

ULTRIX

digital

Guide to Diskless Management Services

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ULTRIX

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**digital equipment corporation
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About This Manual

This manual describes how to install and maintain your diskless server area using the diskless management services utility, `dms`.

New and Changed Information

The features of the `dms.new` utility have been incorporated into `dms` and other features added. New functionality like using the `dms` database to manage clients is described. The new options for showing products and copying client kernels are also described.

Information about estimating disk space requirements has been added to the guide. The boot information for clients is more complete.

Finally, the client customization section has been simplified.

Audience

The audience for this manual is anyone installing and maintaining the diskless server area. The manual assumes that:

- You, or a Digital Field Service representative, have checked the hardware to ensure that it is working properly.
- You have read the Owner's Manuals supplied with your hardware.
- You know the location and function of the controls and indicators on your hardware.
- You understand how to load and unload the installation media and any disks needed during the installation.
- You know how to use ULTRIX software.

Organization

| | |
|-----------|--|
| Chapter 1 | Overview |
| | Describes the diskless server area and introduces the <code>dms</code> utility. |
| Chapter 2 | Diskless Management Services Setup Preparation |
| | Describes the knowledge, information, and tasks required before you set up the diskless server area. |
| Chapter 3 | Server Setup |
| | Describes how to partition a disk and install software into a diskless server area. |

| | | |
|------------|----------------------------|--|
| Chapter 4 | Management and Maintenance | Describes how to add, modify, and delete diskless clients. Tells how to manage diskless clients. |
| Chapter 5 | Troubleshooting | Describes how to perform troubleshooting operations in the diskless server area. |
| Appendix A | Client Customization | Tells how to customize diskless clients' setups. |

Related Documentation

The following list suggests the order in which you should read the related documentation:

1. **Hardware documentation**
You should have on hand the hardware documentation associated with your processor, particularly the Owner's Manual. These manuals show you how to set up the processor and its additional devices. These manuals also supply valuable troubleshooting guidelines.
2. *Release Notes*
Before beginning the installation, you should read the current version of the *Release Notes*.
3. *Guide to Server Setup*
This guide contains information about setting up the diskless server area, and supported software subset information.
4. **System and network management guides**
Read the appropriate system and network management guides to help you prepare to install the diskless server area.

Conventions

The following conventions are used in this manual:

| | |
|--------------------|---|
| # | A number sign is the default superuser prompt. |
| >>> CPU n >>> | The console subsystem prompt is two right angle brackets on RISC systems, or three right angle brackets on VAX systems. On a system with more than one central processing unit (CPU), the prompt displays two numbers: the number of the CPU, and the number of the processor slot containing the board for that CPU. |
| user input | This bold typeface is used in interactive examples to indicate typed user input. |
| system output | This typeface is used in interactive examples to indicate system output and also in code examples and other screen displays. In |

text, this typeface is used to indicate the exact name of a command, option, partition, pathname, directory, or file.

•
•
•

A vertical ellipsis indicates that a portion of an example that would normally be present is not shown.

cat(1) Cross-references to the *ULTRIX Reference Pages* include the appropriate section number in parentheses. For example, a reference to `cat(1)` indicates that you can find the material on the `cat` command in Section 1 of the reference pages.

RETURN This symbol is used in examples to indicate that you must press the named key on the keyboard.

Mbyte Throughout the text, the abbreviation Mbyte is used for megabyte. One megabyte equals 1,048,576 bytes.

A server processor provides diskless management services to client processors from a diskless server area. The diskless server area contains software that is available to registered client processors that are licensed to access that software.

The diskless server area is separate from the server's total software environment and it can contain some or all of the following software:

- One or more versions of software products compatible with the VAX architecture
- One or more versions of software products compatible with the RISC architecture

Each client registered for a diskless server area is booted over the network and uses the software in the diskless server area as if that software were located on the client's processor.

This chapter presents an overview of the diskless management services and introduces the diskless management services utility, `dms`.

Chapter 2 explains how to set up a diskless server area. Chapter 3 and Chapter 4 include descriptions of procedures performed using `dms`. Appendix A contains descriptions of customizing a client's setup.

1.1 The Diskless Server's Environment

The following components make up a diskless server area:

- A server

The server can be any Digital supported processor. The software subset containing support for the maintenance operations protocol, MOP, must be installed in order for your system to be used as a server.

A server processor with either RISC or VAX architecture can serve both RISC and VAX clients.
- A distribution device on the server

The distribution device could be an MT9 tape drive, a TK50 tape drive, a TK70 tape drive, or a CDROM optical disc drive. You use the distribution device to transfer the software subsets for one or more specific products and architectures to the disk on the server that contains the diskless server area. Then, registered clients can access the software.
- The Ethernet

You must set up the server and all client processors as hosts on the Ethernet. Clients use the Ethernet to access the diskless server area.

- Clients
Diskless clients are members of the MicroVAX, VAXstation, DECstation, and DECsystem series of processors.

1.2 Diskless Management Services Utility

You use the Diskless Management Services utility, `dms`, to set up the diskless server area and register diskless clients. You also use the `dms` utility to manage your client processors. See `dms(8)` in the *ULTRIX Reference Pages* for a summary of the `dms` functionality.

1.3 Order of Operations

The system manager on the server processor performs a series of procedures to configure the server for diskless management services. The procedures to set up a diskless server area follow, listed in the order in which they are performed:

- Create the file systems required for diskless management services.
- Install software.
- Add clients.

When the series of procedures performed on the server is complete, clients boot using the generic kernel on the server.

Table 1-1 lists the diskless server area file systems with a brief description of their contents.

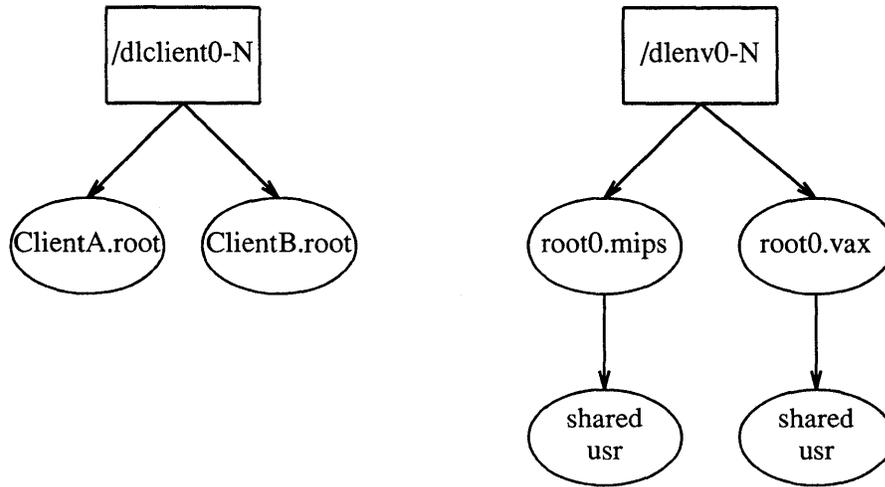
**Table 1-1:
Diskless Server Area File Systems**

| File System | Contents |
|-------------------------|--|
| <code>/dlclient0</code> | individual client root directories, for example, <code>ClientA.root</code> , and <code>ClientB.root</code> , |
| <code>/dlenv0</code> | common root areas, like <code>root0.mips</code> and <code>root1.vax</code> that contain shared <code>usr</code> areas that are mounted by each client and <code>root</code> directories propagated to clients. |

Throughout this guide, the diskless server area file systems are designated `dlenvn` and `dlclientn`. The root directories can be either `rootn.mips` or `rootn.vax`. Throughout this guide the common root directories are designated `rootn.mips`. The letter *n* represents the number assigned to the specific file system or common root directory when it is installed. The portion of the common root directory that is copied to each registered client is designated `client_name.root`.

Figure 1-1 illustrates the diskless server area setup. In this figure, solid boxes represent file systems and ellipses represent directories.

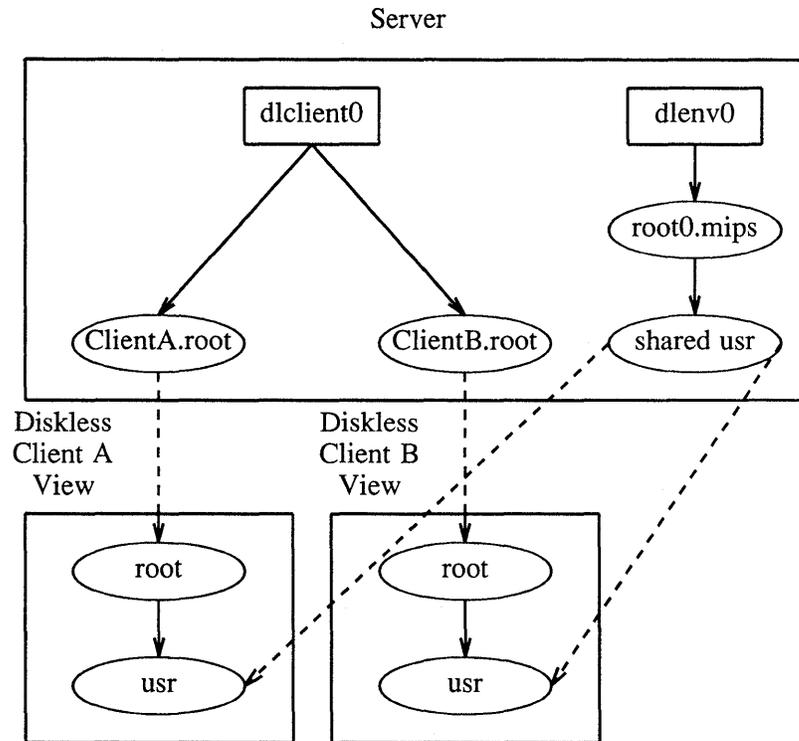
Figure 1-1:
Diskless Server Area Directory Structure



1.3.1 Diskless Server Area from the Client's View

Only the diskless server has access to the entire directory structure. The diskless client has access only to the `shared usr` area that exists in the `rootn.mips` for which it is registered in the `dlenvn` file system and to its own `client_name.root` directory and swap file in the `dlclient?` file system. Figure 1-2 shows each client's view of the diskless server area and of its own `root` and `usr` area.

**Figure 1-2:
Client Views of the Diskless Server Area**



The dashed lines indicate the two areas that each client mounts when it is booted. The two areas are the `rootn.mips` directory in the `dlclient` file system and the `shared usr` area in the `client_name.root` directory of the `dlenv` file system.

The solid lines around each client processor's view box indicate that from a client's view both `root` and `usr` seem to be located on the local machine. Users on the client processor access the software on the server just as they would if the software were actually located on their local processor.

Diskless Management Services Setup Preparation 2

This chapter describes how to prepare to set up your diskless server area. The chapter describes how to:

- Gather prerequisite information.
- Set up ULTRIX network services on the server.
- Plan the server configuration.
- Plan client registrations.

2.1 Gathering Prerequisite Information

As the system manager at the server, you should:

- Know your superuser password.
- Make sure that your clients are licensed for all the software that they access in the diskless server area.

2.2 Setting Up ULTRIX Network Services on the Server

Perform the following tasks before you start the `dms` setup preparation:

- Install an ULTRIX operating system on the server.
- Set up a local area network.
- Set up a network file system.

2.2.1 Installing an ULTRIX Operating System on the Server

The *Basic Installation Guide* explains how to install an ULTRIX operating system. The *Advanced Installation Guide* tells you how to perform an advanced installation. It also provides a table that lists supported software subset sizes.

The subset containing the maintenance operations protocol, MOP, must be installed on a server.

To load the subset containing MOP, either perform an advanced installation or use the `setld` command after the basic installation is complete. For example:

```
# setld -a /dev/rmt0h UDTMOP400
```

For more information, refer to `setld(8)` in the *ULTRIX Reference Pages*.

2.2.2 Setting Up a Local Area Network

You must connect the `dms` server and all of your client processors to the Ethernet. See the *Introduction to Networking and Distributed System Services* for instructions on how to set up a local area network (LAN).

2.2.3 Setting Up a Network File System

The network file system (NFS) must be set up before you install a diskless server area.

Make sure the following daemons are running:

```
biod
mountd
nfsd
portmap
```

See the *Guide to the Network File System* for instructions on how to set up NFS.

The diskless client environments are already set up for NFS.

2.3 Planning the Server Configuration

Perform the following tasks to prepare to configure a diskless server:

- Plan the disk allocation.
- Plan your diskless server area software installation
- Identify the distribution media.
- Obtain the full pathname of the device special file name or mount point for the distribution media.

2.3.1 Planning the Disk Allocation

You can install both the shared and client-specific portions of each diskless server area on separate partitions on one disk. Or, you can spread a diskless server area over multiple disks. For example, one disk can contain the `dlenv` file system. Another disk can contain the `dlclient` file system.

Spreading diskless server areas over multiple disks may improve system performance because client access is not concentrated on one disk.

2.3.1.1 Allocating Disk Partitions with `dms` – You can use the `dms` utility to set up the file systems necessary for a diskless server area. The utility sets up `dlenv` and `dlclient` file systems in consecutive order, starting with `dlenv0` and `dlclient0`. These file systems must be in place before you can install software subsets into a diskless server area using `dms`.

A description of creating file systems with `dms` is included in Chapter 3.

2.3.2 Planning Diskless Server Area Software Installation

When you install software into a diskless server area, you install software products in the `dlenv` file system. Software is installed into one or more common `rootn.mips` areas.

It is recommended that you install all the software you want in each diskless environment before registering any clients. This avoids having to update clients registered for that diskless environment. Start with your ULTRIX product subsets, then install any additional software products that clients will share.

See the *Guide to Server Setup* for a description of ULTRIX product subsets and their sizes. In addition, see the documentation provided with your other software products to decide which subsets to install. If all the software you want will not fit into the `dlenv` file system, consider mounting another disk.

Make sure that you allow enough space for all the software you plan to install in all the common `rootn.mips` areas when you allocate disk space for the `dlenv` file system.

2.3.2.1 Disk Space Required for the `dlenv` File System – Each common `rootn.mips` area contains at least the mandatory ULTRIX and ULTRIX Worksystem Software subsets, plus other supported subsets and additional software desired for clients who are registered to access that area.

In addition, reserve the following:

- About 20% of the disk space for file system administration, like adding files, and for file system information
- Enough space for any layered products, such as DECnet, that you plan to install

Table 2-1 shows the approximate sizes of the software subsets for some ULTRIX products that you might want to install.

Table 2-1: Approximate Disk Space Required

| Software Subsets | Approximate Size in Mbytes (RISC) | Approximate Size in Mbytes (VAX) |
|------------------------|-----------------------------------|----------------------------------|
| All ULTRIX | 170 | 125 |
| All ULTRIX unsupported | 25 | 35 |

Allow 20% of the disk partition size for file system administration and information. In addition, be sure to allow space for any other software products you plan to install.

For example, you might calculate the space requirement for a `dlenv` file system to be accessed by RISC clients as follows:

| | |
|---------------------------|------------|
| All ULTRIX | 170 Mbytes |
| All ULTRIX unsupported | 25 Mbytes |
| One layered product | 50 Mbytes |
| Subtotal | 245 Mbytes |
| 20% file system allowance | 49 Mbytes |
| Total | 294 Mbytes |

2.3.2.2 Disk Space Required for the `dlclient` File System – You must allow disk space in each `dlclient` file system on the server for clients' `root` directories and, in some cases, for clients' swap files and for clients to crash dump over the network to the server.

Use the following guidelines for your estimates:

- Allow a minimum of 10 Mbytes for each client's `root` area.
- If network crash dump to the server will be enabled, add an amount equal to the client's memory size plus its kernel size.
- If any of the client's swap files will be located on the server, you may want to allow two to three times the client's physical memory size depending on need.
- The clients' volatile files, like those in the `tmp` directory, and volatile directories like `var/spool` and `var/adm/crash` are located in `dlclient?` and require space.
- Clients that add files to their `client_name.root` areas use space.

You can estimate the space that different clients in a group require and spread that amount of space over the whole group when determining your `dlclient?` disk space requirements.

Use the formulas that follow to help you estimate the space you need in the `dlclient` file system.

The formula to determine the minimum amount of space required for the clients' `root` areas, with an example, follows:

$$\begin{array}{rcl} \text{Number of} & 10 \text{ Mbytes} & \text{Minimum} \\ \text{Clients} & * \text{ Root Area} & = \text{dlclient Space} \\ \\ 5 & * 10 & = 50 \text{ Mbytes} \end{array}$$

The formula to determine the amount of additional space you need if clients can dump across the network, with an example, follows:

$$\begin{array}{rcl} \text{Number of} & (\text{Client Memory} & \text{Kernel} & \text{Additional dlclient} \\ \text{Clients} & * \text{ Size (Mbytes)} & + \text{ Size)} & = \text{Space for Dump} \\ \\ 3 & * (8 & + 2.5) & = 31.5 \text{ Mbytes} \\ \\ 2 & * (16 & + 2.5) & = 37 \text{ Mbytes} \end{array}$$

If clients' swap files are located on the server, two to three times the client's physical memory size depending on need is required. The formula to determine the amount of additional space required, with an example using three times each client's physical

memory size, follows:

| | | | | | | |
|-------------------|---|------------------------------|---|------|---|------------------------------------|
| Number of Clients | * | (Client Memory Size (Mbytes) | * | 2-3) | = | Additional dlclient Space for Swap |
| 3 | * | (8 | * | 3) | = | 72 Mbytes |
| 2 | * | (16 | * | 3) | = | 96 Mbytes |

Using the examples given with the formulas, plus an allowance of 15 Mbytes per client for user files, the `dlclient` would require about 365 Mbytes of disk space on the server for five clients.

| | |
|----------------------|------------|
| Root Space | 50 Mbytes |
| Swap Space | 168 Mbytes |
| Crash Dump Space | 69 Mbytes |
| User Space | 75 Mbytes |
| Total Space Required | 362 Mbytes |

2.3.3 Identifying the Distribution Media

See the bill of materials for the distribution media types and associated labels for your products.

2.3.4 Obtaining the Device Special File Name or Mount Point

Obtain the full path for the device special file name or mount point associated with your software distribution media. The device special file name points to the device on which you mount the media containing the software subsets.

Table 2-2 lists possible distribution media and, where applicable, the device special file name for each. The first column lists the distribution media type, the second column lists the full pathname for the device special file or mount point, and the last column contains the Digital name for the distribution media.

The letter *n* in the device special file name represents the unit number of the distribution device. For example, if the distribution device is a TU81 unit 0, then the device special file name is `/dev/rmt01`.

Table 2-2: Device Special File Names

| Media Type | Device Special File Name | Digital Name |
|-----------------------|-------------------------------|---|
| TK50 tape cartridge | <code>/dev/rmt<i>n</i></code> | TK50, TK70, TZ30 |
| 9-track magnetic tape | <code>/dev/rmt<i>n</i></code> | TS05, TU80 TU45, TE16 TU77 |
| | <code>/dev/rmt<i>n</i></code> | TA78, TA79, TA81 TU81, TU81E TU78, TU79 |
| | <code>/dev/rzn</code> | RRD40 |

2.4 Planning Client Registrations

Perform the following tasks to prepare to register diskless clients:

- Obtain information about each client.
- Register each client's host name and Internet Protocol (IP) with the appropriate naming service servers files.
- Fill out the DMS Client Setup Worksheet, located at the end of this chapter.

2.4.1 Obtaining Information About Each Client

You need the following information about each processor you plan to register as a client:

- Host name

Note

For registration, the MOP protocol and DECnet/ULTRIX software recognize only six characters for the host name. A host name can contain more than six characters, but the first six characters must be unique. The name must contain alphanumeric characters only and be entered in lower case, with the initial character an alphabet character.

- Whether the client is a RISC or a VAX processor
- Superuser password
- Hardware Ethernet address

See the *Guide to Ethernet Communications Servers* for information about hardware Ethernet addresses.

- Swap file location
- Swap device, if swapping on the client's disk

2.4.2 Registering Clients' Host Names and IP Addresses with Servers

If the host system is served by any of the following naming services, check with your site administrator to be sure that your clients are registered with the appropriate naming service servers:

`/etc/hosts`

Berkeley Internet Name Domain (BIND)

Yellow Pages (YP)

You automatically place each client processor's host name and Internet Protocol (IP) address in the `/etc/hosts` file when you initially set up your LAN using the `netsetup` utility. The `netsetup` utility is described in the *Introduction to Networking and Distributed System Services*.

You can also place the host name and IP address in the `/etc/hosts` file by using a text editor, such as `vi`. The host name and IP address for each client processor must be unique.

See the *Guide to the Yellow Pages Service* for information about the Yellow Pages (YP) service. See the *Guide to the BIND/Hesiod Service* for information about Berkeley Internet Name Domain (BIND) server.

2.4.3 Filling Out the DMS Client Setup Worksheet

Use the DMS Client Setup Worksheet to record the information you need to set up a client processor using the `dms` utility option, `Add Client Processor`, which is described in Chapter 4. Fill out a worksheet for each diskless client processor you plan to add.

Figure 2-1: DMS Client Setup Worksheet

DMS Client Setup Worksheet

Fill out a worksheet for each diskless client you plan to register.

1. Enter the client's host name. _____
2. Enter the client's hardware Ethernet address: _____
3. Other information you need for each client:
 - The `/dlenvnrootn.mips` or `/dlenvnrootnvax` area for the client
 - The `dlclientn` area for the client
 - Root password
 - Swap file location (on server or local)
 - Swap file size, if swap file is located on the server
 - Swap device, if swap file is located on the client's disk
 - Full or no memory dump across network for client
 - Whether to duplicate an existing client configuration for this client

This chapter describes how to use `dms` options to configure a diskless server. The instructions tell you how to perform the following tasks:

- Allocate disk partitions using `dms`.
- Establish a new diskless server area.

3.1 Allocating Disk Partitions Using `dms`

You can use the `dms` utility to allocate disk partitions for a diskless server area. The utility allocates disk partitions for the file system, `dlenvn`, that will contain the diskless clients' `rootn.mips` and sharable `usr` area, and for the file system, `dlclientn`, that will contain each diskless client's `root` and `swap` areas. The letter `n` represents the number corresponding to the file systems for each diskless server area.

This section describes how to use the `dms` utility `Set Up Diskless Area` option to set up the file systems necessary for a diskless server area.

If you want to repartition your disk before setting up the diskless server area file systems, use the `chpt` utility. See the *Guide to Disk Maintenance* and the `chpt(8)` command in the *ULTRIX Reference Pages*.

Use the following procedure to set up the file systems for a diskless server area.

1. Log in and become the superuser.
2. Type the following command at the system prompt to invoke the `dms` utility:

```
# /etc/dms
```

3. A diskless management services menu appears. Choose the `Create Diskless Area on Disk` option by typing `c`:

```
DISKLESS MANAGEMENT SERVICES (DMS) UTILITY MENU
```

```
a - Add Client Processor
m - Modify Client Parameters
r - Remove Client Processor
l - List Registered Clients
s - Show Products in Diskless Environments
i - Install Software
c - Create Diskless Area on Disk
k - Kernel Rebuild or Copy
e - Exit
```

```
Enter your choice: c
```

4. A message appears describing the software installation alternatives available, followed by the `Diskless Area Software Installation Menu`. For example:

Diskless Area Setup Menu

d - Diskless Environment Setup
c - Diskless Client Setup
r - Return to previous menu

Enter your choice:

5. After you choose which part of the diskless server area to set up, a prompt appears for the disk and partition that you want to use, for example:

Enter disk and partition you want to use for the diskless environment.
For example, /dev/rra1g: /dev/rra0d

6. After you select the disk and partition, a message appears telling you how much space the disk and partition you chose contains and asking if there is enough space. In the example that follows, the user has chosen to set up a diskless environment:

There are approximately 67 Mbytes on /dev/rra0d. Is this partition large enough to contain the software you intend to install? (y/n) []: y

7. If there is enough space, answer y to the prompt. A message appears specifying where the file system will be placed and mounted. The message warns that any data or file systems on the partition will be unrecoverable. A prompt for confirmation that you want to continue follows the message.
8. If you choose to continue, informational messages appear as the disk partition is allocated. When disk partition allocation is complete, the diskless management services menu appears.

You can use this procedure to allocate as many disk partitions as you need.

3.2 Establishing a New Diskless Server Area

After you create the diskless server area file systems `dlenvn` and `dlclientn`, use the `dms` utility to install software into the `dlenv` file system. Install all the software you plan to use in this diskless server area before you begin registering clients.

Perform the installation procedures described in this section to set up `rootn.mips` areas with different products. Then, licensed clients may access those areas suited to their needs.

Make sure no diskless clients which mount the `usr` area of this common `rootn.mips` area are running when you install an additional software product, or their `usr` area may change.

1. Select the Install Software option from the `dms` menu.

DISKLESS MANAGEMENT SERVICES (DMS) UTILITY MENU

```
a - Add Client Processor
m - Modify Client Parameters
r - Remove Client Processor
l - List Registered Clients
s - Show Products in Diskless Environments
i - Install Software
c - Create Diskless Area on Disk
k - Kernel Rebuild or Copy
e - Exit
```

Type your choice: **i**

2. A message appears describing the software installation options available followed by a menu like the following:

```
Diskless Area Software Installation Menu:
  1 Install Operating System to New Area
  2 Add Software to Existing Area
  3 Return to Previous Menu
```

Enter your choice:

In the following example, you install the operating system to a new area.

A message appears saying that you have chosen to install the operating system to a new area.

3. If there is more than one `dlenv` file system available, a menu appears listing the possible file systems. For example:

```
These are the available file systems to contain the environment:
  1 /dlenv0
  2 /dlenv1
```

Enter your choice []: **1**

4. A prompt asks for the full pathname of the device special file name or mount point for the distribution media.

Enter the device special file name or mount point of your distribution media.

The following example shows how to mount the 9-track magnetic tape labeled **ULTRIX V4.0/ULTRIX WS V4.0 SUPPORTED (RISC) #1** on a TU81 tape drive, unit 0:

Enter the device special file name or the path of the directory where the software is located, for example, `/dev/rmt0h`: **/dev/rmt01**

5. A message appears listing the software subsets that are mandatory and that will be installed automatically, followed by a list of optional software subsets for the product you are installing.

Select the optional software subsets that you want from the list. If you want all of the optional software subsets, enter the number corresponding to the selection, All of the Above.

6. A message appears listing the subsets that you have chosen to install and asking you to confirm your choice.

If the software subsets listed are the ones that you want, type `y`. If you type `n`, the list of optional software subsets is displayed again, and you can select the subsets that you want.

Messages appear as each software subset that you selected is installed and verified. This may take an hour or more if you select all of the software subsets. If you are installing from MT9 tapes, you are prompted to remove Volume 1 and insert Volume 2 at the appropriate time.

3.2.1 Installing Additional Software Products

You can install ULTRIX unsupported software subsets and Digital layered products that are compatible with the ULTRIX V4.0 `setld` utility into the diskless server area.

To install additional software products, invoke the `dms` utility again and select the Install Software option. For example, you might install a different set of optional software subsets to `0/rootn.mips`.

The sample session that follows shows how you would install ULTRIX Worksystem Software into `0/rootn.mips`.

1. When the prompt asking if you are installing ULTRIX supported software appears, type `n`.

A message like this appears:

```
You have chosen to install additional software into an existing
diskless environment.  These are the available installation directories:
```

2. If there is more than one installed `rootn.mips` directory in the diskless server area, choose the appropriate directory from the menu that lists existing `rootn.mips` directories. For example:

```
1. /dlenv0/root0.mips
2. /dlenv0/root1.mips
3. /dlenv0/root0.vax
```

```
Enter your choice [ ]: 1
```

3. A prompt asks for the full pathname of the device special file name or mount point for the distribution media.
Enter the device special file name or mount point of your distribution media.
4. If your distribution media is tape, a message appears asking you to confirm that the tape is mounted and on line.
If your distribution media is tape, confirm that the tape is mounted and on line, then type `y`.
5. A message appears listing the software subsets that are mandatory and that will be installed automatically, followed by a list of optional software subsets for the product you are installing.
6. Select the optional software subsets that you want from the list. If you want all of the optional software subsets, enter the number corresponding to the selection, `All of the Above`.
7. A message appears listing the subsets you have chosen to install and asking you to confirm your choice.

If the software subsets listed are the ones you want, type `y`. If you type `n`, the list of optional software subsets is displayed again, and you can select the

subsets you want.

Messages appear as each software subset you selected is installed and verified.

8. If diskless clients are registered to share this area, a prompt asks if you want to update the `client_name.root` directories of those clients.

Enter `yes` to keep the diskless clients in a consistent state.

Repeat these installation procedures for each `rootn.mips` area you plan to set up.

This chapter describes how to manage and maintain the diskless environment and how to manage diskless clients. The instructions tell you how to perform the following tasks:

- Add a client.
- Boot a client.
- Modify a client.
- Remove a client.
- List registered clients.
- Show products in diskless server areas.
- Rebuild or copy kernels.
- Create links to the `/usr/hosts` directory
- Maintain the diskless server area.
- Use the `dms` database to manage multiple clients.

4.1 Adding a Client

Use the following procedure to add a client processor:

1. Log in and become the superuser.
2. Type the following command at the system prompt to invoke the `dms` utility:

```
# /etc/dms
```

3. Select the Add Client Processor option from the menu that appears by typing `a`:

```
DISKLESS MANAGEMENT SERVICES (DMS) UTILITY MENU
```

```
a - Add Client Processor
m - Modify Client Parameters
r - Remove Client Processor
l - List Registered Clients
s - Show Products in Diskless Environments
i - Install Software
c - Create Diskless Area on Disk
k - Kernel Rebuild or Copy
e - Exit
```

```
Enter your choice: a
```

4. If more than one `rootn.mips` directory has been installed in this diskless server area, a prompt appears asking you to select the name of the environment to assign to this client. Each environment may contain different software subsets.

Enter the number corresponding to the environment that you want. In this example, the system manager selects 1:

Select the diskless environment:

```
1      /dlenv0/root0.mips
2      /dlenv0/root0.vax
```

Enter your choice []: 1

5. A message appears indicating that you have chosen to add a client processor. The message also supplies some additional information.
6. A prompt asks if you want to continue with the add client processor procedure.
7. After you confirm that you want to continue, a prompt asks you to enter the client's host name.

Note

For registration, the MOP protocol and DECnet/ULTRIX software recognize only six characters for the host name. A host name can contain more than six characters, but the first six characters must be unique. The name must contain alphanumeric characters only and be entered in lower case, with the initial character an alphabet character.

Enter the client's host name. For example:

```
Enter the client processor's host name: bergal
```

If the client processor's host name has not been registered with the appropriate naming service servers, the dms utility displays an appropriate error message and repeats the prompt.

8. The next prompt asks you to type the hardware Ethernet address for the client. See the worksheet you filled out in Chapter 2 for the correct entry.

In this example, the system manager specifies the hardware Ethernet address for the client **bergal**:

```
Enter the client processor's hardware Ethernet address, for
example, 08-00-2f-03-f5-08: 08-00-2B-03-05-8B
```

9. If clients are already registered for the diskless environment, a message appears asking if you want to duplicate an existing client's environment for the client you are adding. If you type **y** a list of available environments appears.

If you choose to duplicate an existing client environment, the existing client's root area, kernel, device special file directory, /etc/hosts file, /usr area mount point, and swap file information are all copied to the client you are adding.

The configuration you select appears, followed by a prompt for confirmation.

10. If you choose not to duplicate an existing environment for the client you are adding, a prompt asks you to select the name of the file system to contain the client's root directory.

Enter the number corresponding to the file system that you want. For example:

```
Select the name of the file system to contain the client's
root directory:
```

```
1 /dlclient0
2 /dlclient1
```

```
Enter your choice [ ]: 1
```

If a `client_name.root` directory for the client already exists, you are asked if it should be overwritten.

11. A prompt asks you to choose the swap file location, which can be either on the client, if it has a disk available, or on the server.

Enter the number corresponding to your selection.

12. If the swap file location chosen is on the client, a prompt asks for the device special file name for the swap partition. After you enter the device special file name, a prompt for confirmation appears.
13. If the swap file location chosen is on the server, a prompt asks for the swap file size. The recommended swap size is two to three times the client's physical memory size depending on need.

Enter the number you want. In the example that follows, the system manager enters 32 for a 32-Mbyte swap file size:

```
Select the client's swap file size: 32
```

A message appears saying that the client's swap file is being created.

14. A menu listing crash dump options appears, followed by a prompt to choose one of the options. See the *Guide to System Crash Recovery* for a description of the crash dump process.

Enter the letter corresponding to your choice. In the example that follows, the system manager chooses a full dump for the client:

```
The following crash dump options are available:
```

```
n - no dump
f - full dump
```

```
Enter your choice [ ]: f
```

15. A prompt asks for the `root` password to be used on the client processor. After you enter the password, a prompt asks you to enter the password again for confirmation.
16. System information is displayed as files are created for the diskless client. When the client registration procedure is complete, the `dms` menu appears.
17. Notify each client when registration is complete. Tell the clients to boot the kernel on the server. See Section 4.2 for information about booting a client.

4.2 Booting a Client

When you add a new client, that client first boots from the generic kernel which is swapped over the network and a new kernel is built for the client. Messages appear giving instructions about how to boot the new kernel and how to set the default boot command.

If you specified swapping on the local disk when you registered the client, subsequent boots swap locally.

4.2.1 Boot Command for RISC Clients

The user on a client processor can set the boot path environment variable and boot by using a command sequence with the following syntax:

```
setenv bootpath mop(n)
auto
```

The value of *n* depends on the number of network interfaces the client has set up.

For example, the user on a RISC client processor types this command sequence to set the boot path environment variable and boot a machine that has one network interface:

```
>> setenv bootpath mop(0)
>> auto
```

Once the boot path environment variable is set, the user simply types `auto` to boot the processor.

4.2.2 Sample Boot Commands for VAX Clients

The following examples show the boot commands for VAX clients.

The user on a VAXstation 2000 client processor would type this command:

```
>>> b esa0
```

The user on a VAXstation II/GPX client processor would type this command:

```
>>> b xqa0
```

See the *Guide to System Shutdown and Startup* for information about how to boot your VAX processor.

4.3 Modifying a Client

The procedure for modifying a client processor's registration information is like the procedure for adding a client processor. See the DMS Client Setup Worksheet for a list of the registration information you can modify.

The client's current entry for each type of information appears in square brackets at each prompt. Press the RETURN key to keep the current entry.

A summary of the procedure for modifying a client follows:

1. Invoke the `dms` utility and select the `Modify Client` option by typing `m`:

DISKLESS MANAGEMENT SERVICES (DMS) UTILITY MENU

```
a - Add Client Processor
m - Modify Client Parameters
r - Remove Client Processor
l - List Registered Clients
s - Show Products in Diskless Environments
i - Install Software
c - Create Diskless Area on Disk
k - Kernel Rebuild or Copy
e - Exit
```

Enter your choice: **m**

A message appears indicating that you have chosen to modify a client processor. The message also supplies some additional information.

2. A list of existing environments appears. Select the environment you want.
3. A list of clients registered for that environment appears.
4. A prompt asks you to enter the host name of the client to be modified. In this example, the client is `bergal`.

Enter the name of the client to be modified: **bergal**

5. The next prompt asks you to type the hardware Ethernet address for the client.
6. If there is more than one choice, a prompt asks you to select the name of the file system to copy for the client's `client_name.root` directory.
7. A prompt asks for the swap file system location.

If you change the swap file location, or if the swap file is located on the local disk and you change the partition on which it resides, the client must reboot so that the `dms` utility can automatically build a new kernel. Messages appear giving the client instructions about how to proceed.

If you change the swap file size or location, the software recreates the swap file.

8. A prompt asks whether the client can crash dump across the network.

After you type your answer to the last prompt, the client modification is complete and the `dms` menu appears.

4.4 Removing a Client

To remove a client:

1. Invoke the `dms` utility and select the `Remove Client` option by typing `r`:

DISKLESS MANAGEMENT SERVICES (DMS) UTILITY MENU

```
a - Add Client Processor
m - Modify Client Parameters
r - Remove Client Processor
l - List Registered Clients
s - Show Products in Diskless Environments
i - Install Software
c - Create Diskless Area on Disk
k - Kernel Rebuild or Copy
e - Exit
```

Enter your choice: **r**

A message appears indicating that you have chosen to remove a client processor.

2. A list of existing environments appears. Select the environment you want.
3. A list of clients registered for that environment appears.
4. A prompt appears asking you to specify the name of the client that you want to remove. In the following example, the system manager removes the client called profun.

You have chosen to remove a diskless client. This will remove the client's root directory and swap file.

Enter the host name of the client processor to be removed:
profun

If you type an invalid name, an appropriate error message appears.

After you specify a valid client processor, the dms utility prompts for verification. For example:

Remove profun? (y/n) [n]: **y**

When you type **y** to confirm your choice, the dms utility deletes that client's `client_name.root` directory and swap file, removes its entries from `/etc/exports`, and removes the client from the MOP database. When removal is complete, a message like this appears, followed by the system prompt:

Removed profun as a diskless client.

4.5 Listing Registered Clients

You can use the `List Registered Clients` option to see the registered clients for a common `rootn.mips` area.

1. Invoke the dms utility and select the `List Registered Clients` option by typing `l`:

DISKLESS MANAGEMENT SERVICES (DMS) UTILITY MENU

- a - Add Client Processor
- m - Modify Client Parameters
- r - Remove Client Processor
- l - List Registered Clients
- s - Show Products in Diskless Environments
- i - Install Software
- c - Create Diskless Area on Disk
- k - Kernel Rebuild or Copy
- e - Exit

Enter your choice: 1

2. A display similar to this appears:

Registered Clients:

bergal
erlang
mostro
noturn
profun

Do you want to see the configuration for one of these clients?

If no, press RETURN.

If yes, enter the client's host name:

If there are no registered clients, the message No registered clients appears.

In the following example, the system manager selects bergal and a display like this appears:

```
Copied root area:      /dlenv0/root0.mips
bergal's root area:   /dlclient0/bergal.root
bergal's usr area:    /dlenv0/root0.mips/usr
Swap file:            /dlclient0/bergal.root/dlclient/swap
Swap file size:       32 Mbytes
No crash dumping
```

```
Ethernet Address:     08-00-2B-03-05-8B
Internet Address      (128.45.1.126)
```

4.6 Showing Products in Diskless Server Areas

You can view the current products in a diskless server area by using the following procedure:

1. Invoke the dms utility and select the Show Products in Diskless Server Areas option by typing s.

DISKLESS MANAGEMENT SERVICES (DMS) UTILITY MENU

- a - Add Client Processor
- m - Modify Client Parameters
- r - Remove Client Processor
- l - List Registered Clients
- s - Show Products in Diskless Environments
- i - Install Software
- c - Create Diskless Area on Disk
- k - Kernel Rebuild or Copy
- e - Exit

Enter your choice: **s**

2. A display similar to this appears:

Show Products in Diskless Server Areas:

```
1 /dlenv0/root0.mips
   ULTRIX Worksystem Software V4.0 (RISC)
```

4.7 Rebuilding or Copying Kernels

You can use Kernel Rebuild or Copy option either to rebuild a client's kernel or to copy one client's kernel to another client.

Rebuild the kernel if you add devices or if the client's kernel object code is changed for any reason. This rebuild command replaces the client's customized kernel with the generic kernel. When the client boots, a new kernel will be built.

When you copy one client's kernel to another client, make sure that both clients' configurations and architectures are the same.

Use the following procedure to rebuild or copy a kernel:

1. Invoke the dms utility and select the Kernel Rebuild or Copy option by typing **k**:

DISKLESS MANAGEMENT SERVICES (DMS) UTILITY MENU

- a - Add Client Processor
- m - Modify Client Parameters
- r - Remove Client Processor
- l - List Registered Clients
- s - Show Products in Diskless Environments
- i - Install Software
- c - Create Diskless Area on Disk
- k - Kernel Rebuild or Copy
- e - Exit

Enter your choice: **k**

2. A list of diskless environments appears. Select the environment you want.

3. A menu like the following appears:

```
1 Kernel Rebuild
2 Kernel Copy from another client.
```

Enter your choice:

4. A list of clients registered for that environment appears. Select the client whose kernel you want to rebuild or to copy.

4.8 Creating Links to the /usr/hosts Directory

The `/usr/hosts` directory contains links to the names of host systems available. Since the shared `/usr` area is read only for diskless clients, the system manager on the server can create links to the `/usr/hosts` directory. Then, diskless clients can log in to any of the systems whose names are linked to the `/usr/hosts` directory by entering the system's name as a command.

On the server, to create the links for clients registered for a RISC environment, type:

```
# /usr/hosts/MAKEHOSTS /dlenv?/root?.mips/usr/hosts
```

On the server, to create the links for clients registered for a VAX environment, type:

```
# /usr/hosts/MAKEHOSTS /dlenv?/root?.vax/usr/hosts
```

4.9 Using the dms Database to Manage Multiple Clients

The `dms` utility generates a database file automatically when you register the first client for the first diskless server area. The pathname for the file is `/usr/diskless/dmsdb`.

Every time you add, delete, or modify a diskless client using the `dms` utility interactively, the database file is updated. The database file has the following format:

```
hostname:Ethernet_address:common_area:client_root:swap:dump
```

If the client's swap file is located on the server, the number of Mbytes the client can swap appears in the `swap` field. If the swap file is located on the client's local disk, the swap device location appears in the `swap` field. The `dump` field contains either `f` for a full dump over the network or `n` for no dump over the network.

For example, the database file entry for `bergal` with the swap file on the local disk and full network dump might look like the following:

```
bergal:08-00-2B-03-05-8B:/dlenv0/root0.mips:/dlclient0:rz0b:f
```

4.9.1 Adding Multiple Clients

You can edit the `/usr/diskless/dmsdb` file to add a group of clients, then use a `dms` command line to add the clients.

In the example that follows, the system manager adds a group of four diskless clients, after editing `/usr/diskless/dmsdb`.

The file contains the following entries before editing:

```
bergal:08-00-2B-03-05-8B:/dlenv0/root0.mips:/dlclient0:rz0b:f
erlang:08-00-6A-03-05-2B:/dlenv0/root0.mips:/dlclient0:rz3b:f
mostro:08-00-2B-06-05-8B:/dlenv0/root0.vax:/dlclient0:ra0g:f
noturn:08-00-2B-03-04-7B:/dlenv0/root0.mips:/dlclient1:rz4b:f
profun:08-00-2B-03-09-8B:/dlenv0/root0.vax/dlclient1:rz0b:f
```

The system manager uses a text editor to add entries to the file, for example:

```
bergal:08-00-2B-03-05-8B:/dlenv0/root0.mips:/dlclient0:rz0b:f
erlang:08-00-6A-03-05-2B:/dlenv0/root0.mips:/dlclient0:rz3b:f
mostro:08-00-2B-06-05-8B:/dlenv0/root0.vax:/dlclient0:ra0g:f
noturn:08-00-2B-03-04-7B:/dlenv0/root0.mips:/dlclient1:rz4b:f
profun:08-00-2B-03-09-8B:/dlenv0/root0.vax/dlclient1:rz0b:f
extra:08-00-2B-03-06-3B:/dlenv0/root0.mips:/dlclient8:rz0b:n
```

```
miler:08-00-6A-03-07-5B:/dlenv0/root0.mips:/dlclient8:rz3b:f
pastry:08-00-2B-16-05-4B:/dlenv0/root0.vax:/dlclient1:rz4b:f
overly:08-00-4B-03-09-3B:/dlenv0/root0.vax:/dlclient1:rz0b:f
```

Then, the system manager enters a command like the following to register the group of clients:

```
# /etc/dms -a extra miler pastry overly
```

This command does not set up the super user password for the clients. Tell each of the clients to enter a super user password after they log in to their systems.

4.9.2 Removing Multiple Clients

You can also use a `dms` command line to remove a group of clients, for example:

```
# /etc/dms -r pastry overly profun
```

4.9.3 Building Multiple Client Kernels

You can also use a `dms` command line to build kernels for a group of clients, for example:

```
# /etc/dms -k pastry overly profun
```

4.9.4 Listing Multiple Clients

You can use a `dms` command line to list all the registered clients, for example:

```
# /etc/dms -l
```

You can also use a `dms` command line to list the parameters assigned to a group of clients, for example:

```
# /etc/dms -l pastry overly profun
```

4.9.5 Showing Products from the Command Line

You can use a `dms` command line to show the products installed in each diskless server area.

The syntax of the command to show products in a diskless server area follows:

```
/etc/dms -s
```

For example, if you type the following command:

```
# /etc/dms -s
```

A display similar to this appears:

Show Products in Diskless Server Areas:

```
1 /dlenv0/root0.mips
   ULTRIX Worksystem Software V4.0 (RISC)
```

4.10 Maintaining the Diskless Environment

This section contains information about maintaining the diskless server area.

4.10.1 Controlling Root File System Growth

Use the `df` command to show how much space clients are using. This helps you keep track of the file growth in each client's `root` directory. If clients use too much space, performance is adversely affected. See `df(1)` in the *ULTRIX Reference Pages*.

4.10.2 Listing Installed Software Subsets

Use the `setld` command to find out which software subsets are installed into a particular `rootn.mips` area.

For example, the following command produces a list of the software subsets that have been installed into the common `client_name.root` area of `dlenv0`:

```
# setld /dlenv0/root0.mips -i
```

Refer to `setld(8)` in the *ULTRIX Reference Pages* for more information.

4.10.3 Removing Subsets

You can also use the `setld` command to remove software subsets from a common `rootn.mips` area.

For example, if you had installed the On-Line Manual Pages subset, `ULTMAN400`, and wanted to remove it, you would use a command like this:

```
# setld /dlenv0/root0.vax -d ULTMAN400
```

This command removes the subset from `/dlenv0/root0.vax`. However, the subset may not be fully removed from `/dlclient0/root0.vax` if the subset placed files in that directory.

This chapter contains both suggestions on which areas of the server to check if a client is having trouble booting the system and a description of the sequence of events that occur when a diskless client crashes.

5.1 Server Areas to Check for Client Booting Problems

This section contains suggestions for areas on the server processor which should be checked if a diskless client has trouble booting its system.

- Examine the recent entries in the file, `/usr/spool/mqueue/syslog`.
This file should contain the sequence of MOP transmissions and specify any problems that occurred in the process.
- If a client crashes while booting with a message, `panic mountrpc: cannot NFS mount file`, check to make sure that the following daemons are running on the server:

```
biod
mountd
nfsd
portmap
```

Type the following command on the server to see if the daemons are running:

```
# ps aux | egrep "biod|mountd|nfsd|portmap"
```

Process status will appear for any of those daemons that are running.

Also, make sure that the client's directories are properly exported in the file, `/etc/exports`.

- If the client only boots to single-user mode, check to make sure that the client's `/usr` file system is exported and that the `dlclient?` area has an entry in the `/etc/exports` file.

Proper `/etc/exports` entries on the server should look similar to these:

```
/dlenv0/root0.mips/usr -o -r=0 bergal
/dlclient0/bergal.root -r=0 bergal
```

- Use the `getnode` command to identify the pathname of the kernel that the client was trying to boot. Refer to `getnode(8)` in the *ULTRIX Reference Pages*.

5.2 Client Crash Description

When a client set up by the `dms` utility for either a full or a partial crash dump of memory over the network crashes, the following events occur:

1. The client processor tries to dump the contents of its memory to the server using the maintenance operations protocol, MOP.
2. A message like this appears on the client:

```
Network Dumping ...
```
3. A core dump file is generated. This file is located in the directory, `/var/adm/crash/vmcore`, on the client. The MOP dumping procedure may take several minutes to complete, depending on how much traffic there is on the network.
4. Once the contents of the client's memory have been dumped, the client automatically reboots, using its default boot setting. See the hardware documentation for information about setting this parameter.
5. The default `/etc/rc.local` file on the client contains a line that calls the program, `/etc/savecore`, which transforms the `vmcore` image into a format that can be debugged.
6. The `vmunix` image is copied from the `root` directory to the directory specified in the `savecore` line of the `/etc/rc.local` file. For example:

```
/etc/savecore -f /usr/adm/crash/vmcore /usr/adm/crash
```
7. After the `savecore` program completes, two files, `vmunix.*` and `vmcore.*`, are added to the directory specified. See `savecore(8)` in the *ULTRIX Reference Pages* for further information.

The client user should notify the system manager on the server when a crash occurs so that the cause of the crash can be investigated.

This chapter describes how to customize a diskless client's setup. The instructions tell you how to perform the following tasks:

- Use the `rwhod` command on a diskless client
- Read mail on a client.
- Reconfigure client kernels

A.1 Using the `rwhod` Command on a Diskless Client

By default, the `rwhod` daemon is called with the `-b` option, which sets broadcast-only mode, in the `/etc/rc` file on each diskless client machine. This enhances diskless client performance. See `rwhod(8c)` in the *ULTRIX Reference Pages* for more information about the daemon.

If you want to use the `rwho(1)` command on a diskless client machine, you must mount the server's `/var/spool/rwho` directory to the client's `/var/spool/rwho` directory. The procedure that follows describes how to set up both server and client to use the `rwho` command on a diskless client machine.

On the server machine, add a line like the following to the `/etc/exports` file:

```
/var/spool/rwho -o
```

On the client machine, you must add a line to the `/etc/fstab` file that includes the server's host name. For example:

```
/var/spool/rwho@tigris:/var/spool/rwho:ro:0:0:bg,soft:
```

A.2 Reading Mail on a Client

This section describes two methods for setting up a diskless client to read electronic mail on a server. The first method is recommended when multiple users log in to the client processor. The second method is recommended when only a single user will be logging in to the client processor.

In the examples used in the two sections that follow, the user is named `rjones`, the client processor is named `bergal`, and the server processor is named `tigris`.

A.2.1 Reading Mail from a Diskless Client with Multiple Users

If the diskless client has multiple users logging in, the recommended method is to have all mail forwarded to the server machine. The users on the client use the `rlogin` command to log in to the server to read their mail.

This method requires no change on the server and minor changes on the client.

Each user on the client machine creates a file to contain the forwarded mail. For example:

```
bergal:/usr/spool/mail/rjones.forward
```

The contents of the file look like this:

```
rjones@tigris
```

When users on the client processor want to read their mail, which is located on the server, they use the `rlogin` command. For example, `rjones` types commands like these from `bergal`:

```
$ rlogin tigris
.
.
% mail
```

A.2.2 Reading Mail from a Diskless Client with a Single User

If the diskless client has a single user logging in, the recommended method for reading mail is one that makes mail appear to be present on the local processor even though it is located on the server. This method requires changes on both the server and the client.

Follow this procedure at the server machine:

1. Become the superuser.
2. Create a directory with a pathname like the following:
`/usr/spool/mail/$USER`. This directory will contain the user's mail messages. For example:

```
# mkdir /usr/spool/mail/rjones
```

3. Export the mail directory to the client machine by adding a line similar to the following to the `/etc/exports` file:

```
/usr/spool/mail/rjones bergal
```

Follow this procedure at the client machine:

1. Become the superuser.
2. Add the appropriate line to the `/etc/fstab` file. For example:
`/usr/spool/mail/rjones@tigris:/usr/spool/mail/rjones:rw:0:0:nfs:bg,soft:`
3. Remotely mount the mail directory, `/usr/spool/mail/$USER`. For example:

```
$ mount tigris:/usr/spool/mail/rjones /usr/spool/mail/rjones
```

4. Set the `MAIL` environment variable in the user's `.login` file to `/usr/spool/mail/$USER/$USER`. For example: `rjones` would add a line like this:

```
setenv MAIL /usr/spool/mail/rjones/rjones
```

The user types a command like this to read mail:

```
$ mail
```

A.3 Reconfiguring Client Kernels

You can reconfigure client kernels either by using the `dms Kernel Rebuild` or `Copy` option, or by building the kernel manually. In a diskless environment, you must build kernels under the `/sys` directory because the `/usr/sys` directory is part of the shared user area.

In the sample procedure that follows, a user on the client `bergal`, a RISC machine, creates a customized kernel. If you perform this procedure on a VAX processor, substitute `vax` for `VAX` or `mips` for `MIPS` throughout.

1. Become the superuser.
2. Change directory using a command like the following:

```
# cd /sys/conf/mips
```

3. Edit the `BERGAL` file, adding and deleting the options you want. The user changes the swap location from the server to the local disk in the example that follows. The configuration file line to be edited looks like the following when the swap location is on the server:

```
config      vmunix  root on ln0
```

The configuration file line looks like the following after being edited to change the swap location to the local disk:

```
config      vmunix  root on ln0 swap on rz0b
```

4. Build the new kernel, using a command like the following:

```
# doconfig -c BERGAL
```

5. To change the swap location, the client must edit the `netblk.c` program. The sample section of `netblk.c` that follows shows the lines to be edited in bold type. Each line contains a comment indicating its purpose:

```
#include <sas/mop.h>
struct netblk  nblk={
  "tigris",
  -2144534260, "bergal", -2144534144, -2144534017, -256,
  1, /* change to 0 for local disk */
  5,
  40, /* size / 2 = swap size --> 20 meg */
  0, /* size / 2 = dump size */
  "/usr/var/diskless/dlclient9/bergal.root",
  "/usr/var/diskless/dlclient9/bergal.root/dlclient/swap", /* swap location */
  ""
};
```

The same sample section of `netblk.c` follows showing the edited lines in bold type. Each line contains a comment indicating the change made:

```
#include <sas/mop.h>
struct netblk  nblk={
"tigris",
-2144534260, "bergal", -2144534144, -2144534017, -256,
0,          /* means local disk swap */
5,
0,          /* local disk, swap size is 0 */
-1,         /* -1 means a full dump */
"/usr/var/diskless/dlclient9/bergal.root",
"rz0b", /* new swap location on local disk */
""
};
```

6. Issue a command like the following to recompile the `netblk.c` program:

```
# cc -c netblk.c
```

7. In this example, the client is changing the swap location from the server to the local machine. The client issues a command like this to remove its swap area on the server:

```
# rm /dev/swap
```

If the client were changing the swap location from the local machine to the server, the client would issue a command with the following syntax:

```
/usr/diskless/make_swap /dev/swap (<swap_size * 2>)
```

The recommended swap file size is two to three times the client's physical memory size depending on need. In the following example the user enters 60 to create a 30-Mbyte swap file (30 Mbytes * 2):

```
# /usr/diskless/make_swap /dev/swap 60
```

8. If the `make` command executed successfully, type a command like the following to replace the old kernel with the new kernel:

```
# mv ./vmunix /vmunix
```

9. Halt the client system.
10. Reboot the client system. See the *Guide to System Shutdown and Startup* for information about booting.

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