status of the UMCZ80 and detected the same error message whenever a user was connected from a TIU port to the VAX through the DIU and after the DIU was reset.

In order to understand the UMCZ80 console messages, IMS needed the source code of the UMCZ80. To be able to do any tests and/or debugging, IMS needed Z80 C cross complier package. IMS relayed this problem to Mr. Pat Marques and then obtained the source code for the UMCZ80.

(1) Problem 1: There was no C cross compiler package. IMS required the proper Z80 C compiler package to maintain the UMCZ80 software. Since there were bugs in the NAP, IMS needed tools for testing and debugging. Solution: IMS purchased a Z80 C compiler package from Interactive Systems Inc., the same company where MITRE Corp. purchased their Z80 C cross compiler package.

(2) Problem 2: The Z80 C cross compiler package purchase from the Interactive Systems Co. had been changed since MITRE Corp. purchased it several years ago. The mnemonic code of the Z80 assembler was different.
Solution: IMS converted all of the Z80 assembly language code of the old assembler for the new assembler.

(3) Problem 3: Several files in the UMCZ80 package were missing.
Solution: IMS contacted MITRE Corp. and obtained two missing files, <umc.h> and "transfer.C".

(4) Problem 4: The I/O library routines were unavailable from MITRE Corp.
Solution: IMS retrieved these I/O library routines (in assembly source code) from a MITRE Corp. furnished UMCZ80 object code file.

(5) Problem 5: After fixing the above problems, a running object code could still not be attained. IMS dumped and compared the object code of the compiled version (new code) and the MITRE Corp. furnished object code (old code) and found that the old code data section always started at an even address; however, the new code data section did'nt always start at an even address.
Solution: IMS had to modify some of the C source code in order to eliminate the inconsistency of these two versions of compiler. After, fixing this, IMS retrieved the UMCZ80 source code which could produce a running version of the UMCZ80 EPROMs.

(6) Problem 6: The source codes of UMCZ80 supplied by MITRE Corp. were not the running revision of the EPROMs inside the UMCZ80 processor board.
Solution: IMS dumped the old and new object codes and detected that the "transfer.C" was not the running version. IMS modified "transfer.C" and then retrieved the source code of the running version.

(7) Problem 7: After a connection of the TIU to the DIU was made, the UMCZ80 debugging console printed a "/TRcnrO" message each time a user depressed a key on the TIU terminal.
Solution: IMS compiled a version of the UMCZ80 code with a debugging message and then ran a set of EPROMS. The debugging message showed this error message should not be displayed under normal conditions, thus IMS modified the code, thereby fixing the problem.

VAX-11/UNIX KERNEL AND "LTELSRV" SERVER PROBLEMS AND SOLUTIONS

The VAX-11/UNIX Kernel of MITRENET, which contains libraries and files, follows the NAP on the VAX-11 side. IMS found several problems with the UNIX Kenel.

At first, "vi" could not work through MITRENET. The open connection from the TIU to the DIU had a lot of problems and was not reliable. Initially, IMS did not have any source codes. IMS had to obtain the source codes of the UNIX Kernel and Ltelsrv server and then IMS was able to isolate and fix many problems.

These problems were system problems because the protocols invovled in the TIU-DIU connection included NAP and TCP/IP. In order to work on these problems, IMS had to obtain tools to do the tests, such as an EPROM programmer, Z8000 C cross compiler package, Z80 C cross compiler package, TIU, DIU, UMCZ80 software, UNIX Kernel and Ltelsrv source code. Also, IMS had to set up a "mini" MITRENET at IMS to do the tests and debugging. Unfortunately, due to the limitation of funds, IMS completed the preliminary tests but did not have a chance to resolve these problems.

(1) Problem 1: The "vi" and "more" commands did not work correctly on the DT80 terminal. When a user tyuped "vi file" or "more file", it lost characters. When IMS used a modified dt80 termcap instead of vt100 termcap, the "vi" and "more" problem disappeared. IMS found that the padding characters in the termcap had caused the problem.

Solution: IMS did not have the source code of the UNIX Kernel and the "ltelsrv" yet, thus IMS notified Mr. Walter Lazear of this situation, whereupon MITRE Corp. modified the UNIX Kernel and fixed the problem.

(2) Problem 2: When an open connection from the TIU to DIU existed, sometimes only a "connection open" message appeared but one could not login to vax-b.

"Ltelsrv" kept printing the error message "Open failure." on the VAX-11 console until the "ltelsrv" was killed.

IMS performed tests and identified severl different cases:

- After a VAX reboot, the first open connection from the TIU to the DIU was okay, but after closing the open connection and trying to open connection again, only a "connection open" message from the VAX appeared and one could then login to the VAX and execute UNIX commands. However, nothing was shown on the screen.

- o If any person had used the "ptyA' through "telnet" the ptyA would become free after usage.
- o If several people have occupied pty[A-D] only the "connection open" message was shown but one could not login to the VAX.

IMS found that cases (1) and (2) were due to the same problem which meant thst if a "pty" had been used by network access then it could not be used anymore. Meanwhile the "ltelsrv" kept printing "Open failure." to the VAX console until it was killed. IMS learned that "ltelsrv" forks two processes to handle a virtual circuit for a connection between the TIU and the VAX. One process was doing the "transmitting" to Net and the other process was "receiving" the inout from the Net. The problem must have happened on the "transmitter" of the "ltelsvr" process.

IMS identified that case (3) resulted in the improper mode of pty[E-P] mode was 664.

With the assistance of DTNSRDC personnel, IMS logged login and error messages into a file for several days for purposes of examination and diagnosis. The file in which two kinds of errors messages, "open failure" and "FLUSHED", were logged grew very rapidly.

Solution: After an extensive review of the source code of "ltelsvr" (the "ltelsvr.c" program), the source of the "FLUSHED" error messages was identified by IMS as the "tcptxmt" procedure in "ltelsvr.c".

It was found that in the procedure, a global variable called "errno" was not reset after an error condition had been cleared. IMS modified the code so that variable "errno" would be reset properly.

After the above modification and the lifting of write protection of all available pseudo ttys for every user, all pseudo ttys could be used by MITRENET.

(3) Problem 3: In the middle of a TIU-DIU session, when a user typed "^C" (Ctrl C), nothing was sent from the VAX. However, the VAX still recognized the user's typing and executed the command. After having made the modification in Problem 2 above, and having lifted write protection of all available pseudo ttys for every user, typing the character "ctrl-C" would not make the TIU hang up any more.

(4) Problem 4: After Problems 1-3 had been resolved, another problem was revealed:

After opening and closing a TIU-DIU connection several times, a user trying to make a connection would get a "connection open" message but would not get the login prompt. When leaving this connection open and trying to open another connection, a "closed:refused" message appeared. The symptoms of this problem look similar to those of Problem 3.

IMS use the debugger program, "adb", to monitor operation of the UNIX Kernel and found that the "stream" and "orequest" tables were two common source pools for system calls and that MITRENET software uses these tables. IMS conducted a test to open/close connection and monitor the operation of these two buffers and determined that if either the "stream" or the "orequest" table was full, the MITRENET died.

After extensive studying and tracing of several source programs including "nipacs.c", "nipio.c", "slp.c", etc., IMS conjectured that the source of the "orequest" table was not properly released after a MITRENET TIU-DIU connection was closed.

IMS traced the operation of "tcp_close()" of ltelsrv" and "nipcls()" of the UNIX Kernel and identified that the "orequest" table was not properly released due to bugs on both programs.

IMS identified a problem on"/usr/include/local_net/orequest.h". The r_pid" variable was declared a character ("char") instead of an integer "short". "Char" is 8 bits long while "short" is 16 bits long. When the process id grew larger than 127, it became a negative number. The final effect was that when the "nipcls()" procedure tried to open or close a stream, it would never find the proper entry by comparing "ltelsrv's" "pid" with the "pid" in the "orequest" table, thus it could not properly release the "orequest" table.

Another bug in "ltelsrv" also contributed to this problem. The original "ltelsrv" did not properly handle the synchronization of the "transmitter" and "receiver" processes. The "transmitter" is a child process of the "receiver". The "id" stored in the "orequest" table was for the "receiver" process instead of for the "transmitter" process. When a "close" command was issued from the "transmitter", the "receiver" process was terminated first, thus, it would not try to release the "orequest" buffer. Then when the "transmitter" was terminating and it tried to release the "orequest" table but could not match the"id" in the "orequest" table, it left the "orequest table unreleased.

Solutions:

(a) IMS modified the "orequest.h" program

(b) IMS synchronized the "transmitter" and "receiver" processes.

To test the proposed modification on the MITRENET software, modification of the system kernel to facilitate frequent shutdowns and reboots of the machine was necessary.

IMS built a small-scale MITRENET at an IMS location with VAX software configuration similar to the VAX computer at DTNSRDC.

(5) Problem 5: After Problem 4 had been resolved, another problem was revealed: In the middle of a TIU-DIU session, suddenly everything stopped. Nothing was received from the VAX and everything typed was not recognized by the VAX. When this happened, other connections on the DIU also died. If a user tried to open a connection from the DIU and attach to it at that time, he could not talk to the VAX. If a user tried to open one or more connection, he would get a "closed:refused" message.

Dual DMA Capability

The purpose of this subtask was to implement the device drive of the UMCZ80 and/or VAX/UNIX Kernel so that multiple UMCZ80s could be supported under the VAX/UNIX.

To implement the dual DMA capability required frequent shutdowns of the system in order to test and debug the UNIX Kernel. DTNRDC did not provide a dedicated VAX system to support this dual DMA capability development.

Ims built a "mini" MITRENET at IMS using the VAX 11/780 to enable IMS to more easily perform the necessary tasks. Furthermore, IMS's VAX wa running UNIX 4.2 BSD; therefore IMS first had to convert the UNIX Kernel of the MITRENET software from 4.1 BSD UNIX to 4.2 BSD UNIX. After the above steps were taken, IMS was able to start the implementation. IMS has sucessfully implemented and tested the 4.2 BSD UNIX Kernel to support Dual DMA capability. During implementation, all the library routines and also "ltelsrv", nipio.C", and "nipacs.C" and their included files were modified.

PDP-11/UNIX HARDWARE/KERNEL

The MITRENET used on the PDP-11/70 consists of a DIU, a UMCZ80 and a PWB/UNIX kernel. The configuration of the PDP-11/70 consists of DIU, a UMCZ80 and a PWB/UNIX kernel. The configuration of the PDP-11/70 consists pf a CPU, memory, one console, one upper case DEC line printer, one UMCZ80, one TU16 tape driver with controller, one TM10 tape driver with controller, one UNIBUS expansion cabinet, and two DL11 serial I/O lines. The UMCZ80 processor board and memory board were installed in the UNIBUS expansion cabinet.

The PDP-11/70 occasionally has hardware problems. Besides running PWB/UNIX on the PDP-11/70, other people also run RSX-11 OS on it.

According to the maintenance agreement between DTNSRDC with TYMSHARE Co., IMS has not been allowed to touch the hardware, therefore, IMS had to work with "TYMSHARE" Co. people in order to identify and/or resolve hardware/software problems.

Beacause other people also use the PDP-11/70, it is hard to know whether the problems already existed or were new problems.

(1) Problem 1: PDP-11/70 could not boot under both RSX-11 and PWB/UNIX. The people from TYMSHARE ran a diagonistic and found that two pins on the backplane of the PDP-11/70 CPU cabinet were bent and shorted. After fixing this problem and replacing some faulted parts, RSX-11 was able to boot, however, PWD/UNIX was not able to boot.

Solution: IMS checked the PDP-11/70 console message and identified that the UMCZ80 processor board was bad. After replacing the UMCZ80 board, the PDP-11/70 PWB/UNIX could boot successfully.

(2) Problem 2: Depressing th reset bottom on the DIU of the PDP-11/70 did not cause the "NIP: BIU reset" message to appear on the PDP-11/70 console.

Analysis: IMS connected both a UMCZ80 debugging console and a DIU debugging console and found that when depressing the DIU reset button, the UMCZ80 debugging console printed "/HOlock/HOlock/HOlock/HOlock/HOlock/HOlock/HOlock..." until halting the CPU.

IMS did not have the source codes of the UMCZ80 and DIU yet, thus IMS discussed this problem with Mr. Walter Lazear of MITRE Corp. IMS had not made any changes on the PWB/UNIX Kernel yet. Mr. Walter Lazear recalled that the same situation had happened several years ago, explaining the problem was due to a UNIBUS repeater made by ACC which does not allow DMA functions on the UNIBUS expansion box. IMS reported this problem to Mr. Pat Marques and requested that he call the TYMSHARE people to check out and/or remove the UNIBUS repeater.

(3) Problem 3: The running version of the kernel could not be rebuilt from the existing source codes. This problem has not been resolved due to other priority subtasks.

(4) Problem 4: The UMCZ80 could not be configured by the "config" command under PDP-11/70 PWB/UNIX. It had to be manually added to the configuration table "1.s". This problem has not been resolved due to priority subtasks.

(5) Problem 5: The tape drivers in the PDP-11/70 were not working. IMS had made a new version of the kernel and wantedto make backups before doing the test; however, the tape driver did notwork.

IMS reported this problem to Mr Marques.

APPENDIX B

RECCOMENDATIONS FOR ENHANCEMENTS AND UTILIZATION OF MITRENET

Ever since the introduction of the MITRENET products, MITRENET implementation method have taken a leading role in LAN engineering and development. To state these facts, MITRENET was the first LAN that utilizes TCP/IP protocol used in long-haul packet switching network and now DoD standards. MITRENET was the first LAN that exploited the CATV technology on a dual-cable broadband system. It was the first LAN that employed a 16-bit Z8000 microprocessor commonly used by other major LAN vendors such as Sytek and Ungermann-Bass. MITRENET was also the LAN that supported a DMA interface to the host with multiplexing capability. Based on these facts, MITRENET was and is still an attractive choice for a testbed LAN system. However, MITRENET was not intended to be and will probable never become a off-the-shelf commercial product. Therefore, this pilot network is unsuitable to become a center-wide production LAN merely because of the tremedous software and hardware maintenance support required that MITRE Corp. as a non-profit organization is not chartered to commit.

Under the assumption that the MITRENET is to be replaced by a full scale DTNET that has been in the procurment cycle and will be in place within one and a half year, the DTNSRDC network management can make the best use of the MITRENET to provide users with some realistic LAN capability so as to contain their over expectation in order to better prepare for the smooth introduction of DTNET.

During this interim period, the MITRENET can be kept as is or can be enhanced with limited capabilities in order to maximize the benefits realizable before the DTNET is in full operation. We would like to provide some suggestions for the enhancements and utilizations to MITRENET is two-fold: (1) the enhancements and utilizations will give DTNSRDC personnel a more reliable network and (2) by implementing these enhancements and utilizations, DTNSRDC personnel will gain more experience in network management.

RECOMMENDATIONS FOR ENHANCEMENTS

In order to improve network performance, the following enhancements to the MITRENET are desirable:

(1) Hardware Modification to the DIU-UMCZ8C Interface -- numerous problems have been experienced with the connectors on the DIU-UMCZ80 cable. These are RS-232C connectors. These connectors can easily come loose breaking the DIU-UMCZ80 link. Replacement of the RS-232C connector on the RS-422 interface with a different type of connector that can provide a more reliable connections between the DIU and the UMCZ80.

(2) Hardware Modification to the NIUs

(a) EPROM Socket Replacement: Some of the EPROM sockets on the Z8000 developement board have been damaged due to frequent insertions and removals of EPROMS to and from the sockets. Replacing the EPROM IC sockets on the NIU Zilog development board with a better quality socket will lengthen the life of the NIU hardware and ease future enhancement.

(b) Addition EPROM: We experienced that the existing EPROMs were not sufficient in system modifications. It will be desirable to have addition EPROMs on the NIU so that information such as user table, RCP password, etc. can be stored after power off and be changed later on and addition system parameters can be added.

(3) Set up Network Control Center (NCC) -- An NCC is a most useful tools to debug system fault, manage network operation, and maintain system configuration. We recommend setting up a NCC in order to improve network management. The following suggestions are possible implementation that can be taken to set up a NCC:

(a) RCP Implementation: Presently only HIU (and THIU) software allow RCP to perform management functions on the interface ports, changing baud rate, tec. It will be essential to implement RCP on the other NIUs (TIU and DIU) so that all NIUs can be controlled through RCP. Special privilege will be required to access the RCP. The implementation of RCP should be able to control each NIU's baud, reset a dummy port, etc.

(b) NCC NIU: One of the possible ways to establish an NCC is to have a special NIU programmed as a NCC. Periodic communications between the NCC and every NIU to gather status and statistical information on each NIU is needed. A port of the NCC NIU can be connected to a microcomputer or minicomputer to record and process the information gathered from the network for future analysis and network management.

(4) Software Modification to NIU Connections -- In order to imprive the management of software in handling connections between NIUs, we recommend modifying the appropriate algorithms and software so that for each virtual connection, a timeout mechanism can be imposed to ensure the active utilization of the virtual circuit. This is particularly important to those users who logout from the host without disconnecting the virtual circuit.

(5) Software/Hardware Modification to HIU-TIU Connections -- Modification of the HIU software and/or hardware so when a session between a TIU and HIU is finished, the HIU or the host computer is able to disconnect the virtual circuit. At present, the connection cannot be closed and the circuit cannot be freed without the initiation of a close command at the TIU. The ability for HIU to receive initiative from the host to close a virtual circuit will be a definite plus.

(6) Modification of NIU Ports -- The HIU presently is used to connect host ports and the TIU to connect terminals. IMS suggests combining these two kinds of NIU into one so that these NIU ports can be configured/reconfigured as either host or terminal ports. This will simplify management since in this arrangement, only one kind of EPROM or software will be needed.

(7) Modification of NIU Hardware/Software to Vary Baud Rate -- It will be good for network management if the hardware and software of the NIU are modified so that the baud rate of each port can be set individually. This will allow a variety of devices with different baud rates to be served by a single MITRENET interface unit.

(8) Modification of HIU Software to Provide Multiple Port Cluster -- We suggest to modify the software of the HIU so that each cluster of ports can service one multiple host. Accordingly, the user can specify different hosts connected to the same HIU. This can maximize the utilization of all the HIU employ the same logical

name. If more than one host are connected to theHIU, network user can easily be confused by the chances of getting onto the desired host.

(9) Modification of NIU Software to Send 8-Bit Characters -- We suggest to modify the software of the NIU so that it will be able to send 8-bit characters. This will increase the NIU's capability to interface with more devices.

(10) Modifications to TIU Software to Allow Transparent Mode -- Modification of the software of the TIU to have a transparent mode after a connection is made is useful for certain communication application. This will provide a raw mode with no processing of input characters, thereby preventing certain characters from being captured and lost by the MITRENET. However, further enhancement is needed to connect the circuit when the session is finished.

POSSIBILITIES OF MITRENET UTILIZATION AT DTNSRDC

In order to improve system management, we suggest the following utilizations of the MITRENET:

(1) Utilization 1: The HIU can be used to connect any host computer with a RS-232C port without no regard on whether it is a UNIX-based system or not; therefore, various microcomputers and/or minicomputers can be accessed through MITRENET via the HIU especially if enhancement (8) can be done. This will increase the utilization of thye MITRENET.

(2) Utilization 2: A TIU can be connected to host computer RS-232C ports so that users of a host compute are able to access MITRENET nodes and use some protocols such as "kermit" to do the file transfers between hosts. "Kermit" is an interactive/file transfer protocol which is available in the domain and exists on hundreds of UNIX and non-UNIX machines. We have transfered files of 3 MBytes from one VAX to another via TIU-HIU connection using "kermit". By connecting the TIU to the host computer RS-232C ports, the capabilities of the MITRENET will be extended.

(3) Utilization 3: It may be possible to run UUCP through the TIU to the DIU if enhancements (9) and (10) can be achieved. UUCP is a very desirable option to have sincee it is the main UNIX file transfer ulility and is he main UNIX file transfer utility and is essential to transfer files among UNIX based computers.

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