DIGITAL MICROSYSTEMS, INC.

HiNet (Tm) SYSTEM MANUAL

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VER 1.02

Notice

Be sure to read section 8 on present limitations before using this manual.

Table of Contents

1. Introduction

The DMS HiNet system is a high speed local computer network. The network uses a shared disk system for data storage and communication. A HiNet system consists of a Network Master computer and one or more Network User Stations. The Network Master provides control of the network communication lines and interfaces the User Stations (and optionally a local master computer user) to the shared disk resources.

The user stations are themselves complete computer systems. Each HiNet User Station has a Z-80 CPU, 64K bytes of memory, and several I/O interfaces. In a typical installation each User Station executes locally its own copy of an operating system, using HiNet to allow sharing of the Master Station's disk and printer. Any user station can, however, have local disks, printers, or other devices if the application should require their use.

Version 1.430 of the HiNet system supports CP/M 1.4 as the operating system for the Network Stations. To the user the system appears to be standard CP/M. Software developed in any CP/M environment is therefore usable on HiNet.

Either a single hard disk or a set of floppy disks can constitute the shared network storage. Due to their slow speed, sharing of floppies makes sense only for very small networks. A shared hard disk is partitioned into as many as 64 logical units. Each unit is assigned a size from 1/4 Mbyte to 4 Mbytes, an 8 character name, and a 6 character password. Each unit has a separate directory, and can be assigned for the exclusive use of one user, or for shared use by several users.

2.1 Starting the Master

Assuming the network has been properly configured and installed (see sections 4 and 5), starting the Master is a simple procedure.

1. Power on the Master Computer. Wait for the hard disk drive to become ready (2 minutes).

2. Load the operating system from the hard disk. If the CPU has been jumpered to boot from the hard disk, then this is accomplished by simply pressing the RESET switch. (See the DSC 3/4 System Manual, section 2.3). Otherwise, press the INT switch and then press the RESET switch. The message "PROM Monitor 1.09" should be displayed on the screen. Type "BH". This loads the operating system from the hard disk.

3. The message "HiNet Master 1.430" should be displayed on the screen. This means that the Network Master is fully operational. User stations may now log into the network. A user may also log into the Network Master; however, he should not do anything or run any program that would interfere with HiNet operation (e.g., change interrupt status, or disturb memory other than the Transient Program Area).

2.2 Starting the Stations

The individual User Stations can be started very simply.

1. Turn the power on.

2. If the user station does not have any local disk storage, press the RESET switch. The terminal should respond with the following message:

   HiNet 1.430

   Login please ...
   Name:

   If this message does not appear, it should be verified that the HiNet master is operating, and that the User Station is attached to the network cable.

   A user name and password must be entered before the user can access any network facilities. If a correct name and password are entered, the the CP/M prompt A> will be displayed. A normal CP/M environment is now available to the user. The ASSIGN command may be used to change the A,B,C, and D disk assignments from the default values to the desired hard disk partitions.

3. If a station has local disk storage, it must be booted from one of its local storage devices. The LOGIN program must then be used to connect to the network. Once the user has logged in, the ASSIGN command can be used to gain access to any of the network disk partitions.

2.3 Network Commands

The environment seen by a HiNet User Station or the local user attached to the HiNet Master is that of standard CP/M 1.4. There are two commands, ALLOC and ASSIGN, that can be used to control the logical disks available under CP/M. ALLOC is a priviledged command available only on the Master and is used to change the size, name, and password of the various hard disk partitions. ASSIGN can be used to assign any of the partitions for which the user has the correct password, or a local disk device, to the CP/M logical disks A:, B:, C:, or D:. A detailed description of ALLOC and ASSIGN follows.

Initialize and/or Modify the Disk Allocation Table

Program: ALLOC

ALLOC allows the master user to modify the Disk Allocation Table on Unit 0 of the hard disk. The ALLOC program can only be run on the network master, and should only be run when the network is inactive. The disk allocation table contains up to 64 16-byte entries. Each 16-byte entry describes one disk partition: one byte for the size (256K to 4Mbytes), 8 bytes for the name, and 6 bytes for the optional password; the extra byte (called the control byte) is currently not used. The size byte indicates the size of the disk partition, as indicated by the following table:

1 - 256K bytes
2 - 512K byte
3 - 1M byte
4 - 2M bytes
5 - 4M bytes

The table is terminated by a size byte of zero. The first 2 disk partitions must be 256K bytes; there are no restrictions on the size of the remaining disk partitions, as long as the total disk size is not exceeded.

ALLOC commands are as follows:

L - List the current allocation table.
H - Help - print a command summary.
M - Modify an entry in the Disk Allocation Table.
S - Save the modified Disk Allocation Table.
Q - Abandon ALLOC program without saving the current table.
Z - Zero out (initialize) the current Disk Allocation Table.

It is very important to note that NO PERMANENT CHANGES IN THE DISK ALLOCATION TABLE ARE MADE UNTIL THE 'S' COMMAND IS USED.

ASSIGN

Assign a CP/M disk to a storage device

Program: ASSIGN [diskname devicename]

Arguments:

diskname	CP/M disk name A, B, C, or D
devicename	S0, S1, ... or S7 for single density floppy D0, D1, ... or D7 for a double density floppy HiNet or hard disk partition name

CP/M drives A, B, C, and D are initially assigned to default disk partitions. The ASSIGN command can be used to change the disk assignments. The default assignments for a User Station depend on the user name (see the USER command).

If a password exists for a disk partition, the user will be asked to enter the password. The password will not be echoed. Three chances will be given to enter the correct password. Enter "CNTL-C" to abort the ASSIGN program.

A special syntax must be used if a user wishes to access a local hard disk while logged into HiNet. Normally, when logged into HiNet, all partition names refer to partitions on the HiNet disk. To access a partition on a local hard disk, the partition name must be preceded by a "H:". Thus, for example, to ASSIGN the "B" drive to the local hard disk partition "PAYROLL", use the following ASSIGN command:

```
A>ASSIGN B H:PAYROLL
```

If no arguments are specified on the ASSIGN command, then the current disk assignments are displayed.

Examples:

```
A>ASSIGN D PAYROLL          Assign D to the hard disk partition
                            named PAYROLL.
Enter Password:             Since this partition is protected,
Assignment accepted.        a password must be entered.


A>ASSIGN

ASSIGN version x.xx

            Current Disk Assignments
            ------------------------

  A - double density, unit 00     size: 482K bytes
  B - double density, unit 01     size: 482K bytes
  C - single density, unit 01     size: 241K bytes
  D - network       , PAYROLL     size: 256K bytes

A>
```

Initialize and/or Modify the User Name Table

Program: USER

USER allows the network master user to modify the User Name Table on unit 0 of the hard disk.

USER commands are as follows:

L - List the current user table.
H - Help - print a command summary.
M - Modify an entry in the User Name Table.
S - Save the modified User Name Table.
Q - Abandon USER program without saving the current table.
Z - Zero out (initialize) the current User Name Table.

Each user should be assigned an 8 character name and a 6 character password. The name and password are used to log into HiNet. A null password is allowed (just enter at least one blank when the USER program asks for the password).

Each user also is assigned (default) partition names for his A, B, C, and D drives. The USER program will ask for four valid partition names. If an invalid partition name is entered, then when the user logs in, the corresponding CP/M drive will be automatically assigned to disk unit 1, which is assumed to be a 256K byte partition. The USER program will also ask for a default IOBYTE assignment for each user.

Connect to HiNet

Program: LOGIN

If a User Station has any local disk storage, then the operating system must be initially booted up from the local storage device. In this case, the LOGIN command must be used to connect to the network. The LOGIN command can also be used at any time to change the name under which a user has logged into HiNet.

Example:

```
A>LOGIN

Network Login Program 1.01

Name: USER1
Password:

Logged in

A>
```

After logging in, the ASSIGN command must be used to gain access to any of the HiNet partitions.

WHO

See who is logged into HiNet

Program: WHO

The WHO program prints the names of all users who are currently connected to HiNet. The time at which each user logged in is also provided.

Example:

```
A>WHO

WHO version 1.02

HiNet status as of 12:30:01

  NAME       LOGIN TIME   STATUS
-------      ----------   ------
USER1         09:12:02    ACTIVE
USER2         10:15:34    ACTIVE

A>
```

DIRNET

List HiNet disk partition names

Program: DIRNET

DIRNET prints the names and sizes of all HiNet disk partitions. Passwords are not printed. The ASSIGN command can be used to assign any of the CP/M drives A, B, C, or D to one of these partitions.

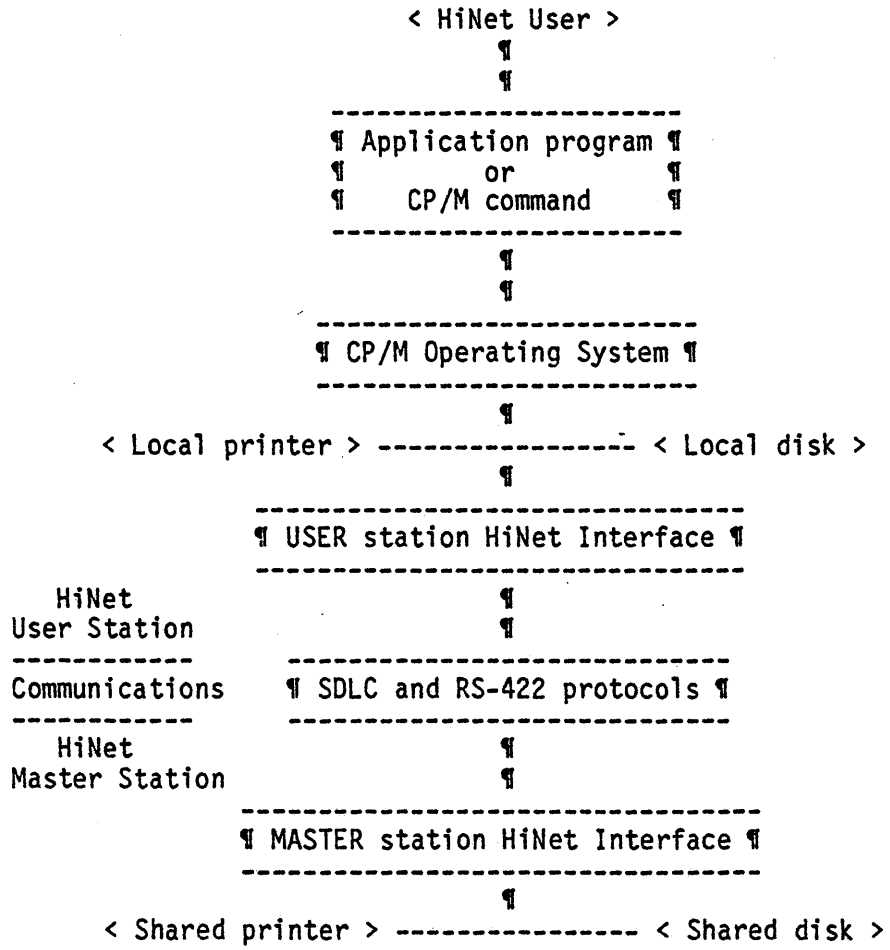
Example:

```
A>DIRNET

DIRNET version 1.00

                  Current HiNet Partitions
                  ------------------------

USER1A  256K bytes    USER1B  512K bytes    USER1C    1M bytes
USER1D    2M bytes    USER2A  256K bytes    USER2B  512K bytes
USER2C    1M bytes    USER2D    2M bytes

A>
```

3.1 Technical Overview of the HiNet

The HiNet architecture can be viewed at several levels. At the uppermost level, different applications may be running on each of the HiNet User Stations. Some applications may be accessing local disks or printers, while other applications may be sharing the master disk or printer. Each application makes operating system requests. The operating system decides whether each request is for a local resource or a network resource. All network requests are passed to the HiNet interface. The HiNet interface provides the communication protocols which are used to handle the request. At the lowermost level are the SDLC and RS-422 protocols. These describe the electronic characteristics of the HiNet communications.

These levels are pictorially represented below. Each level is discussed in more detail in the following sections of this manual.



3.2 Application Programs and CP/M Commands

Any application program which currently runs under CP/M 1.4 can be run on the HiNet with few, if any changes. Many applications, including word processing, accounts payable and receivable, payroll and inventory processing are easily installed on the HiNet. A different application may be running simultaneously on each HiNet station. It is also possible for several users to share a common database.

The standard CP/M 1.4 commands and programs are provided with the HiNet. These include DIR (list directory), STAT (directory status), PIP (file copy utility), ASM (assembler), DDT (dynamic debugger), and ED (text editor). Interpreters and compilers for BASIC, PASCAL, FORTRAN, and COBOL are also available.

Several additional commands are provided so that the user can make full use of the network facilities. For example, the ASSIGN command assigns a physical disk device to one of the CP/M disk names A, B, C, or D. This command allows the user to gain access to any of his local storage devices, or any part of the main network disk for which he has the appropriate password.

3.3 CP/M Operating System

The CP/M operating system processes user disk requests, such as "open file", "get next record", or "get random record". Each request is converted into one or more disk reads or writes, on a selected disk, track, and sector. CP/M 1.4 allows for up to 4 disks (A, B, C, and D), 256 tracks per disk, and 128 sectors per track. Each sector is 128 bytes. Thus, the maximum CP/M 1.4 disk size is 4 Mbytes. This provides each user with a maximum of 16 Mbytes of direct disk access at any one time.

Local disk and printer requests can be handled directly by CP/M. Thus, many requests can be handled entirely locally to a network station. Network requests are passed on to the next level, called the HiNet interface.

3.4 The User Station HiNet Interface

Each I/O request which cannot be processed locally is handled by the HiNet interface. The User Station waits for a poll from the Master. Normally, when a User Station is polled, it answers with a negative acknowledgement, indicating that it has no active requests for the Master. When a request is active, the poll is answered with one of the following commands.

1) Read a sector from the master disk.

2) Write a sector to the master disk.

3) Log onto the network.

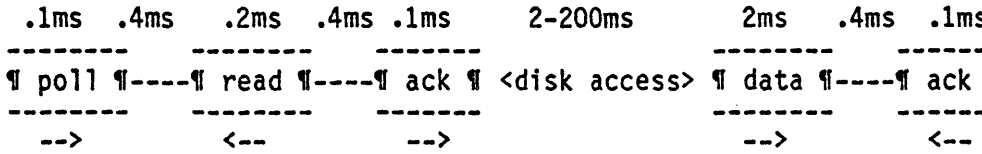
4) Assign named disk parition to the requesting user.

The read/write command includes the disk, track, sector, and number of bytes to be processed. The normal byte count is 128. The Master acknowledges reception of the command. For a write command, the User Station then sends the write-data to the Master. The Master acknowledges reception of the data, and the User Station then returns back to the CP/M operating system. A read command is handled in a similar fashion.

To log into the network, the User Station is programmed to receive requests for pseudo-user number 253. The Master transmits special polls to this "user" every 1/4 second. Any User Station wishing to log on must answer this poll, and if the answer is received successfully by the Master, the User Station is assigned a unique user number. This user number is used for all further communication with the Master. If several users attempt to answer this poll simultaneously, the Master responds with a negative acknowledgement, and the User Station will wait for a random period of time, and try logging in again. This will rarely happen.

As a first step in loading CP/M onto a User Staton, the Master broadcasts the bootstrap code to pseudo-user number 254 once per second. Any User Station wishing to log in must execute this code. Then the User Station is assigned a user number by the login procedure above. The Master transfers CP/M to the User Station's memory. Upon completion of this transfer, the user can begin executing CP/M.

A typical HiNet transaction is illustrated below. The read request is for 128 bytes. The amount of real time required for each message, and the direction of each message is indicated. An arrow pointing to the right indicates a message from the Master to a User Station ; an arrow pointing to the left indicates a message from user to master.



The time delay between messages is needed so that the sender of a message has time to execute the necessary code to receive an answer-back message. In order to minimize this time delay, a sophisticated disk buffering scheme is used in the network master, so a typical transaction is completed in fewer than 10 ms.

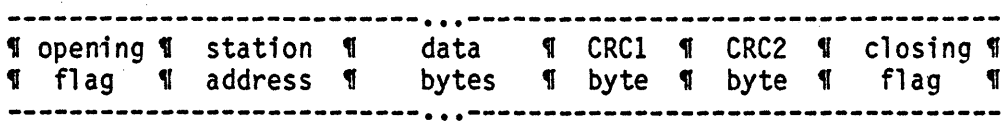
3.5 SDLC and RS-422

SDLC is an abbreviation for "Synchronous Data Link Control". It is a protocol which was originally devised by IBM for inter-computer communications. Each User Station is assigned a unique user number. A station only accepts network data which is addressed to it. An 8-bit address is assigned to each User Station; thus, there can be up to 255 network stations. Any data addressed to the special network address of all ones (i.e., 255) can be "heard" by all stations on the network.

The HiNet electrical interface between stations is RS-422. This uses a differential electrical signal carried on one twisted pair of wires. All station transmitters are connected to one pair and all except one will have their transmitters disabled at any one time. All stations (including the one transmitting) will receive data from the common wires, but only the one programmed with the destination address will accept this data. To simplify the hardware interface, a clock signal is carried on a separate twisted pair and is provided by the station that is transmitting. A fifth wire in the cable is used to provide a common ground.

Data is transmitted as a series of zeros and ones, at 500 KHz. Each transmission begins and ends with a "FLAG". This flag consists of the bit pattern 01111110. To avoid confusing data with a flag, the transmitter inserts a zero after each 5 consequtive ones, and the receiver removes the zeroes at the other end. The closing flag is preceded by a 16 bit CRC error code. This code is used to detect transmission errors. A typical data transmission is illustrated below:

SDLC frame



3.6 MASTER HiNet Interface

The MASTER HiNet interface communicates with the USER HiNet interface. The network master runs in the "background" of the master computer, while a user may run in the "foreground". The master is "awakened" every 1/60th of a second. It consults its list of users, and polls each logged-on user. A user may respond to a poll in one of three ways:

1) Negative acknowledge - this means that the user has no active requests. In this case, the master immediately polls the next user.

2) Network read, write, or login request - the master uses the necessary protocol to handle the request.

3) No answer to poll - the master assumes that the user station has either powered off or logged out. The user station must answer every poll to remain logged in. The user station will do this automatically as long as interrupts are enabled and the operating system is functional. The master provides for a grace period of 8 seconds, during which the user station is re-polled every 1/2 second. If the user station fails to answer any of these polls, the user is officially logged off. The user number associated with that user is returned to the list of available user numbers, and may be reused later.

After each logged-in user has been polled and all requests have been processed, the CPU is returned to the user who is running on the master. For networks with greater then 4 users, the master should be dedicated to servicing the network, because a user attached to the master would experience a significant degradation in performance.

The master interface is designed so that a failure of any one particular user station will not cause the master to malfuction. A user station failure will affect only one user, and leave the rest of the network functioning normally. However, more caution must be exercised by a user attached to the master station, as a malfunction at the master could have a greater effect on overall network functions. Specifically, users with local disk storage would still be able to perform all their local computing functions, however, they would obviously be unable to access any data stored at the master station.

3.7 Sharing the System disk

Either a single hard disk or a set of floppy disks can constitute the shared network storage. Due to their slow speed, sharing of floppies makes sense only for very small networks. A shared hard disk is partitioned into as many as 64 logical units. Each unit is assigned a size from 1/4 Mbyte to 4 Mbytes, an 8 character name, and a 6 character password. Each unit has a separate directory, and can be assigned for the exclusive use of one user, or for shared use by several users. The ASSIGN command is used to assign one of the CP/M disk names A, B, C, or D to a disk unit. For example, the command

```
ASSIGN  B  PAYROLL
```

assigns the B disk to the hard disk partition named PAYROLL. If this unit is password-protected, the ASSIGN command will ask for a password before allowing the assignment.

The privileged user running on the master station can control the partitioning of the disk. There is a 1K table on the hard disk which contains this information. The ALLOC program constructs this table, and allows an authorized user to change this table as desired.

To provide high disk access performance, all hard disk I/O is done in 1K blocks. The 24 most recently accessed 1K blocks are kept in memory. Since most disk requests are for sequentially stored data, disk accesses can be kept to a minimum, and the speed of the system is significantly improved.

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4.1 HiNet Cable Installation

For basic systems, the DMS HiNet uses RS422 receivers and drivers operating at 500K baud over distances of up to 1000 feet. Longer distances may require coaxial cable and high speed modems at each station.

Each network device transmits a separate data and clock signal when it has authority to talk on the network. All other stations will disable their transmitters and listen for packets addressed to themselves. Since RS422 uses a differential signal, data and clock each require 2 wires. There should also be at least one ground wire in the network cable to protect the receivers and drivers from large common mode voltages. If the building power distribution system develops large differences in ground potential some form of isolating connection system must be used.

The minimum network cable therefore consists of 5 conductors, 2 differential signals, plus ground. The connectors used in the HiNet are 9 pin "D" connectors, similar to the 25 pin version used for RS232. Each instrument will be fitted with a female connector and the network cable itself will have male connectors daisy chained past all stations in the system.

For physically short networks, (up to ??? feet) the most rapidly installed and economical network cable is made from flat cable with mass terminated 9 pin "D" connectors. Longer networks should use twisted wires, and this type of cable is also manufactured with "straight" sections every few feet to facilitate mass termination. Standard twisted pair communication cable can also be used with soldered connections to the 9 pin "D" connectors. If flat cable is used, the minimum number of conductors is 6 to span the 2 differectial signals, separated by 2 grounds.

Network Cable Connections

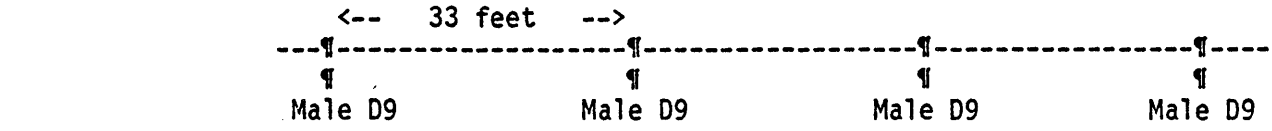
J5 connections on ZSBC 3/4				9 Pin "D" connector	
Pin				Pin	
1	-->	GROUND	<--	1	
2	-->	GROUND	<--	6	
3	-->	+ CLOCK	<--	2	®
4	-->	- CLOCK	<--	7	®
5	-->	GROUND	<--	3	®min. required
6	-->	GROUND	<--	8	/
7	-->	+ DATA	<--	4	/
8	-->	- DATA	<--	9	/
9	-->	GROUND	<--	5	
10	-->	GROUND	<--	no connection	

For reliable operation over long distances the network cable should be properly terminated at both ends. This termination consists of 180 Ohm resistors across the differential pair for both data and clock. These resistors can be inserted by installing jumpers JP1 and JP11 on the ZSBC 3/4 CPU board of the station physically closest to each end of the cable. Note that all other stations must not have these jumpers installed. If the last station is not near the end of the cable, or if it may be necessary to disconnect this station while the network is operational, the terminating resistors should be installed directly on the end of the cable.

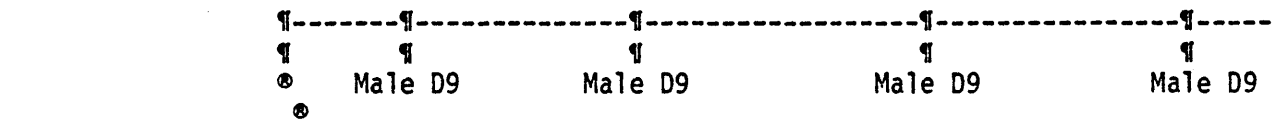
4.2 Network Cable Products

To facilitate the installation of demonstration systems and simple networks, the following parts and materials may be ordered from DMS:

1. Network Demonstration Cable 1 (DMS part number CBL-N/1). This is a 100 foot flat cable with 4 male DB9 connectors, spaced approximately every 33 feet.



2. Network Demonstration Cable 2 (DMS part number CBL-N/2). Similar to Cable 1, but has a female D9 connector at one end to allow more than one cable to be connected together.



3. Male D9 connector for mass termination. (DMS part number CBL-N/CONM)

4. Male D9 connector for solder termination. (DMS part number CBL-N/CONSM)

5. Female D9 connector for mass termination. (DMS part number CBL-N/CONF)

6. Female D9 connector for solder termination. (DMS part number CBL-N/CONSF)

7. 500 foot spool of Belden type 8725 communication cable containing 2 twisted, shielded pairs plus ground. (DMS part number CBL-N/500) This cable is for use with soldered connectors.

As with all electrical installations, safety should be a primary consideration. Installations should be performed by technically competent individuals and all applicable building and electrical codes must be observed.

5.0 HiNet Software Installation

The following procedures should be followed to install HiNet onto a freshly formatted hard disk:

1. Run the HARDCTRL program. This program writes the hard disk controller software onto blocks 0 and 1 of the hard disk. Note that older versions of hard disk controller software supplied with DSC-2's are not compatible with the either the HiNet or the DSC 3/4.

2. Construct the disk allocation table. This is done by running program WRUNO or ALLOC. WRUNO writes an existing allocation table from the floppy disk to the hard disk, while ALLOC allows one to create a new allocation table or modify an existing one. If WRUNO is used, write the file ALLOC.TAB to track 0, sector 79h (i.e. block 0Fh).

3. RESET the system. This causes the hard disk controller to use the new controller software and the new disk allocation table.

4. Execute the command "SUBMIT MAKENET". The file MAKENET.SUB contains the commands needed to write the master BIOS and the station BIOS onto the hard disk, and to create a default user table.

5. Change the jumpers on the CPU board to boot automatically from the hard disk (see the DSC 3/4 system manual, section 2.3). Press the RESET switch. The following message should appear on the screen:

   HiNet Master 1.430

   Login please ...
   Name:

   The network is now up and running!

6.0 HiNet Installations on a floppy-only system

Several constraints apply to a HiNet system running on a Master that is not equipped with hard disks. The "A" drive must contain a master BIOS and CP/M, while the "B" drive must contain a station BIOS and CP/M on tracks 0 and 1.

To create the diskette to use in the A drive, use:

```
A>DDT HSTATION.COM
DDT version x.x
-^C
A>SYSGEN
(copy from memory to disk B)
```

To create the diskette to use in the B drive, use:

```
A>DDT FSTATION.COM
DDT version x.x
-^C
A>SYSGEN
(copy from memory to disk B)
```

The ASSIGN command may not be used with a floppy-only network. The C and D drives are assigned to floppy units 4 and 5, which represent the opposite sides of units 0 and 1, on double-sided drives. Single density diskettes cannot be read under a floppy-only network.

8.1 Limitations for Version 1.430

1. All errors, even recoverable ones, will cause an error message to be printed on the master console.

2. The LOCK command is not implemented. Users must either use separate disk partitions, or , if shared, must not cause the CP/M directory to be changed, as this will cause all other users to mark their disk READ ONLY (Only record updates to existing file should be allowed).

3. The control byte in the Disk Allocation Table is not currently used.

4. WRUNO cannot get files from other than the logged drive. Also, for files with an 8 character name, the file name must be given on the command line (i.e. A>WRUNO HSTATION.COM).

5. The IOBYTE feature in the USER program is not yet implemented.