

# Installing ESXi Using PXE

VMware vSphere 6.0

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**VMware, Inc.**  
3401 Hillview Ave.  
Palo Alto, CA 94304  
[www.vmware.com](http://www.vmware.com)

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# About Installing ESXi Using PXE

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The *Installing ESXi Using PXE* technical note explains how you can PXE boot hosts with ESXi.

The technical note explains how to boot using TFTP or using a Web Server, and discusses both legacy BIOS and UEFI.

## Intended Audience

This information is intended for anyone who wants to install, upgrade, or use ESX. The information is written for experienced administrators who understand the PXE boot process.

## VMware Technical Publications Glossary

VMware Technical Publications provides a glossary of terms that might be unfamiliar to you. For definitions of terms as they are used in VMware technical documentation, go to <http://www.vmware.com/support/pubs>.



# PXE Booting the ESXi Installer

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You can use the preboot execution environment (PXE) to boot a host. Starting with vSphere 6.0, you can PXE boot the ESXi installer from a network interface on hosts with legacy BIOS or using UEFI.

ESXi is distributed in an ISO format that is designed to install to flash memory or to a local hard drive. You can extract the files and boot by using PXE.

PXE uses Dynamic Host Configuration Protocol (DHCP) and Trivial File Transfer Protocol (TFTP) to boot an operating system over a network.

PXE booting requires some network infrastructure and a machine with a PXE-capable network adapter. Most machines that can run ESXi have network adapters that can PXE boot.

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**NOTE** PXE booting with legacy BIOS firmware is possible only over IPv4. PXE booting with UEFI firmware is possible with either IPv4 or IPv6.

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This chapter includes the following topics:

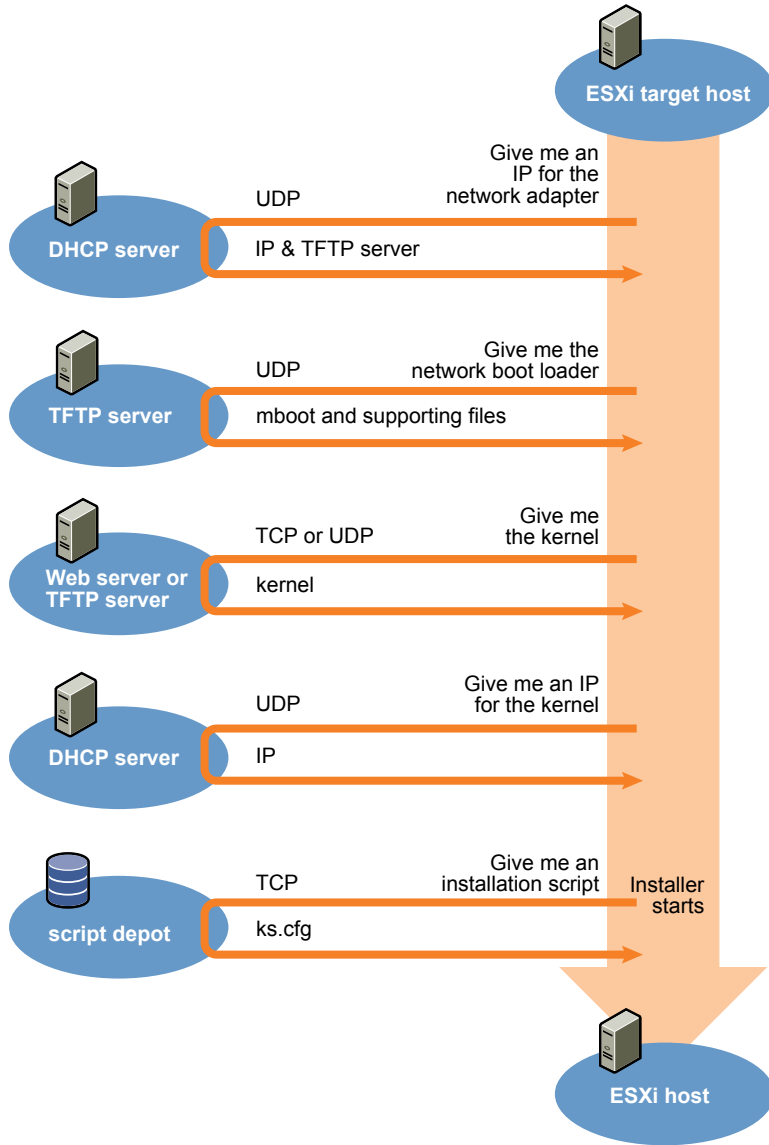
- [“Overview of the PXE Boot Installation Process,”](#) on page 7
- [“PXE Boot the ESXi Installer Using TFTP,”](#) on page 9
- [“PXE Boot the ESXi Installer Using a Web Server,”](#) on page 11
- [“Sample DHCP Configurations,”](#) on page 13
- [“PXE Boot Background Information,”](#) on page 15

## Overview of the PXE Boot Installation Process

Some of the details of the PXE boot process vary depending on whether the target host is using legacy BIOS or UEFI firmware, and whether the boot process uses TFTP only or TFTP plus HTTP.

When you boot the target host, it interacts with the different servers in the environment to get the network adapter, boot loader, kernel, IP address for the kernel, and finally the installation script. When all components are in place, installation starts, as shown in the following illustration.

**Figure 1-1.** Overview of PXE Boot Installation Process



The interaction between the ESXi host and other servers proceeds as follows:

- 1 The user boots the target ESXi host.
- 2 The target ESXi host makes a DHCP request.
- 3 The DHCP server responds with the IP information and the location of the TFTP server.
- 4 The ESXi host contacts the TFTP server and requests the file that the DHCP server specified.
- 5 The TFTP server sends the network boot loader, and the ESXi host executes it. The initial boot loader might load additional boot loader components from the TFTP server.
- 6 The boot loader searches for a configuration file on the TFTP server, downloads the kernel and other ESXi components from the HTTP server or the TFTP server and boots the kernel on the ESXi host.
- 7 The installer runs interactively or using a kickstart script, as specified in the configuration file.



## PXE Boot the ESXi Installer Using TFTP

You can use a TFTP server to PXE boot the ESXi installer. The process differs slightly depending on whether you use UEFI or boot from a legacy BIOS. Because most environments include ESXi hosts that support UEFI boot and hosts that support only legacy BIOS, this topic discusses prerequisites and steps for both types of hosts.

- For legacy BIOS machines, the procedure supports booting multiple different versions of the ESXi installer by using the same `pxelinux.0` or `gpxelinux.0` initial boot loader for all target machines, but potentially different PXELINUX configuration files depending on the target machine's MAC address.
- For UEFI machines, the procedure supports booting multiple different versions of the ESXi installer by using the same `mboot.efi` initial boot loader for all target machines, but potentially different `boot.cfg` files depending on the target machine's MAC address.

### Prerequisites

Verify that your environment meets the following prerequisites.

- ESXi installer ISO image, downloaded from the VMware Web site.
- Target host with a hardware configuration that is supported for your version of ESXi. See the *VMware Compatibility Guide*.
- Network adapter with PXE support on the target ESXi host.
- DHCP server configured for PXE booting. See “[Sample DHCP Configurations](#),” on page 13.
- TFTP server.
- Network security policies to allow TFTP traffic (UDP port 69).
- For legacy BIOS, you can use only IPv4 networking. For UEFI PXE boot, you can use IPv4 or IPv6 networking.
- (Optional) Installation script (kickstart file).
- Use a native VLAN in most cases. If you want to specify the VLAN ID to be used with PXE booting, check that your NIC supports VLAN ID specification.

For legacy BIOS systems, version 3.86 of the SYSLINUX package, available from <https://www.kernel.org/pub/linux/utils/boot/syslinux/>.

### Procedure

- 1 Configure the DHCP server for TFTP boot.

- 2 (Legacy BIOS only) Obtain and configure PXELINUX:
  - a Obtain SYSLINUX version 3.86, unpack it, and copy the `pxelinux.0` file to the top-level `/tftpboot` directory on your TFTP server.
  - b Create a PXELINUX configuration file using the following code model.

ESXi-6.x.x-XXXXXX is the name of the TFTP subdirectory that contains the ESXi installer files.

```
DEFAULT install
NOHALT 1
LABEL install
  KERNEL ESXi-6.x.x-XXXXXX/mboot.c32
  APPEND -c ESXi-6.x.x-XXXXXX/boot.cfg
  IPAPPEND 2
```

- c Save the PXELINUX file in the `/tftpboot/pxelinux.cfg` directory on your TFTP server with a filename that will determine whether all hosts boot this installer by default:

Option	Description
<b>Same installer</b>	Name the file <code>default</code> if you want for all host to boot this ESXi installer by default.
<b>Different installers</b>	Name the file with the MAC address of the target host machine (01- <i>mac_address_of_target_ESXi_host</i> ) if you want only a specific host to boot with this file, for example, 01-23-45-67-89-0a-bc.

- 3 (UEFI only) Copy the file `efi/boot/bootx64.efi` from the ESXi installer ISO image to `/tftpboot/mboot.efi` on your TFTP server.

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**NOTE** Newer versions of `mboot.efi` can generally boot older versions of ESXi, but older versions of `mboot.efi` might be unable to boot newer versions of ESXi. If you plan to configure different hosts to boot different versions of the ESXi installer, use the `mboot.efi` from the newest version.

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- 4 Create a subdirectory of your TFTP server's top-level `/tftpboot` directory and name it after the version of ESXi it will hold, for example, `/tftpboot/ESXi-6.x.x-xxxxx`.
- 5 Copy the contents of the ESXi installer image to the directory you just created.
- 6 Modify the `boot.cfg` file

- a Add the following line:

```
prefix=ESXi-6.x.x-xxxxxx
```

Here, `ESXi-6.x.x-xxxxxx` is the pathname of the installer files relative to the TFTP server's root directory.

- b If the filenames in the `kernel=` and `modules=` lines begin with a forward slash (/) character, delete that character.

- 7 (Optional) For a scripted installation, in the `boot.cfg` file, add the `kernelopt` option to the line after the kernel command, to specify the location of the installation script.

Use the following code as a model, where `XXX.XXX.XXX.XXX` is the IP address of the server where the installation script resides, and `esxi_ksFiles` is the directory that contains the `ks.cfg` file.

```
kernelopt=ks=http://XXX.XXX.XXX.XXX/esxi_ksFiles/ks.cfg
```

- 8 (UEFI only) Specify whether you want for all UEFI hosts to boot the same installer.

Option	Description
<b>Same installer</b>	Copy or link the <code>boot.cfg</code> file to <code>/tftpbboot/boot.cfg</code>
<b>Different installers</b>	<ul style="list-style-type: none"> <li>a Create a subdirectory of <code>/tftpbboot</code> named after the MAC address of the target host machine (<code>01-mac_address_of_target_ESXi_host</code>), for example, <code>01-23-45-67-89-0a-bc</code>.</li> <li>b Place a copy of (or a link to) the host's <code>boot.cfg</code> file in that directory, for example, <code>/tftpbboot/01-23-45-67-89-0a-bc/boot.cfg</code>.</li> </ul>

## PXE Boot the ESXi Installer Using a Web Server

You can use a Web server to PXE boot the ESXi installer. Because most environments include ESXi hosts that support UEFI boot and hosts that support only legacy BIOS, this topic discusses prerequisites and steps for both types of hosts.

- For legacy BIOS machines, the procedure supports booting multiple different versions of the ESXi installer by using the same `pxelinux.0` or `gpxelinux.0` initial boot loader for all target machines, but potentially different PXELINUX configuration files depending on the target machine's MAC address.
- For UEFI machines, the procedure supports booting multiple different versions of the ESXi installer by using the same `mboot.efi` initial boot loader for all target machines, but potentially different `boot.cfg` files depending on the target machine's MAC address.

### Prerequisites

Verify that your environment has the following components:

- ESXi installer ISO image, downloaded from the VMware Web site.
- Target host with a hardware configuration that is supported for your version of ESXi. See the *VMware Compatibility Guide*.
- Network adapter with PXE support on the target ESXi host.
- DHCP server configured for PXE booting. See “[Sample DHCP Configurations](#),” on page 13.
- TFTP server.
- Network security policies to allow TFTP traffic (UDP port 69).
- For legacy BIOS, you can use only IPv4 networking. For UEFI PXE boot, you can use IPv4 or IPv6 networking.
- (Optional) Installation script (kickstart file).
- Use a native VLAN in most cases. If you want to specify the VLAN ID to be used with PXE booting, check that your NIC supports VLAN ID specification.

Verify that your environment also meets the following prerequisites required for PXE boot using a Web Server:

- Verify that the HTTP Web server is accessible by your target ESXi hosts.
- (UEFI) Obtain iPXE, available at <http://ipxe.org>.
- (Legacy BIOS) Obtain version 3.86 of the SYSLINUX package, available from <https://www.kernel.org/pub/linux/utils/boot/syslinux/>.

### Procedure

- 1 Configure the DHCP server for HTTP boot.

- 2 (UEFI only) Obtain and configure iPXE:
  - a Obtain the iPXE source code, as described at <http://ipxe.org/download>.
  - b Follow the instructions on that page, but use the following make command:
 

```
make bin-x86_64-efi/snponly.efi
```
  - c Copy the resulting file `snponly.efi` to `/tftpboot` directory on your TFTP server.
- 3 (UEFI only) Copy the file `efi/boot/bootx64.efi` from the ESXi installer ISO image to `/tftpboot/mboot.efi` on your TFTP server.

---

**NOTE** Newer versions of `mboot.efi` can generally boot older versions of ESXi, but older versions of `mboot.efi` might be unable to boot newer versions of ESXi. If you plan to configure different hosts to boot different versions of the ESXi installer, use the `mboot.efi` from the newest version.

---

- 4 (Legacy BIOS only) Obtain and configure PXELINUX:
  - a Obtain SYSLINUX version 3.86, unpack it, and copy the `pxelinux.0` file to the top-level `/tftpboot` directory on your TFTP server.
  - b Create a PXELINUX configuration file using the following code model.
 

ESXi-6.x.x-XXXXXX is the name of the TFTP subdirectory that contains the ESXi installer files.

```
DEFAULT install
NOHALT 1
LABEL install
  KERNEL ESXi-6.x.x-XXXXXX/mboot.c32
  APPEND -c ESXi-6.x.x-XXXXXX/boot.cfg
  IPAPPEND 2
```
  - c Save the PXELINUX file in the `/tftpboot/pxelinux.cfg` directory on your TFTP server with a filename that will determine whether all hosts boot this installer by default:

Option	Description
<b>Same installer</b>	Name the file <code>default</code> if you want for all host to boot this ESXi installer by default.
<b>Different installers</b>	Name the file with the MAC address of the target host machine ( <i>01-mac_address_of_target_ESXi_host</i> ) if you want only a specific host to boot with this file, for example, <code>01-23-45-67-89-0a-bc</code> .

- 5 Create a directory on your HTTP server named for the version of ESXi it will hold, for example, `/var/www/html/ESXi-6.x.x-XXXXXX`.
- 6 Copy the contents of the ESXi installer image to the directory you just created.
- 7 Modify the `boot.cfg` file
  - a Add the following line:
 

```
prefix=http://XXX.XXX.XXX.XXX/ESXi-6.x.x-XXXXXX
```

where `http://XXX.XXX.XXX.XXX/ESXi-6.x.x-XXXXXX` is the location of the installer files on the HTTP server.
  - b If the filenames in the `kernel=` and `modules=` lines begin with a forward slash (/) character, delete that character.

- 8 (Optional) For a scripted installation, in the `boot.cfg` file, add the `kerneLopt` option to the line after the kernel command, to specify the location of the installation script.

Use the following code as a model, where `XXX.XXX.XXX.XXX` is the IP address of the server where the installation script resides, and `esxi_ksFiles` is the directory that contains the `ks.cfg` file.

```
kerneLopt=ks=http://XXX.XXX.XXX.XXX/esxi_ksFiles/ks.cfg
```

- 9 (UEFI only) Specify whether you want for all UEFI hosts to boot the same installer.

Option	Description
<b>Same installer</b>	Copy or link the <code>boot.cfg</code> file to <code>/tftpboot/boot.cfg</code>
<b>Different installers</b>	<ul style="list-style-type: none"> <li>a Create a subdirectory of <code>/tftpboot</code> named after the MAC address of the target host machine (<i>01-mac_address_of_target_ESXi_host</i>), for example, <code>01-23-45-67-89-0a-bc</code>.</li> <li>b Place a copy of (or a link to) the host's <code>boot.cfg</code> file in that directory, for example, <code>/tftpboot/01-23-45-67-89-0a-bc/boot.cfg</code>.</li> </ul>

## Sample DHCP Configurations

To PXE boot the ESXi installer, the DHCP server must send the address of the TFTP server and the filename of the initial boot loader to the ESXi host.

When the target machine first boots, it broadcasts a packet across the network requesting information to boot itself. The DHCP server responds. The DHCP server must be able to determine whether the target machine is allowed to boot and the location of the initial boot loader binary, typically a file on a TFTP server.



**CAUTION** Do not set up a second DHCP server if your network already has one. If multiple DHCP servers respond to DHCP requests, machines can obtain incorrect or conflicting IP addresses, or can fail to receive the proper boot information. Talk to a network administrator before setting up a DHCP server. For support on configuring DHCP, contact your DHCP server vendor.

Many DHCP servers can PXE boot hosts. If you are using a version of DHCP for Microsoft Windows, see the DHCP server documentation to determine how to pass the `next-server` and `filename` arguments to the target machine.

### Example of Booting Using TFTP with IPv4

This example shows how to configure a ISC DHCP server to boot ESXi using a TFTP server at IPv4 address `xxx.xxx.xxx.xxx`.

```
#
# ISC DHCP server configuration file snippet. This is not a complete
# configuration file; see the ISC server documentation for details on
# how to configure the DHCP server.
#
allow booting;
allow bootp;
option client-system-arch code 93 = unsigned integer 16;
class "pxeclients" {
    match if substring(option vendor-class-identifier, 0, 9) = "PXEClient";
    next-server xxx.xxx.xxx.xxx;
    if option client-system-arch = 00:07 or option client-system-arch = 00:09 {
        filename = "mboot.efi";
    }
}
```

```

    } else {
        filename = "pxelinux.0";
    }
}

```

When a machine attempts to PXE boot, the DHCP server provides an IP address and the location of the `pxelinux.0` or `mboot.efi` binary file on the TFTP server.

## Example of Booting Using TFTP with IPv6

This example shows how to configure a ISC DHCPv6 server to boot ESXi via a TFTP server at IPv6 address `xxxx:xxxx:xxxx:xxxx::xxxx`.

```

#
# ISC DHCPv6 server configuration file snippet. This is not a complete
# configuration file; see the ISC server documentation for details on
# how to configure the DHCP server.
#
allow booting;
allow bootp;
option dhcp6.bootfile-url code 59 = string;
option dhcp6.bootfile-url "tftp://[xxxx:xxxx:xxxx:xxxx::xxxx]/mboot.efi";

```

When a machine attempts to PXE boot, the DHCP server provides an IP address and the location of the `mboot.efi` binary file on the TFTP server.

## Example of Booting Using HTTP with IPv4

This example shows how to configure a ISC DHCP server to boot ESXi via a Web server at IPv4 address `xxx.xxx.xxx.xxx`. The example uses `gPXE` for legacy BIOS hosts and `iPXE` for UEFI hosts.

```

#
# ISC DHCPv6 server configuration file snippet. This is not a complete
# configuration file; see the ISC server documentation for details on
# how to configure the DHCP server.
#
allow booting;
allow bootp;
option client-system-arch code 93 = unsigned integer 16;
class "pxeclients" {
    match if substring(option vendor-class-identifier, 0, 9) = "PXEClient";
    next-server xxx.xxx.xxx.xxx;
    if option client-system-arch = 00:07 or option client-system-arch = 00:09 {
        if exists user-class and option user-class = "iPXE" {
            # Instruct iPXE to load mboot.efi as secondary bootloader
            filename = "mboot.efi";
        } else {
            # Load the snponly.efi configuration of iPXE as initial bootloader
            filename = "snponly.efi";
        }
    } else {
        filename "gpxelinux.0";
    }
}

```

When a machine attempts to PXE boot, the DHCP server provides an IP address and the location of the `gpxelinux.0` or `snponly.efi` binary file on the TFTP server. In the UEFI case, iPXE then asks the DHCP server for the next file to load, and this time the server returns `mboot.efi` as the filename.

## Example of Booting Using HTTP with IPv6

This example shows how to configure a ISC DHCPv6 server to boot ESXi via a TFTP server at IPv6 address `xxxx:xxxx:xxxx:xxxx::xxxx`.

```
#
# ISC DHCPv6 server configuration file snippet. This is not a complete
# configuration file; see the ISC server documentation for details on
# how to configure the DHCP server.
#
allow booting;
allow bootp;

option dhcp6.bootfile-url code 59 = string;
if exists user-class and option user-class = "iPXE" {
    # Instruct iPXE to load mboot.efi as secondary bootloader
    option dhcp6.bootfile-url "tftp://[xxxx:xxxx:xxxx:xxxx::xxxx]/mboot.efi";
} else {
    # Load the snponly.efi configuration of iPXE as initial bootloader
    option dhcp6.bootfile-url "tftp://[xxxx:xxxx:xxxx:xxxx::xxxx]/snponly.efi";
}
```

When a machine attempts to PXE boot, the DHCP server provides an IP address and the location of the `snponly.efi` (iPXE) binary file on the TFTP server. iPXE then asks the DHCP server for the next file to load, and this time the server returns `mboot.efi` as the filename.

## PXE Boot Background Information

Understanding the PXE boot process can help you during troubleshooting.

### TFTP Server

Trivial File Transfer Protocol (TFTP) is similar to the FTP service, and is typically used only for network booting systems or loading firmware on network devices such as routers. TFTP is available on Linux and Windows.

- Most Linux distributions include a copy of the `tftp-hpa` server. If you require a supported solution, purchase a supported TFTP server from your vendor of choice. You can also acquire a TFTP server from one of the packaged appliances on the VMware Marketplace.
- If your TFTP server will run on a Microsoft Windows host, use `tftpd32` version 2.11 or later. See <http://tftpd32.jounin.net/>.

### SYSLINUX, PXELINUX, and gPXELINUX

If you are using PXE in a legacy BIOS environment, you need to understand the different boot environments.

- SYSLINUX is an open source boot environment for machines that run legacy BIOS firmware. The ESXi boot loader for BIOS systems, `mboot.c.32`, runs as a SYSLINUX plugin. You can configure SYSLINUX to boot from several types of media, including disk, ISO image, and network. You can find the SYSLINUX package at <http://www.kernel.org/pub/linux/utils/boot/syslinux/>.
- PXELINUX is a SYSLINUX configuration for booting from a TFTP server according to the PXE standard. If you use PXELINUX to boot the ESXi installer, the `pxelinux.0` binary file, `mboot.c32`, the configuration file, the kernel, and other files are all transferred by TFTP.

- gPXELINUX is a hybrid configuration that includes both PXELINUX and gPXE and supports booting from a Web server. gPXELINUX is part of the SYSLINUX package. If you use gPXELINUX to boot the ESXi installer, only the `gpxelinux.0` binary file, `mboot.c32`, and the configuration file are transferred via TFTP. The remaining files are transferred via HTTP. HTTP is typically faster and more reliable than TFTP, especially for transferring large amounts of data on a heavily loaded network.

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**NOTE** VMware currently builds the `mboot.c32` plugin to work with SYSLINUX version 3.86 and tests PXE booting only with that version. Other versions are likely to be incompatible. This is not a statement of limited support. For support of third-party agents that you use to set up your PXE booting infrastructure, contact the vendor.

---

## UEFI PXE and iPXE

Most UEFI firmware natively includes PXE support that allows booting from a TFTP server. The firmware can directly load the ESXi boot loader for UEFI systems, `mboot.efi`. Additional software such as PXELINUX is not required.

iPXE can also be useful for UEFI systems that do not include PXE in firmware and for older UEFI systems with bugs in their PXE support. For such cases you can try installing iPXE on a USB flash drive and booting from there.

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**NOTE** Apple Macintosh products do not include PXE boot support. They include support for network booting via an Apple-specific protocol instead.

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## Alternative Approaches to PXE Booting

Alternative approaches to PXE booting different software on different hosts are also possible, for example:

- Configuring the DHCP server to provide different initial boot loader filenames to different hosts depending on MAC address or other criteria. See your DHCP server's documentation.
- Approaches using iPXE as the initial bootloader with an iPXE configuration file that selects the next bootloader based on the MAC address or other criteria.



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