



Mac OS X Server System Image Administration

For Version 10.3 or Later



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034-2348/09-20-03

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This chapter describes how to start up client computers using an operating system stored on a server and install software on client computers over the network.

NetBoot and Network Install

The NetBoot and Network Install features of Mac OS X Server offer you alternatives for managing the operating system and application software your Macintosh clients (or even other servers) need to start up and do their work. Instead of going from computer to computer to install OS and application software from CDs, you can prepare an OS install image that is automatically installed on each computer when it starts up. Or, you can choose not to install software on the clients at all but, instead, have them start up (or “boot”) directly from an image stored on the server. Clients don’t even need their own disk drives.

Using NetBoot and Network Install, you can have your client computers start up from a standardized Mac OS configuration suited to their specific tasks. Because the client computers start up from the same image, you can quickly update the operating system for the entire group by updating a single boot image.

A boot image is a file that looks and acts like a mountable disk or volume. NetBoot boot images contain the system software needed to act as a startup disk for client computers on the network. An install image is a special boot image that boots the client long enough to install software from the image, after which the client can boot from its own hard drive. Both boot images and install images are special kinds of disk images. Disk images are files that behave just like disk volumes.

You can set up multiple boot or install images to suit the needs of different groups of clients or to provide several copies of the same image to distribute the client startup load.

You can use NetBoot in conjunction with Mac OS X client management services to provide a personalized work environment for each client computer user. For information about client management services, see the user management guide.

You can use the following Mac OS X Server applications to set up and manage NetBoot and Network Install:

- *Network Image Utility*—to create Mac OS X disk images. Installed with Mac OS X Server software in the /Applications/Server folder.
- *Server Admin*—to enable and configure NetBoot service and supporting services. Installed with Mac OS X Server software in the /Applications/Server folder.
- *PackageMaker*—to create package files that you use to add additional software to disk images. On the *Administration Tools* CD in the Utilities folder.
- Property List Editor—to edit property lists such as NBImageInfo.plist. On the *Administration Tools* CD in the Utilities folder.
- *NetBoot Desktop Admin*—an optional application for modifying Mac OS 9 system disk images and accompanying disk image for applications.

If you still have Mac OS 9 clients, you'll need a copy of the *NetBoot for Mac OS 9* CD (available separately). The CD includes a preconfigured Mac OS 9.2.2 system disk image and the NetBoot Desktop Admin application.

Inside NetBoot

This section describes how NetBoot is implemented on Mac OS X Server, including information on the protocols, files, directory structures, and configuration details.

Disk Images

The read-only disk images contain the system software and applications used over the network by the client computers. The name of a disk image file typically ends in “.img” or “.dmg.” Disk Utility—a utility included with Mac OS X and Mac OS 9.2.2—can mount disk image files as volumes on the desktop.

You set up Mac OS 9 and Mac OS X disk images in slightly different ways.

You use Network Image Utility to create Mac OS X disk images, using a Mac OS X install disc or an existing system volume as the source. See “Creating a Mac OS X Boot Image” on page 19.

A preconfigured Mac OS 9 disk image is provided for you on a CD named *NetBoot for Mac OS 9*, which is available separately. The CD contains localized versions of the Mac OS 9 image in several languages. See “Installing a Mac OS 9 Boot Image” on page 25. You can modify the Mac OS 9 disk image using NetBoot Desktop Admin. See “Modifying a Mac OS 9 Boot Image” on page 25.

NetBoot Share Points

NetBoot sets up share points to make images and shadow files available to clients.

NetBoot creates share points for storing boot and install images in /Library/NetBoot on each volume you enable and names them NetBootSP n , where n is 0 for the first share point and increases by 1 for each additional share point. If, for example, you decide to store images on three separate server disks, NetBoot will set up three share points named NetBootSP0, NetBootSP1, and NetBootSP2.

The share points for client shadow files are also created in /Library/NetBoot and are named NetBootClients n .

You can create and enable additional NetBootSP n and NetBootClients n share points on other server volumes using the NetBoot service General settings in Server Admin.

Warning: Don't rename a NetBoot share point or the volume on which it resides. Don't use Workgroup Manager to stop sharing for a NetBoot share point unless you first deselect the share point for images and shadow files in Server Admin.

Client Information File

NetBoot gathers information about a client the first time the client tries to start up from the NetBoot server. NetBoot stores this information in the file /var/db/bsdpcd_clients.

Shadow Files

Many clients can read from the same boot image, but when a client needs to write anything back to its startup volume (such as print jobs and other temporary files), NetBoot automatically redirects the written data to the client's shadow files, which are separate from regular system and application software.

The shadow files preserve the unique identity of each client during the entire time it is running off a NetBoot image. NetBoot transparently maintains changed user data in the shadow files, while reading unchanged data from the shared system image. The shadow files are re-created at boot time, so any changes made by the user to his or her startup volume are lost at restart.

For example, if a user saves a document to the startup volume, after a restart that document will be gone. This behavior preserves the condition of the environment the administrator set up. Therefore it is recommended that users have accounts on a file server on the network to save their documents.

Balancing the Shadow File Load

NetBoot creates an AFP share point on each server volume you specify (see "Choosing Where Shadow Files Are Stored" on page 35) and distributes client shadow files across them as a way of balancing the load for NetBoot clients. There is no performance gain if the volumes are partitions on the same disk. See "Distributing Shadow Files" on page 47.

Allocation of Shadow Files for Mac OS X NetBoot Clients

When a client computer starts up from a Mac OS X boot image, it creates its shadow files on a server NetBootClients n share point or, if no share point is available, on a drive local to the client. For information about changing this behavior, see “Changing How Mac OS X NetBoot Clients Allocate Shadow Files” on page 24.

NetBoot Image Folders

A NetBoot image folder contains the startup image file, a boot file that the firmware uses to begin the startup process, and other files required to start up a client computer over the network. The name of a NetBoot image folder has the suffix “.nbi.”

An NBI folder for Mac OS 9 is slightly different from an NBI folder for Mac OS X since the components required for startup are different.

Mac OS X NetBoot image folder

File	Description
booter	Boot file
mach.macosx	UNIX kernel
mach.macosx.mkext	Drivers
System.dmg	Startup image file (may include application software)
NBIImageInfo.plist	Property list file

You use Network Image Utility to set up Mac OS X NBI folders. The utility lets you:

- Name the image
- Choose the image type (NetBoot or Network Install)
- Provide an image ID
- Choose the default language
- Specify a default user name and password
- Enable automatic installation for install images
- Add additional package or preinstalled applications

See “Creating a Mac OS X Boot Image” on page 19.

Mac OS 9 NetBoot image folder

File or folder	Description
Mac OS ROM	Boot file
NetBoot HD.img	System startup image file
Application HD.img	Application image file
NBIImageInfo.plist	Property list file
Backup	Folder created by NetBoot Desktop Admin (while it is running) for the backup image

You use NetBoot Desktop Admin to modify the Mac OS 9 NBI folder. This utility lets you change the image file (NetBoot HD.img), change the name of the image, adjust the size of the image, and add software to the application image.

Property List File

The property list file (NBImageInfo.plist) stores image properties. The property lists for Mac OS 9 and Mac OS X are described in the following tables. Initial values in the NBImageInfo.plist are set by the tools you use to work with the image files—NetBoot Desktop Admin (for Mac OS 9 images) and Network Image Utility (for Mac OS X images)—and you usually don't need to change the property list file directly. Some values are set by Server Admin. If you need to edit a property list file, however, you can use TextEdit or Property List Editor, which you can find in the Utilities folder on the *Mac OS X Server Administration Tools CD*.

Mac OS 9 property list

Property	Type	Description
BootFile	String	Name of boot ROM file: Mac OS ROM.
Index	Integer	1–4095 indicates a local image unique to the server. 4096–65535 is a duplicate, identical image stored on multiple servers for load balancing.
IsDefault	Boolean	True specifies this image file as the default boot image on the subnet.
IsEnabled	Boolean	Sets whether the image is available to NetBoot (or Network Image) clients.
IsInstall	Boolean	True specifies a Network Install image; False specifies a NetBoot image.
Name	String	Name of the image as it appears in the Startup Disk control panel (Mac OS 9) or Preferences pane (Mac OS X).
Type	String	Classic.
SupportsDiskless	Boolean	True directs the NetBoot server to allocate space for the shadow files needed by diskless clients.

Mac OS X property list

Property	Type	Description
BootFile	String	Name of boot ROM file: booter.
Index	Integer	1–4095 indicates a local image unique to the server. 4096–65535 is a duplicate, identical image stored on multiple servers for load balancing.
IsDefault	Boolean	True specifies this image file as the default boot image on the subnet.
IsEnabled	Boolean	Sets whether the image is available to NetBoot (or Network Image) clients.
IsInstall	Boolean	True specifies a Network Install image; False specifies a NetBoot image.
Name	String	Name of the image as it appears in the Startup Disk control panel (Mac OS 9) or Preferences pane (Mac OS X).
RootPath	String	Specifies path to disk image on server, or the path to an image on another server. See “Using Images Stored on Other Servers” on page 13.
Type	String	NFS or HTTP.
SupportsDiskless	Boolean	True directs the NetBoot server to allocate space for the shadow files needed by diskless clients.
Description	String	Arbitrary text describing the image.
Language	String	A code specifying the language to be used while booted from the image.

Boot Server Discovery Protocol (BSDP)

NetBoot uses an Apple-developed protocol based on DHCP called Boot Server Discovery Protocol (BSDP). This protocol provides a way of discovering NetBoot servers on a network. NetBoot clients obtain their IP information from a DHCP server and their NetBoot information from BSDP. BSDP offers built-in support for load balancing. See “Performance and Load Balancing” on page 45.

BootP Server

NetBoot uses a BootP server (bootpd) to provide necessary information to client computers when they try to boot from an image on the server.

If you have BootP clients on your network, they might request an IP address from the NetBoot BootP server, and this request will fail because the NetBoot BootP server doesn't have addresses to offer. To prevent the NetBoot BootP server from responding to requests for IP addresses, use NetInfo Manager to open the NetBoot server's local NetInfo directory and add a key named `bootp_enabled` with no value to the directory `/config/dhcp`.

TFTP and the Boot Files

NetBoot uses the Trivial File Transfer Protocol (TFTP) to send boot files from the server to the client.

The boot files are set up by Network Image Utility when you create an image, and are stored on the server in `/Library/NetBoot/NetBootSPn/image.nbi` (where *n* is the volume number and *image* is the name of the image). For Mac OS 9 there is a single file named Mac OS ROM. For Mac OS X images, there are three files: `booter`, `mach.macosx`, and `mach.macosx.mkext`. The `NetBootSPn` directory is automatically set up on your server's boot volume if you enable NetBoot when you install Mac OS X Server. Otherwise, `NetBootSPn` share points are set up on each volume you choose for storing images in the NetBoot settings in Server Admin.

Using Images Stored on Other Servers

You can store Mac OS X boot or install images on NFS servers other than the NetBoot server itself. For more information, see “Using Images Stored on Other NFS Servers” on page 36.

Security

You can restrict access to NetBoot service on a case-by-case basis by listing the hardware (also called the Ethernet or MAC) addresses of computers that you want to allow or deny access. A client computer's hardware address is automatically added to the NetBoot Filtering list when the client starts up using NetBoot and is, by default, enabled to use NetBoot. You can specify others. See “Restricting NetBoot Clients by Filtering Addresses” on page 38.

Before You Set Up NetBoot

Before you set up a NetBoot server, review the following considerations and requirements.

What You Need to Know

To set up NetBoot on your server, you should be familiar with your network configuration, including the DHCP services it provides. Be sure you meet the following requirements:

- You're the server administrator.
- You're familiar with network setup.
- You know the DHCP configuration.

You might also need to work with your networking staff to change network topologies, switches, routers, and other network settings.

Client Computer Requirements

Most Macintosh computers that can run Mac OS 9.2.2 or later can use NetBoot to start up from a Mac OS X disk image on a server. At the time of this publication, this includes the following Macintosh computers:

- Slot-loading G3 iMac (tray-loading iMacs are not supported)
- G4 iMac
- iBook
- eMac
- Power Mac G5
- Power Mac G4
- Power Mac G4 Cube
- PowerBook G3 (FireWire)
- PowerBook G4
- Xserve

You should install the latest firmware updates on all client computers. Firmware updates are available from the Apple support website: www.apple.com/support/.

Power Mac G5 clients can't boot from images prepared for Power Mac G4 or earlier processors, nor can Power Mac G4 or earlier processors boot from images prepared for Power Mac G5 processors. If you have both types of clients, you must set up two separate images.

Older Macintosh computers—tray-loading iMac computers and Power Macintosh G3 (blue and white) computers—need older versions of firmware that require version 1.0 of the NetBoot software, and are no longer supported. Mac OS X Server version 10.3 supports only NetBoot version 2.0.

Client Computer RAM Requirements

The following are the minimum RAM requirements for a client computer starting up from a Mac OS 9 or Mac OS X boot image.

- *Start up from Mac OS 9 disk image:* 64 MB
- *Start up from Mac OS X disk image:* 128 MB

Client computers using Network Install must also have 128 MB of RAM.

Software Updates for NetBoot System Disk Images

You should use the latest system software when creating NetBoot disk images.

New Macintosh computers require updates of system software, so if you have new Macintosh clients you'll need to update your boot images.

To update a Mac OS X disk image, see "Adding an OS Update Package to a Mac OS X Boot Image" on page 22.

To update a Mac OS 9 disk image, see "Modifying a Mac OS 9 Boot Image" on page 25.

Ethernet Support on Client Computers

NetBoot is supported only over the built-in Ethernet connection. Multiple Ethernet ports are not supported on client computers. Clients should have at least 100 Mbit Ethernet adapters.

Network Hardware Requirements

The type of network connections you should use depends on the number of clients you expect to boot over the network:

- 100 Mb Ethernet (for booting fewer than 10 clients)
- 100 Mb switched Ethernet (for booting 10–50 clients)
- Gigabit Ethernet (for booting more than 50 clients)

These are estimates for the number of clients supported. See "Capacity Planning" on page 16 for a more detailed discussion of the optimal system and network configurations to support the number of clients you have.

Network Service Requirements

Depending on the types of clients you want to boot or install, your NetBoot server must also provide the following supporting services.

Service provided by NetBoot Server	For booting Mac OS X computers with hard disks	For booting Mac OS X computers without hard disks	For booting Mac OS 9 computers
DHCP	optional	optional	optional
NFS	required if no HTTP	required if no HTTP	
AFP		required	required
HTTP	required if no NFS	required if no NFS	
TFTP	required	required	required

Note: DHCP service is listed as optional because, although it is required for NetBoot, it can be provided by a server other than the NetBoot server. Services marked “required” must be running on the NetBoot server.

NetBoot and AirPort

The use of AirPort wireless technology to NetBoot clients is not supported by Apple and is discouraged.

Capacity Planning

The number of NetBoot client computers your server can support depends on how your server is configured, when your clients routinely start up, the server’s hard disk space, and a number of other factors. When planning for your server and network needs, consider these factors:

- *Ethernet speed:* 100Base-T or faster connections are required for both client computers and the server. As you add more clients, you may need to increase the speed of your server’s Ethernet connections. Ideally you want to take advantage of the Gigabit Ethernet capacity built in to your Mac OS X server hardware to connect to a Gigabit switch. From the switch you should connect Gigabit Ethernet or 100 Mb Ethernet to each of the NetBoot clients.
- *Hard disk capacity and number of images:* Boot and install images occupy hard disk space on server volumes, depending on the size and configuration of the system image and the number of images being stored. Images can be distributed across multiple volumes or multiple servers. For more information, see “Performance and Load Balancing” on page 45.
- *Hard disk capacity and number of users:* If you have a large number of Mac OS 9 or Mac OS X diskless clients, consider adding a separate file server to your network to store temporary user documents. Because the system software for a disk image is written to a shadow image for each client booting from the disk image, you can get a rough estimate for the required hard disk capacity required by multiplying the size of the shadow image by the number of clients.
- *Number of Ethernet ports on the switch:* Distributing NetBoot clients over multiple Ethernet ports on your switch offers a performance advantage. Each port must serve a distinct segment.

Setup Overview

Here is an overview of the basic steps for setting up NetBoot service.

Step 1: Evaluate and update your network, servers, and client computers as necessary

The number of client computers you can support using NetBoot is determined by the number of servers you have, how they're configured, hard disk storage capacity, and other factors. See "Capacity Planning" on page 16.

Depending on the results of this evaluation, you may want to add servers or hard disks, add Ethernet ports to your server, or make other changes to your servers. You may also want to set up more subnets for your BootP clients, depending on how many clients you support.

You may also want to implement subnets on this server (or other servers) to take advantage of NetBoot filtering. See "Restricting NetBoot Clients by Filtering Addresses" on page 38.

If you plan to provide authentication and personalized work environments for NetBoot client users by using Workgroup Manager (Mac OS X clients) and Macintosh Manager (Mac OS 9 clients), you should set this up and import users from the Mac OS X Server Users & Groups database before you create disk images. Make sure you have at least one Macintosh Manager user assigned to the System Access workgroup for Mac OS 9 clients and the Workgroup Manager for Mac OS X clients.

Step 2: Create disk images for client computers

You can set up both Mac OS 9 disk images and Mac OS X disk images for client computers to start up from. A preconfigured Mac OS 9 image is supplied with Mac OS X Server on the *NetBoot for Mac OS 9* CD, available separately. The Mac OS 9 disk image can be modified. If you're supporting new client computers that were released after Mac OS X Server version 10.0.3, you'll need to modify the Mac OS 9 disk image to support the new clients. See "Modifying a Mac OS 9 Boot Image" on page 25.

To create Mac OS X disk images, you use Network Image Utility. See "Creating a Mac OS X Boot Image" on page 19.

To create application packages that you can add to an image, use PackageMaker. Application software packages can be installed by themselves or along with Mac OS X system software. See "Creating Packages" on page 30.

Step 3: Set up DHCP

NetBoot requires that you have a DHCP server running either on the local server or another server on the network. Make sure that you have a range of IP addresses sufficient to accommodate the number of clients that will be using NetBoot at the same time.

If your NetBoot server is also supplying DHCP service, you might get better performance if you configure your server as a gateway. That is, configure your subnets to use the server's IP address as the router IP address.

Be sure DHCP service is started.

Step 4: Configure and turn on NetBoot service

You use the NetBoot settings in Server Admin to configure NetBoot on your server. See Chapter 3, "Setting Up NetBoot Service."

You turn on NetBoot service using Server Admin. See "Starting NetBoot and Related Services" on page 34 and "Enabling Images" on page 34.

Step 5: Set up Ethernet address filtering (optional)

NetBoot filtering is done by client computer hardware address. Each client's hardware address is automatically registered the first time the client attempts to start up from a NetBoot disk image. You can allow or disallow specific clients by address. See "Restricting NetBoot Clients by Filtering Addresses" on page 38.

Step 6: Test your NetBoot setup

Because there is risk of data loss or bringing down the network (by misconfiguring DHCP), it is recommended that you test your NetBoot setup before implementing it on all your clients. You should test each different model of Macintosh that you're supporting. This is to make sure that there are no problems with the boot ROM for a particular hardware type.

Step 7: Set up all client computers to use NetBoot

When you're satisfied that NetBoot is working on all types of client computers, then you can set up the client computers to start up from the NetBoot disk images.

Clients running Mac OS 9: Use the Startup Disk control panel to select a startup disk image on the server, then restart the computer. See "Selecting a NetBoot Boot Image (Mac OS 9)" on page 40.

Note: You may have to update the Startup Disk control panel on client computers running Mac OS 9 from their local hard disks so they can view NetBoot disk images in the control panel. See "Updating the Startup Disk Control Panel" on page 39.

Clients running Mac OS X version 10.2 or later: Use the Startup Disk System Preference pane to select a startup disk image on the server, then restart the computer. See "Selecting a NetBoot Boot Image (Mac OS X)" on page 40.

Any client: Restart the computer and hold down the N key until the NetBoot icon starts flashing on the screen. The client starts up from the default image on the NetBoot server. See "Starting Up Using the N Key" on page 42.

This chapter provides step-by-step instructions for preparing boot or install images that can be used with NetBoot service.

Creating Mac OS X Boot Images

The instructions in this section show how to create boot images of the Mac OS X operating system that you can use to start up client computers over the network. For help creating Mac OS 9 images, see “Creating Mac OS 9 Boot Images” on page 25.

Creating a Mac OS X Boot Image

You use Network Image Utility to create Mac OS X NetBoot images.

Note: You must purchase an OS user license for each client that starts up from a NetBoot disk image.

To create a boot image:

- 1 Log in to the server as an administrative user.
- 2 Open Network Image Utility and click New Boot.
- 3 In the General pane, type a name for the image you’re creating.
This name will identify the image in the Startup Disk preferences pane on client computers.
- 4 Type an Image ID.
To create an image that is unique to this server, choose an ID in the range 1–4095.
To create one of several identical images to be stored on different servers for load balancing, use an ID in the range 4096–65535. Multiple images of the same type with the same ID in this range are listed as a single image in a client’s Startup Disk preferences panel.
- 5 (Optional) Type notes or other information that will help you characterize the image in the Description field. Clients can’t see what you type.

- 6 (CD source only) Choose the default language for the system. (Available only if you have already inserted the CD and chosen it as the source.)
- 7 Choose whether the image is to be delivered using NFS or HTTP.
If you're not sure which to choose, choose NFS.
- 8 Click Contents and choose the source for the image.
You can choose an install CD, a mounted boot volume, or an existing disk image.
If you're creating the image from CDs, be sure it is inserted.
Important: If you have created a standard disk image (.dmg file) from an OS install CD and want to use that image as the source for a NetBoot image, double-click the .dmg file in the Finder to mount the image, then choose it from the pop-up menu.
- 9 (Optional) Click the Add (+) button below the Other Items list to add an application package, system update package, or script to the image.
- 10 (CD source only) Click Default User, type a user name, short name, and password (in both the Password and Verify fields) for the system's default user account. You can log in to a booted client using this account.
- 11 Click Create Image.
If the Create button is not enabled, make sure you have entered an image name and ID, chosen an image source, and entered a default user name with a password that is at least four characters long.
- 12 In the Save As dialog, choose where to save the image.
If you don't want to use the image name you typed earlier, you can change it now by typing a new name in the Save As field.
If you're creating the image on the same server that will serve it, choose a volume from the "Serve from NetBoot share point on" pop-up menu.
To save the image somewhere else, choose a location from the Where pop-up menu or click the triangle next to the Save As field and navigate to a folder.
- 13 Click Save.
To check progress, look in the lower-left corner of the window. If you need to insert another CD, you'll be prompted there. To create the image without including the contents of a subsequent CD, click Finish when you are prompted to insert it.
Important: Don't open the .nbi folder in /Library/NetBoot/NetBootSPn while the image is being created; clients won't be able to use the resulting image.

From the Command Line

You can also create a boot image using commands in Terminal. For more information, see the system image chapter of the command-line administration guide.

Installing the Classic Environment on a Mac OS X Disk Image

You can install the Classic environment onto a Mac OS X image by copying a Mac OS 9.2.2 system folder into an “unlocked” NetBoot image. You must also specify the Mac OS X image as the Classic startup volume and start the Classic environment from the image using the System 9 preference pane to complete the integration.

Don't try to install the Classic environment onto Network Install images. This procedure works only for NetBoot images.

Warning: Don't modify a disk image that is in use by any NetBoot clients. Doing so will result in unpredictable behavior for the clients. Before modifying a disk image, make sure no one is using the image or make a copy of the file and modify the copy.

To install the Classic environment on a Mac OS X boot image:

- 1 Make sure the disk image file (.dmg) is unlocked.
If there is a small lock on the file's icon in the Finder (in /Library/NetBoot/NetBootSPn), log in to the server as the root user, select the image file, choose Get Info from the Finder's File menu, and deselect the Locked checkbox.
- 2 Double-click the image file to mount it.
- 3 Drag a Mac OS 9 System Folder to the disk image.
You can use the System Folder from the *NetBoot for Mac OS 9* CD (available separately) or use another Mac OS 9 version 9.2.2 System Folder that has been previously run as the Classic environment under Mac OS X.
- 4 In your server's System Preferences, open the Classic preferences pane and select the disk image as the startup volume for the Classic environment.
- 5 Click Start to start up the Classic environment.
- 6 Shut down the Classic environment, then eject the image file.

Configuring Directory Access for a Boot Image

If you are not using DHCP to provide NetBoot clients with Open Directory information, you can set up directory access information and copy it to a boot image.

To add directory access information to a boot image:

- 1 Open Directory Access (in /Applications/Utilities) on a running system and configure directory settings as you want them for your booted clients.
- 2 Mount the boot image and copy the directory /Library/Preferences/DirectoryService/ from the running system you just configured into the same location in the boot image.

Adding an OS Update Package to a Mac OS X Boot Image

You can add a Mac OS X system update package to an existing NetBoot image so that your clients start up from the latest available system.

To apply a Mac OS X update to a NetBoot image:

- 1 Open Server Admin and select NetBoot in the Computers & Services list.
- 2 Disable the image you want to update to prevent access while you're modifying it. Click Settings, click Images, deselect Enabled for the image, and click Save.
- 3 Open Network Image Utility and click Images.
- 4 Select the image and click Edit.
- 5 In the Contents tab, click the Add (+) button and choose the OS update package.
- 6 Click Save.
- 7 Reenable the image in the Images pane of Server Admin NetBoot settings.

From the Command Line

You can also update a boot image using commands in Terminal. For more information, see the system image chapter of the command-line administration guide.

Creating a Mac OS X Boot Image From an Existing System

If you already have a client computer set up to suit your users, you can use Network Image Utility to create a boot image that is based on that client's configuration.

You need to boot from a volume other than the one you're using as the image source (boot from an external FireWire hard disk or a second partition on the client's hard disk, for example). You can't create the image on a volume over the network.

To create a boot image based on an existing system:

- 1 Boot the computer from a partition other than the one you're using for the image source.
- 2 Copy the Network Image Utility to the client computer.
- 3 Open the Network Image Utility on the client and click New Boot.
- 4 Click the Contents tab and choose the partition you want to use from the Image Source pop-up list.
- 5 Enter the remaining image information in the other panes as usual, then click Create.
- 6 After the image has been created on the client, export it to the server. Click Images, select the image in the list, and click Export.

From the Command Line

You can also create a boot image clone of an existing system using the `hdiutil` command in Terminal. For more information, see the system image chapter of the command-line administration guide.

Synchronizing an Image With an Updated Source Volume

If you create an image from a system volume and later update the original volume, you can automatically apply the updates to the image without re-creating it.

Important: Be sure you synchronize the image with the correct original volume. The updated original volume must be a local volume on the server where the image is being edited.

To sync an image with an updated source volume:

- 1 Open Server Admin and select NetBoot in the Computers & Services list.
- 2 Disable the image you want to update to prevent access while you're modifying it. Click Settings, click Images, deselect Enabled for the image, and click Save.
- 3 Open the Network Image Utility (in /Applications/Server).
- 4 Choose Network Image Utility > Preferences, enable "Add items and sync with source when editing," and close the preferences window.
- 5 Click Images, select the image, and click Edit.
- 6 Click Contents and choose the updated source volume from the Image Source pop-up menu.
- 7 Click Save.
- 8 Reenable the image using Server Admin.

Choosing the Protocol Used to Deliver an Image

You can use either NFS or HTTP to send images from the server to a client. You can choose this protocol when you create the image using the Network Image Utility or later when the image is listed in Server Admin.

To choose the protocol when you create the image, choose either NFS or HTTP in the General pane in the Network Image Utility.

To choose the protocol for an existing image, choose the NetBoot service in Server Admin, click Settings, and choose a protocol from the pop-up list next to the image in the Images pane.

From the Command Line

You can also change the delivery protocol by modifying the image's `NBImageInfo.plist` file using Terminal. For more information, see the system image chapter of the command-line administration guide.

Compressing Images to Save Disk Space

You can create compressed images by setting a preference in the Network Image Utility.

To create compressed images:

- 1 Open Network Image Utility.
- 2 Choose Network Image Utility > Preferences and select “Compress image when creating or editing.”

Be sure the volume on which you’re creating the image has enough free space for both the uncompressed image and the compressed image.

From the Command Line

You can also compress images using the `hdiutil` command in Terminal. For more information, see the system image chapter of the command-line administration guide.

Changing How Mac OS X NetBoot Clients Allocate Shadow Files

By default, a Mac OS X NetBoot client places its shadow files in a `NetBootClients/n` share point on the server. If no such share point is available, the client tries to store its shadow files on a local hard disk.

For Mac OS X version 10.3 and later images set for diskless booting, you can change this behavior by using a text editor to specify a value for the `NETBOOT_SHADOW` variable in the image’s `/etc/hostconfig` file. These values are allowed:

Value of <code>NETBOOT_SHADOW</code>	Client shadow file behavior
<code>-NETWORK-</code>	(Default) Try to use a server <code>NetBootClients/n</code> share point for storing shadow files. If no server share point is available, use a local drive.
<code>-NETWORK_ONLY-</code>	Try to use a server <code>NetBootClients/n</code> share point for storing shadow files. If no server share point is available, don’t boot.
<code>-LOCAL-</code>	Try to use a local drive for storing shadow files. If no local drive is available, use a server <code>NetBootClients/n</code> share point.
<code>-LOCAL_ONLY-</code>	Try to use a local drive for storing shadow files. If no local drive is available, don’t boot.

Note: This value is set in the `/etc/hostconfig` file in the image .dmg file, not in the server’s `hostconfig` file.

Creating Mac OS 9 Boot Images

You can't use the Network Image Utility to create Mac OS 9 images. However, you can use the image provided on the *NetBoot for Mac OS 9* CD (available separately).

Installing a Mac OS 9 Boot Image

To install the preconfigured Mac OS 9 disk image, log in as root, then open NetBoot.pkg on the *NetBoot for Mac OS 9* CD (available separately).

The Installer installs the Mac OS 9 NetBoot image folder in the `/Library/NetBoot/NetBootSPn/DefaultMacOS92.nbi` directory (where *n* is the volume number).

Modifying a Mac OS 9 Boot Image

To install software on, or change, the preconfigured Mac OS 9 disk image, you need to start up from a NetBoot client computer, connect to the NetBoot server volume, and open the NetBoot Desktop Admin program. Your changes are not available to you or other users until after the last time the NetBoot client computer running NetBoot Desktop Admin restarts.

Before you start this procedure, be sure to have the name and password of a user with read/write access to the NetBoot server volume (for example, the administrator).

The following procedure requires that you restart the client computer several times.

Important: Be careful if there is more than one NetBoot server on your network. The client may restart from a disk image on a server other than the one you're working on.

If you're using Macintosh Manager with NetBoot client computers, each time you start or restart the client computer, you need to log in as a Macintosh Manager administrator who belongs to the System Access workgroup.

To install software or change the Mac OS 9 disk image:

- 1 Log in to the server volume as a user with read/write access (for example, as an administrator).
- 2 Using the Chooser, log in to all the server volumes on the client.
- 3 Copy the NetBoot Desktop Admin application to a local volume on the client, then open the application.

NetBoot Desktop Admin is supplied on the *NetBoot for Mac OS 9* CD (available separately).

4 Click Make Private Copy.

NetBoot Desktop Admin creates a copy of the disk image. This may take several minutes, and you should not interrupt the process. When it finishes, your NetBoot client computer restarts automatically.

Important: Because the copy of a disk image is associated with the NetBoot client computer you used to create it, you must make the changes to the image using the same computer. If you change computers, you won't be able to see the changes you have made and your changes won't be available to users. In addition, you increase the risk of unauthorized users making changes to the disk image.

5 If you're installing a new version of the Mac OS or adding system extensions, you may need to increase the size of the disk image.

Make sure the disk image is large enough to accommodate the size of the new system and extensions you're installing. You can't reduce the size of an image without reverting to a smaller backup copy.

6 If you're installing new application software, you may need to increase the size of the application disk image.

Be sure the disk image has enough space for the software you want to install. However, increase the size of an image only as much as needed. You can't reduce the size of an image without reverting to a smaller backup copy.

7 Install the software or make changes to the system configuration.

Make sure to install the latest updates for the system software.

If you're installing software, follow the installation instructions that came with the software. If necessary, restart the computer.

After installing an application, open it. Doing so lets you enter a registration number, if necessary. If you don't enter the number now, every time users open the application they will need to enter the registration number. In addition, most applications create a preferences file in the System Folder. If you don't open the application, users may not be able to open the application because the preferences won't exist.

8 Be sure there aren't any files in the Trash that you want to save. (The Trash is emptied automatically after the next step.)

Note: If you can't empty the Trash because it contains files that are in use, you may need to restart the computer.

9 If necessary, use the Chooser to log back in to all the server volumes.

10 Open the NetBoot Desktop Admin application, then click Save. The computer restarts automatically.

If you need to make other changes, click Quit and return to Step 7.

Clicking Discard removes the changes you've made to the disk image.

- 11 Start the NetBoot client computer again, and log back in to all the server volumes.
- 12 Open NetBoot Desktop Admin.

If you want to keep a backup copy of the old disk image, leave the “Keep previous disks as backup” option selected. Backup copies are stored in the Backup Images folder in the Shared Images folder on the NetBoot server.

Note: Because there is only one backup folder, the backup image saved at this time will overwrite any backup image in the folder from a previous session.

- 13 If you clicked Save in Step 10, click Restart. Otherwise, click OK.

If you click Restart, NetBoot Desktop Admin saves your changes, deletes the old disk image, and then restarts the computer. Changes are available the next time a NetBoot client computer restarts. If you click OK, NetBoot Desktop Admin deletes the old disk image.

Setting Up Multiple Mac OS 9 Images

To create more than one Mac OS 9 disk image, make copies of the preconfigured disk image you installed from the *NetBoot for Mac OS 9* CD into the directory `/Library/NetBoot/NetBootSPn` on any server volume. Then use NetBoot Desktop Admin to modify the Mac OS 9 disk images as desired.

Use Server Admin to enable disk images and select the default disk image. See “Enabling Images” on page 34 and “Specifying the Default Image” on page 37.

Unlocking an Image

If an image is locked, you’ll need to unlock it before you can make any changes to it.

To unlock a Network Install image:

- 1 Log in as the root user.
- 2 Select the image file and choose File > Show Info.
- 3 Uncheck the Locked checkbox.

Creating Install Images

The following sections show how to create images you can use to install software on client computers over the network.

Creating an OS Install Image

To create an image that will install the OS software on a client computer, use the Network Image Utility. You can find this application in the folder `/Applications/Server/`.

To create an OS install image:

- 1 Log in to the server as an administrative user.
- 2 Open Network Image Utility and click New Install.
- 3 In the General pane, type a name for the image you're creating.
- 4 Type an Image ID.
Choose a number in the range 1–4095 for an image that will be available on a single server, or 4096–65535 for an image that you plan to make available on multiple servers but want to list only once in the client computer Startup Disk preferences.
- 5 (CD source only) Choose the default language for the software. (Available only if you have already inserted the CD and chosen it as the source.)
Note: This is the language used by the installed software only. The installer that runs always appears in English (if this is not an automated install).
- 6 Choose whether the image is to be delivered using NFS or HTTP.
If you're not sure which to choose, choose NFS.
- 7 On the Contents pane, choose the source for the image.
You can choose an install CD, a mounted boot volume, or an existing disk image.
- 8 (Optional) Click the Add (+) button below the list to add applications or post-install scripts to the image.
- 9 In the Installation Options pane, enable "Checksum destination after installing" to have the installer verify the integrity of the image after it is transferred to the client but before it is installed. (For images from volume source only.)
- 10 To have the software install with limited or no interaction at the client computer, select "Enable automated installation," then click Options.
- 11 Click Create Image.
If the Create button is not enabled, make sure you have entered an image name and ID, and have chosen an image source.
- 12 In the Save As dialog, choose where to save the image.
If you don't want to use the image name you typed earlier, you can change it now by typing a new name in the Save As field.

If you're creating the image on the same server that will serve it, choose a volume from the "Serve from NetBoot share point on" pop-up menu.

To save the image somewhere else, choose a location from the Where pop-up menu or click the triangle next to the Save As field and navigate to a folder.

13 Click Save.

To check progress, look in the lower-left corner of the window. If you need to insert another CD, you'll be prompted there. To create the image without including the contents of a subsequent CD, click Finish when you are prompted to insert it.

Adding Software to Boot and Install Images

There are two basic approaches to including additional software in an image:

- Add additional applications and files to an existing system before creating an image using that system as the source (see "Creating a Mac OS X Boot Image From an Existing System" on page 22)
- Add packages containing the additional applications and files to an existing image (see "Creating an Application-Only Install Image" on page 30)

About Packages

If you plan to add application software or other files to an image at creation time (instead of installing the applications or files on the image source volume before you create the image), you need to group the applications or files into a special file called a *package*.

A package is a collection of compressed files and related information used to install software onto a computer. The contents of a package are contained within a single file, which has the extension ".pkg." The following table lists the components of a package.

File in Package	Description
product.pax.gz	The files to be installed, compressed with gzip and archived with pax. (See man pages for more information about gzip and pax.)
product.bom	Bill of Materials: a record of where files are to be installed. This is used in the verification and uninstall processes.
product.info	Contains information to be displayed during installation.
product.sizes	Text file; contains the number of files in the package.
product.tiff	Contains custom icon for the package.
product.status	Created during the installation, this file will either say "installed" or "compressed."
product.location	Shows location where the package will be installed.
software_version	(Optional) Contains the version of the package to be installed.

Creating Packages

To add applications or other files to an image (instead of installing them first on the image source volume before creating the image), use PackageMaker to create packages containing the application or files. PackageMaker is in the Utilities folder on the *Mac OS X Server Administration Tools* CD that comes with Mac OS X Server.

For more information on creating packages, open PackageMaker and choose PackageMaker Help, PackageMaker Release Notes, or Package Format Notes from the Help menu.

After creating the packages, add them to your boot or install image using the Network Image Utility. See “Creating an Application-Only Install Image” on page 30 or “Adding Packages to a Boot or Install Image” on page 30.

Adding Packages to a Boot or Install Image

To include additional application or file packages in an image, add the packages to the image using the Network Image Utility.

You can add packages at the time you create an image or add packages to an existing image.

To add packages to a new image you’re creating using Network Image Utility, click the Add (+) button after you select the image source in the Contents pane.

To add packages to an existing image, open Network Image Utility, click Images, and select the image in the list. Then click Edit, and click the Add (+) button in the Contents pane.

In either case, you can drag package icons from the Finder to the Other Items list in the Contents tab instead of using the Add (+) button.

Note: You can’t add metapackages to an image using the Network Image Utility.

From the Command Line

You can also add packages to a boot or install image by modifying the image and its associated `rc.cdrom.packagePath` or `mininstallconfig.xml` file in Terminal. For more information, see the system image chapter of the command-line administration guide.

Creating an Application-Only Install Image

To create an install image that contains application software but no OS software, deselect the Include Mac OS X option in the Contents pane in the Network Image Utility.

Note: You can’t use the Network Image Utility to create an automated install image that contains a metapackage or more than one regular package. You can do this using commands in Terminal. For more information, see the system image chapter of the command-line administration guide.

To add packages to a new image you're creating using Network Image Utility, click the Add (+) button after you select the image source in the Contents pane.

You can drag package icons from the Finder to the Other Items list in the Contents tab instead of using the Add (+) button.

Automating Installation of an Image

To install Mac OS software (along with any packages you add) with limited or no interaction from anyone at the client computer, use the Network Image Utility to create an automated install image. Otherwise, a user at the client computer will have to respond to questions from the installer.

To set up an OS image for automated installation:

- 1 Open Network Image Utility and click New Install.
- 2 Provide information in the General and Contents panes as usual.
- 3 In the Installation Options pane, select "Enable automated installation."
- 4 Click the Options button.
- 5 For unattended installation, choose "Install on volume" next to Target Volume and type the name of the volume on the client computer where the software will be installed.
To allow the user at the client computer to select the volume on which to install, choose "User selects."
- 6 To install the software on a clean drive, enable "Erase the target volume before installing."
- 7 To install without requiring user confirmation at the client computer, disable "Require client user to respond to a confirmation dialog."
- 8 If the installed software requires a restart, enable "Restart the client computer after installing."

If the name you provide for the install volume does not match the name of a volume on the client computer, a user at the client computer must respond to an installer prompt for another target volume.

From the Command Line

You can also set up an image for automated install by modifying the associated `mininstallconfig.xml` file using Terminal. For more information, see the system image chapter of the command-line administration guide.

Viewing the Contents of a Package

To view the contents of a package, hold down the Control key as you click the package in a Finder window and choose Show Package Contents from the menu that appears.

You use PackageMaker (in the Utilities folder on the *Mac OS X Server Administration Tools* CD) to create application software packages to use with Network Install.

From the Command Line

You can also list the contents of a package using commands in Terminal. For more information, see the system image chapter of the command-line administration guide.

Installing Mac OS Updates

To use Network Install to install operating system updates on client computers, add the system update package to an installer image in the same way you would add any other package. See “Creating an Application-Only Install Image” on page 30.

You can download Mac OS updates from www.apple.com/support.

This chapter describes how to set up NetBoot service to make boot and install images available to clients.

Setting Up NetBoot

Follow the instructions in the following sections to set up your NetBoot server.

Configuring NetBoot Service

You use Server Admin to configure the Mac OS X Server NetBoot service.

To configure NetBoot:

- 1 Open Server Admin and select NetBoot in the Computers & Services list.
- 2 Click the Settings button, then click General.
- 3 Click Enable next to the network ports you want to use for serving images.
- 4 Click in the Images column of the Volume list to choose where to store images.
- 5 Click in the Client Data column of the Volume list for each local disk volume on which you want to store shadow files used by Mac OS 9 clients and Mac OS X diskless clients.
- 6 Click Save, then click Images.
- 7 Click in the Default column of the Image list to select the default image.
- 8 Enable the images you want your clients to use, specify if they are available for diskless clients, and choose the protocol for delivering them.
If you're not sure which protocol to use, choose NFS.
- 9 Click Save.
- 10 (Optional) Click the Filters tab to restrict clients to a known group. For more information, see "Restricting NetBoot Clients by Filtering Addresses" on page 38.

From the Command Line

You can also configure NetBoot service using the `serveradmin` command in Terminal. See the system image chapter of the command-line administration guide.

Starting NetBoot and Related Services

NetBoot service uses AFP, NFS, DHCP, Web, and TFTP services, depending on the types of clients you're trying to boot (see "Network Service Requirements" on page 15). You can use Server Admin to start AFP, DHCP, Web, and NetBoot. NFS and TFTP start automatically.

Note: NetBoot does not start automatically after server restart when you enable NetBoot service in the Setup Assistant when you first install the server software. Only the required share points are set up.

To start NetBoot service:

- 1 Open Server Admin.
- 2 If you'll be booting Mac OS 9 clients or diskless Mac OS X clients, start AFP service.
Select AFP in the Computers & Services list and click Start Service.
- 3 If your server is providing DHCP service, make sure the DHCP service is configured and running. Otherwise, DHCP service must be supplied by another server on your network.
If your NetBoot server is also supplying DHCP service, you might get better performance if you configure your server as a gateway. That is, configure your subnets to use the server's IP address as the router IP address.
- 4 Make sure NetBoot is enabled on a network port.
Open Server Admin, select NetBoot in the Computers & Services list, and click Settings.
- 5 Start NetBoot service.
Select NetBoot in the Computers & Services list and click Start Service.

From the Command Line

You can also start NetBoot and supporting services using commands in Terminal. For more information, see the system image chapter of the command-line administration guide.

Enabling Images

You must enable one or more disk images on your server to make the images available to client computers for NetBoot startups.

To enable disk images:

- 1 Open Server Admin and select NetBoot in the Computers & Services list.
- 2 Click Settings, then click Images.
- 3 Click in the Enable column for each image you want your clients to see.
- 4 Click Save.

Choosing Where Images Are Stored

You can use Server Admin to choose the volumes on your server you want to use for storing boot and install images.

To choose volumes for storing image files:

- 1 Open Server Admin and select NetBoot in the Computers & Services list.
- 2 Click Settings, then click General.
- 3 In the list of volumes in the lower half of the window, click the checkbox in the Images column for each volume you want to use to store image files.
- 4 Click Save.

Warning: Don't rename a NetBoot share point or the volume on which it resides. Don't use Workgroup Manager to stop sharing for a NetBoot share point unless you first deselect the share point for images and shadow files in Server Admin.

From the Command Line

You can also specify that a volume should be used to store image files using the `serveradmin` command in Terminal. For more information, see the system image chapter of the command-line administration guide.

Choosing Where Shadow Files Are Stored

When a diskless client boots, temporary “shadow” files are stored on the server. You can use Server Admin to specify which server volumes are used to store the temporary files.

To use a volume for storing shadow files:

- 1 Open Server Admin and select NetBoot in the Computers & Services list.
- 2 Click Settings, then click General.
- 3 In the list of volumes in the lower half of the window, click the checkbox in the Client Data column for the volumes you want to use to store shadow files.
- 4 Click Save.

Warning: Don't rename a NetBoot share point or the volume on which it resides. Don't use Workgroup Manager to stop sharing for a NetBoot share point unless you first deselect the share point for images and shadow files in Server Admin.

From the Command Line

You can also specify that a volume should be used to store shadow files using the `serveradmin` command in Terminal. For more information, see the system image chapter of the command-line administration guide.

Using Images Stored on Other NFS Servers

You can store boot or install images on NFS servers other than the NetBoot server itself.

To store an image on a separate NFS server:

- 1 If you haven't already, create the image on the NetBoot server. This creates an image (.nbi) folder for the image in /Library/NetBoot/NetBootSPn on the NetBoot server.
- 2 Copy the image (.dmg) file from the .nbi folder on the NetBoot server to a shared (exported) directory on the other server. Leave the .nbi folder and the other files it contains on the NetBoot server.
- 3 Open the NBImageInfo.plist file for the image using a text editor or the Property List Editor and set the value of the `RootPath` property to point to the new location of the image using the following syntax:

```
host:path:image
```

where `host` is the name or IP address of the NFS server, `path` is the location of the image on the server, and `image` is the name of the image (.dmg) file.

If the mount point specified by `path` is directly bootable, you don't need to specify `image`.

For example:

- `server3:/Images/OSX/Jaguar:Jag_10_2.dmg` points to the image file `Jag_10_2.dmg` in `/Images/OSX/Jaguar` on the host `server3`
- `172.16.12.20:/Images/OS_X/Jaguar` specifies a directly bootable mount point on a server identified by IP address

If the image is already on the remote server, you can create the .nbi folder on the NetBoot server by duplicating an existing .nbi folder and adjusting the values in its NBImageInfo.plist file.

Moving Images to Headless Servers

Use the Export feature of the Network Image Utility to move images to another server, including servers without displays or keyboards.

To copy an image to another server:

- 1 Open Network Image Utility and click Images.
- 2 Select the image in the list and click Export, and provide the target information.

Important: To avoid problems with file permissions, don't use Terminal or the Finder to copy boot or install images across the network to other servers.

Specifying the Default Image

The *default image* is the image used when you start a client computer while holding down the N key. See “Starting Up Using the N Key” on page 42. If you’ve created more than one startup disk image, you can use the NetBoot service settings in Server Admin to select the default startup image.

Important: If you have diskless clients, set their boot image as the default image.

If you have more than one NetBoot server on the network, a client uses the default image on the first server that responds. There is no way to control which default image is used when more than one is available.

To specify the default boot image:

- 1 Open Server Admin and select NetBoot in the Computers & Services list.
- 2 Click Settings, then click Images.
- 3 Click the button in the Default column next to the image.
- 4 Click Save.

From the Command Line

You can also specify the default image using the `serveradmin` command in Terminal. For more information, see the system image chapter of the command-line administration guide.

Setting an Image for Diskless Booting

You can use Server Admin to make an image available for booting client computers that have no local disk drives. Setting an image for diskless booting instructs the NetBoot server to allocate space for the client’s shadow files.

To make an image available for diskless booting:

- 1 Open Server Admin and select NetBoot in the Computers & Services list.
- 2 Click Settings, then click Images.
- 3 Click the box in the Diskless column next to the image in the list.
- 4 Click Save.

Important: If you have diskless clients, set their boot image as the default image.

For help specifying where the client’s shadow files are stored, see “Choosing Where Shadow Files Are Stored” on page 35.

From the Command Line

You can also set an image to boot diskless using the `serveradmin` command in Terminal. For more information, see the system image chapter of the command-line administration guide.

Restricting NetBoot Clients by Filtering Addresses

The filtering feature of NetBoot service lets you restrict NetBoot service based on a client computer's Ethernet hardware (MAC) address. A client's address is added to the filter list automatically the first time it starts up from an image on the server, and is allowed access by default, so it is usually not necessary to enter hardware addresses manually.

To restrict client access to NetBoot service:

- 1 Open Server Admin and select NetBoot in the Computers & Services list.
- 2 Click Settings, then click Filters.
- 3 Select either "Allow only clients listed below" or "Deny only clients listed below."
- 4 Select "Enable NetBoot filtering."
- 5 Use the Add (+) and Delete (-) buttons to set up the list of client addresses.

To look up a MAC address, type the client's DNS name in the Host Name field and click the Search button.

To find the hardware address for a computer using Mac OS X, look on the TCP/IP pane of the computer's Network preference or run Apple System Profiler. On a Mac OS 9 computer, open the TCP/IP control panel, choose File > Get Info.

Changing Advanced NetBoot Options

You can control additional NetBoot options by running the `bootpd` program directly and by modifying configuration parameters in `NetInfo`. For more information, read the `bootpd` man page.

To view the `bootpd` man page:

- 1 Open Terminal.
- 2 Type `man bootpd`.

This chapter describes how to set up client computers to start up from or install software from images on a server.

Supporting Client Computers

See “Client Computer Requirements” on page 14 for a list of supported Macintosh computers and the client system requirements for using NetBoot.

Updating the Startup Disk Control Panel

You need to replace the Startup Disk control panel for client computers running Mac OS 9 so that the control panel can display the available NetBoot disk images.

Version 9.2.6 of the Startup Disk control panel is located on the *NetBoot for Mac OS 9 CD* (available separately).

- Drag the new version of the control panel to the System Folder of each client computer running Mac OS 9 locally.

Setting Up Diskless Clients

NetBoot makes it possible to configure client computers without locally installed operating systems or even without any installed disk drives. “System-less” or diskless clients can start up from a NetBoot server using the N key method. (See “Starting Up Using the N Key” on page 42.)

After the client computer has started up, you can use the Startup Disk preference pane (Mac OS X) or Startup Disk control panel (Mac OS 9) to select the NetBoot disk image as the startup disk for the client. That way you no longer need to use the N key method to start up the client from the server.

Removing the system software from client computers gives you additional control over users’ environments. By forcing the client to boot from the server and using client management to deny access to the client computer’s local hard disk, you can prevent users from saving files to the local hard disk.

Selecting a NetBoot Boot Image (Mac OS X)

If your computer is running Mac OS X version 10.2 or later, you use the Startup Disk System Preferences pane to select a NetBoot boot image.

To select a NetBoot startup image from Mac OS X:

- 1 In System Preferences select the Startup Disk pane.
- 2 Select the network disk image you want to use to start up the computer.
- 3 Click Restart.

The NetBoot icon appears, and then the computer starts up from the selected image.

Selecting a NetBoot Boot Image (Mac OS 9)

If your computer is running Mac OS 9, you use the Startup Disk control panel to select a NetBoot boot image.

Note: You must update the Startup Disk control panel on client computers running Mac OS 9 from their local hard disks so they can see individual NetBoot disk images in the control panel. See “Updating the Startup Disk Control Panel” on page 39.

To select a NetBoot startup image from Mac OS 9:

- 1 Open the Startup Disk control panel.
- 2 Select the network disk image you want to use to start up the computer.
- 3 Click Restart in the warning dialog that appears.

The NetBoot icon appears, and then the computer starts up from the selected NetBoot disk image.

Selecting a NetBoot Install Image (Mac OS X)

If your computer is running Mac OS X version 10.2 or later, you use the Startup Disk System Preferences pane to select a network boot image.

To select an install image from Mac OS X:

- 1 In System Preferences select the Startup Disk pane.
- 2 Select the network disk image you want to use to start up the computer.
- 3 Click Restart.

The NetBoot icon appears, the computer starts up from the selected image, and the installer runs.

Selecting a NetBoot Install Image (Mac OS 9)

If your computer is running Mac OS 9, you use the Startup Disk control panel to select a network install image.

Note: You must update the Startup Disk control panel on client computers running Mac OS 9 from their local hard disks so they can see individual NetBoot disk images in the control panel. See “Updating the Startup Disk Control Panel” on page 39.

To select an install image from Mac OS 9:

- 1 Open the Startup Disk control panel.
- 2 Select the install image you want to use to start up the computer.
- 3 Click Restart in the warning dialog that appears.

The NetBoot icon appears, the computer starts up from the selected NetBoot disk image, and the installer runs.

Starting Up Using the N Key

You can use this method to start up any supported client computer from a NetBoot disk image. When you start up with the N key, the client computer starts up from the default NetBoot disk image. (If multiple servers are present, then the client starts up from the default image of the first server to respond.)

If you have an older client computer that requires BootP for IP addressing (a tray-loading iMac, blue and white PowerMac G3, or older computer), you must use this method for starting up from a NetBoot disk image. Older computers don't support selecting a NetBoot startup disk image from the Startup Disk control panel or preferences pane.

The N key also provides a way to start up client computers that don't have system software installed. See "Setting Up Diskless Clients" on page 39.

To start up from a NetBoot disk image using the N key:

- 1 Turn on (or restart) the client computer while holding the N key down on the keyboard.
Hold the N key down until the NetBoot icon appears in the center of the screen (Mac OS X) or an arrow appears in the upper-left corner of the screen (Mac OS 9).
- 2 If a login window appears, enter your name and password.
The network disk image has an icon typical of server volumes.

This chapter describes typical day-to-day tasks you might perform to keep NetBoot service running efficiently, and includes information on load balancing across multiple volumes on a server or across multiple servers.

Controlling and Monitoring NetBoot

The following sections show how to stop NetBoot service, disable individual images, and monitor or restrict clients.

Turning Off NetBoot Service

The best way to prevent clients from using NetBoot on the server is to disable NetBoot service on all Ethernet ports.

To disable NetBoot:

- 1 Open Server Admin and select NetBoot in the Computers & Services list.
- 2 Click Stop Service.

To stop service on a specific Ethernet port, click Settings, click General, and deselect the Enable checkbox for the port.

To stop serving a particular image, click Settings, click Images, and deselect the Enable checkbox for the image.

To stop service to a particular client, click Settings, click Filters, select Enable NetBoot Filtering, choose “Deny only clients listed below,” and add the client’s hardware address to the list.

From the Command Line

You can also stop NetBoot service or disable images using the `serveradmin` command in Terminal. For more information, see the system image chapter of the command-line administration guide.

Disabling Individual Boot or Install Images

Disabling an image prevents client computers from starting up using the image.

To disable a NetBoot disk image:

- 1 Open Server Admin and select NetBoot in the Computers & Services list.
- 2 Click Settings, then click Images.
- 3 Deselect the checkbox in the Enable column for the image.
- 4 Click Save.

From the Command Line

You can also disable images using the `serveradmin` command in Terminal. For more information, see the system image chapter of the command-line administration guide.

Viewing a List of NetBoot Clients

You can use Server Admin to see a list of clients that have booted from the server.

Note: This is a cumulative list—a list of all clients that have connected—not a list of just currently connected clients. The last boot time is shown for each client.

To view the client list:

- 1 Open Server Admin and select NetBoot in the Computers & Services list.
- 2 Click Clients.

Checking the Status of NetBoot and Related Services

You can use Server Admin to check the status of NetBoot service and the other services (such as NFS and TFTP) that it uses.

To check NetBoot service status:

- 1 Open Server Admin and select NetBoot in the Computers & Services list.
- 2 To see a summary of service status, click Overview. To view the log file, click Logs.

From the Command Line

You can check the status of NetBoot and its supporting services using commands in Terminal. See the system image chapter of the command-line administration guide.

Viewing the NetBoot Service Log

You can use Server Admin to view a log containing diagnostic information.

To view NetBoot service log:

- 1 Open Server Admin and select NetBoot in the Computers & Services list.
- 2 Click Logs.

From the Command Line

You can see the log by viewing the contents of the log file in Terminal. For more information, see the system image chapter of the command-line administration guide.

Performance and Load Balancing

For good startup performance, it is critical that the NetBoot server be available to the client computer relying on it. To provide responsive and reliable NetBoot service, you can set up multiple NetBoot servers in your network infrastructure.

Many sites using NetBoot achieve acceptable responsiveness by staggering the boot times of client computers in order to reduce network load. Generally, it isn't necessary to boot all client computers at exactly the same time; rather, client computers are booted early in the morning and remain booted throughout the work day. You can program staggered startup times using the Energy Saver preferences pane (Mac OS X version 10.3 or later) or control panel (Mac OS 9).

Boot Images

If heavy usage and simultaneous client startups are overloading a NetBoot server and causing delays, consider adding additional NetBoot servers to distribute the demands of the client computers across multiple servers (*load balancing*). When incorporating multiple NetBoot servers, it is important to use switches in your network infrastructure, as the shared nature of hubs creates a single shared network on which additional servers would have to vie for time.

Distributing Boot Images Across Servers

If you set up more than one NetBoot server on your network, you can place copies of a particular boot image on multiple servers to distribute the load. By assigning the copies the same image ID in the range 4096–65535, you can advertise them to your clients as a single image to avoid confusion.

To distribute an image across servers:

- 1 Open Network Image Utility on the server where the original image is stored.
- 2 Click Images (near the top of the window) and select the image in the list.
- 3 If the image's Index is 4095 or lower, click Edit and give the image an index in the range 4096–65535.
- 4 Use the Export button to place copies of the image on the other servers.
- 5 On each of the other servers, use Server Admin to enable the image.

Clients still see the image listed only once in their Startup Disk preferences, but the server that delivers its copy of the image is automatically selected based on how busy the individual servers are.

Smaller improvements can be achieved by distributing boot images across multiple disk drives on a single server.

Distributing Boot Images Across Server Disk Drives

Even with a single NetBoot server, you might improve performance by distributing copies of an image across multiple disk drives on the server. By assigning the copies the same image ID in the range 4096–65535, you can advertise them to your clients as a single image.

Note: Don't distribute images across different partitions of the same physical disk drive. Doing so does not improve, and can even reduce, performance.

To distribute an image across disk drives:

- 1 Open Server Admin and select NetBoot in the Computers & Services list.
- 2 Click Settings, then click General.
- 3 Click in the Images column for each volume you want to use for storing images. Choose volumes on different physical disk drives.
- 4 Click Save, then click Images.
- 5 If the image's ID in the Index column is 4095 or lower, double-click the ID, type an index in the range 4096–65535, and save the change.
- 6 Open Terminal, switch to the root user, and use the cp command to copy the image to the NetBootSPn share points on the other volumes. For example:

```
sudo root
cp -R /Library/NetBoot/NetBootSP0/image.nbi /Volumes/Drive2/Library/
NetBoot/NetBootSP1/image.nbi
```

Balancing Boot Image Access

If you add a second NetBoot server to a network, have your clients reselect their boot image in the Startup Disk control panel or preferences pane. This causes the NetBoot load to be redistributed among the servers. You can also force redistribution of the load by deleting the file `/var/db/bsdspd_clients` from the existing NetBoot server. Similarly, if you're recovering from a server or infrastructure failure, and your clients have been booting from a reduced number of NetBoot servers, you'll need to delete the `bsdspd_clients` file from the running servers so that clients can once again spread out across the entire set of servers.

The `bsdspd_clients` file on any given server holds the Ethernet Media Access Control (MAC) addresses of the computers that have selected this server as their NetBoot server. As long as a client has an entry in an available server's `bsdspd_clients` file, it will always boot from that server. If that server should become unavailable to those clients, they will locate and associate themselves with an available server until such time as you remove their entries (or the entire files) from their servers. (If a client is registered on more than one server because an unavailable server comes back on line, the client boots from the server with the fewest number of clients booted off of it.)

Distributing Shadow Files

Clients booting from Mac OS 9 images and clients booting from Mac OS X diskless images store temporary “shadow” files on the server. The way the server distributes these shadow files depends on whether the client is booting diskless Mac OS X or Mac OS 9.

Mac OS X Diskless Booting

By default, NetBoot for Mac OS X clients creates a share point for client shadow files on the server boot volume. (You can change this behavior; see “Changing How Mac OS X NetBoot Clients Allocate Shadow Files” on page 24.) You can use Server Admin to see this share point and to add others. The share points are named NetBootClients*n* where *n* is the share point number. Share points are numbered starting with zero.

For example, if your server has two disk volumes, the default shadow-file directory is NetBootClients0 on the boot volume. If you use Server Admin to specify that client data should also be stored on the second volume, the directory is named NetBootClients1. NetBoot stores the first client’s shadow files on NetBootClients0, the second client’s shadow files on NetBootClients1, the third client’s shadow files on NetBootSP0, and so on. Likewise, with three volumes selected and eight clients, the first, fourth, and seventh clients will use the first volume; the second, fifth, and eighth clients will use the second volume; and the third and sixth clients will use the third volume. This load balancing is automatic and usually ensures optimal performance.

To prevent shadow files from being placed on a particular volume, use the General pane in the NetBoot service settings in Server Admin.

Mac OS 9 Booting

By default, NetBoot for Mac OS 9 creates share points for client shadow files on the server boot volume. For example, if your server has two volumes installed, it has two share points (NetBootSP0 and NetBootSP1), and NetBoot stores the first client’s shadow image on NetBootSP0, the second client’s shadow image on NetBootSP1, the third client’s shadow image on NetBootSP0, and so on.

Suppose, for example, that you partition a 60 GB drive into a 10 GB boot partition and a 50 GB data partition with the intention of keeping just your operating system and associated configuration files on the boot partition and all user data (such as client shadow images) on the data partition. After installation of the NetBoot For 9 software, there will be a NetBootClients0 on the boot partition and a NetBootClients1 on the data partition.

To prevent Mac OS 9 shadow files from being placed on a particular volume or partition, delete the hidden file /Library/NetBoot/.clients from the volume, then stop and restart NetBoot service.

Advanced NetBoot Tuning

You can adjust a wide range of NetBoot options by running the `bootpd` program directly and by modifying configuration parameters in specific NetInfo directories. For more information, read the `bootpd` man page. To view the man page, open Terminal and type `man bootpd`.

This chapter provides solutions for common problems you may encounter while working with NetBoot and Network Install.

General Tips

- Make sure a DHCP service is available on your network. It can be provided by the Mac OS X Server DHCP service or another server.
- Make sure required services are started on the server. See “Network Service Requirements” on page 15. Open Server Admin and make sure:
 - AFP is started if you’re booting Mac OS 9 clients or Mac OS X diskless clients
 - Web service is started if you’re using HTTP instead of NFS to deliver images

A NetBoot Client Computer Won’t Start Up

- Sometimes a computer may not start up immediately because other computers are putting a heavy demand on the network. Wait a few minutes and try starting up again.
- Make sure that all the cables are properly connected and that the computer and server are getting power.
- If you installed memory or an expansion card in the client computer, make sure it is installed properly.
- If the server has more than one Ethernet card, or you’re using more than one port on a multiport Ethernet card, check to see if other computers using the same card or port can start up. If they can’t, check to be sure the Ethernet port you set up on the server is the same port to which the client computer is connected. It’s easy to mistake Ethernet port 1 for Ethernet port 4 on a multiport card. On the cards that come preinstalled in Macintosh servers, the ports are numbered 4, 3, 2, 1 (from left to right), if you’re looking at the back of the computer.
- If the computer has a local hard disk with a System Folder on it, disconnect the Ethernet cable and try to start up the computer from the local hard disk. Then reconnect the Ethernet cable and try to start up the computer from the network.

- Boot the client computer from a local drive and check that it is getting an IP address from DHCP.
- On a diskless or systemless client, start up from a system CD and use the Startup Disk preferences to select a boot image.

You're Using Macintosh Manager and a User Can't Log In to a NetBoot Client

- Check to see if the user can log in to other computers. If the user can log in to other computers, then the computer the user can't log in to may be connected to a Macintosh Manager server on which the user does not have an account. If there is more than one Macintosh Manager server, make sure the user has selected a server on which he or she has an account.
- Open Macintosh Manager and make sure the user is a member of at least one workgroup.
- Open Macintosh Manager and reset the user's password.

The Create Button in Network Image Utility Is Not Enabled

- Make sure you have entered an image name and ID in the General pane.
- Make sure you have chosen an image source in the Contents pane.
- For an image based on a CD or DVD source, make sure you have entered a default user name with a password that is at least four characters long in the Default User pane.

Controls and Fields in Network Image Utility are Disabled

- Click New Boot or New Install at the top of the window, or close and reopen the Network Image Utility.

I Can't Set an Image to Use Static Booting (NetBoot version 1.0)

- Static network booting, as provided by NetBoot version 1.0, is not supported in Mac OS X Server version 10.3.

DHCP (Dynamic Host Configuration Protocol) A protocol used to distribute IP addresses to client computers. Each time a client computer starts up, the protocol looks for a DHCP server and then requests an IP address from the DHCP server it finds. The DHCP server checks for an available IP address and sends it to the client computer along with a *lease period*—the length of time the client computer may use the address.

disk image A file that when opened creates an icon on a Mac OS desktop that looks and acts like an actual disk or volume. Using NetBoot, client computers can start up over the network from a server-based disk image that contains system software.

HTTP (Hypertext Transfer Protocol) An application protocol that defines the set of rules for linking and exchanging files on the World Wide Web.

NetBoot server A Mac OS X server on which you have installed NetBoot software and have configured to allow clients to start up from disk images on the server.

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