RIPE NCC
RIPE NETWORK COORDINATION CENTER

Introduction to Network Boot

macOS, RPi & PXE

Trix Taiclet | RIPE NCC | 14 November 2024

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Why should you care?

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  - USB sticks
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- No more
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- Use **the network** instead

Network Boot: the easy way (1)

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How to Re-Install OS X with Internet Recovery on a Mac

Dec 14, 2014 · 114 Comments

In some rare situations, reinstalling OS X on a Mac may be required. This is made fairly easy as all modern Macs include the OS X Internet Recovery feature, which lets you reinstall OS X through a netboot type of mode that is accessed from the internet rather than a local drive. This is helpful in the event you need to reinstall Mac OS X whether for fun, because something has gone truly haywire, or because you need to replace the system software for whatever other reason.

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Step 2

- Once the computer is completely shut down, press the power button, then immediately press and hold the key combination **cmd + option + R**.

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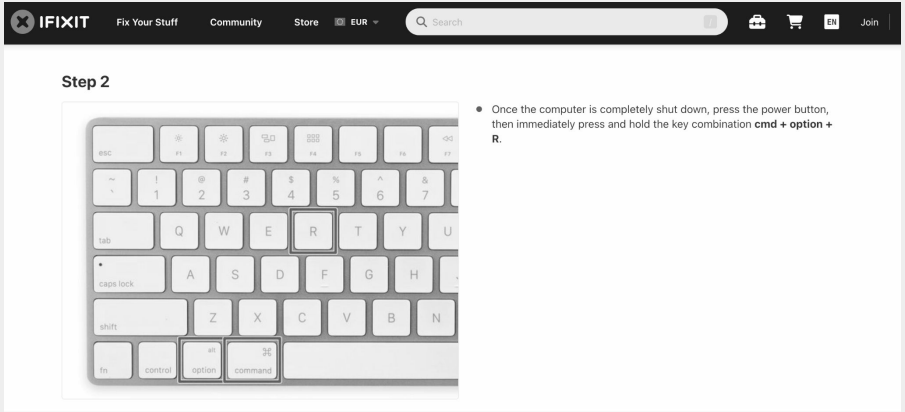
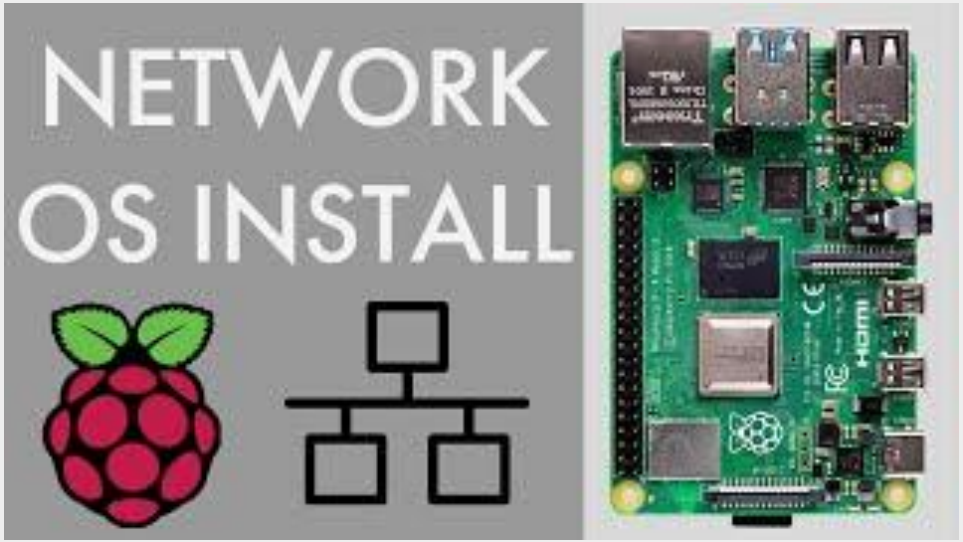


Network Boot: the easy way (2)

Install over the network

Network Install enables a Raspberry Pi to install an operating system on a storage device using a version of Raspberry Pi Imager downloaded over the network. With Network Install, you can get an operating system installed on your Raspberry Pi with no separate SD card reader and no computer other than your Raspberry Pi. You can run Network Install on any compatible storage device, including SD cards and USB storage.

Network Install only runs on Raspberry Pi 4, 400, and 5. If your Raspberry Pi runs an older bootloader, you may need to update the bootloader to use Network Install.



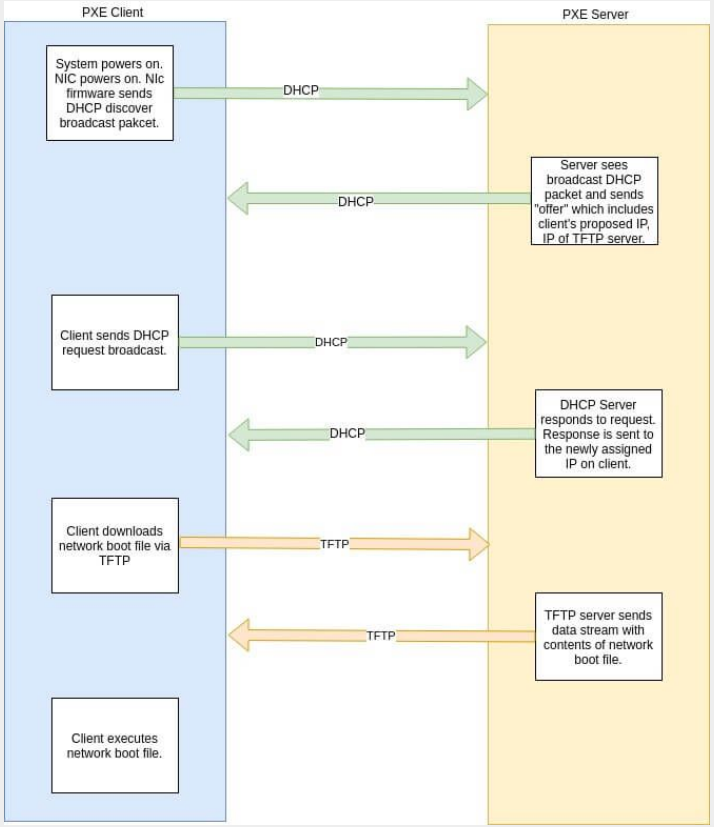
What is PXE? (simplified)

1. Computer **boots up**
2. Computer **asks for DHCP**
3. **DHCP gives** IP + PXE information
4. Computer **gets PXE file**
5. Computer **boots PXE file**

Why?

Unlike previously seen solutions,

PXE is relatively **standard**



Source: Heimdal "What Is PXE Boot and How Does It Work?"

Network Boot: the difficult way (PXE)

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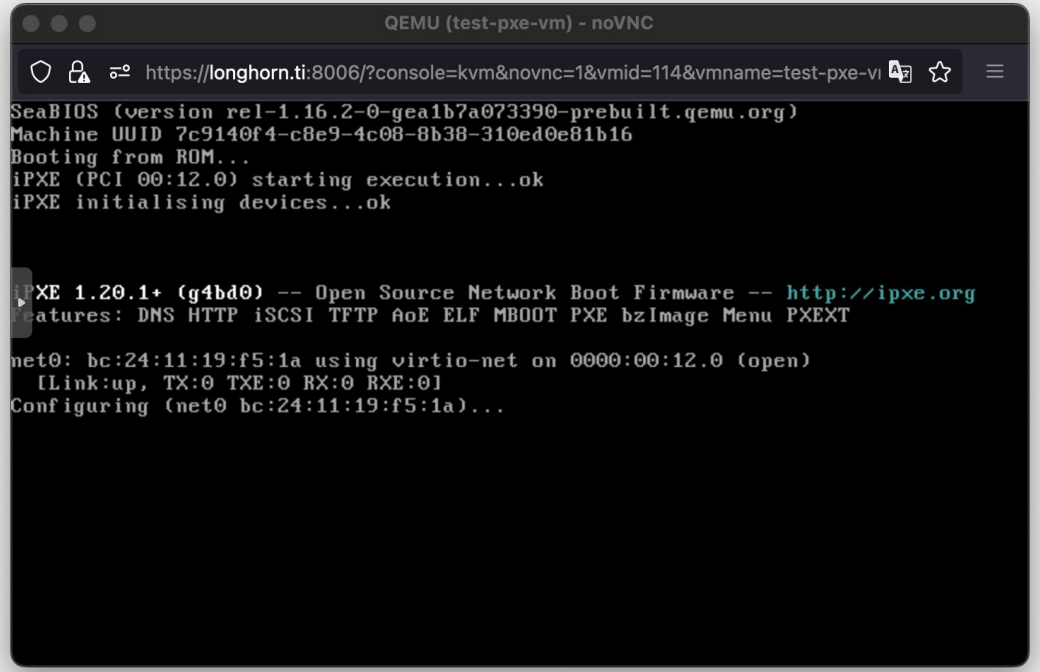
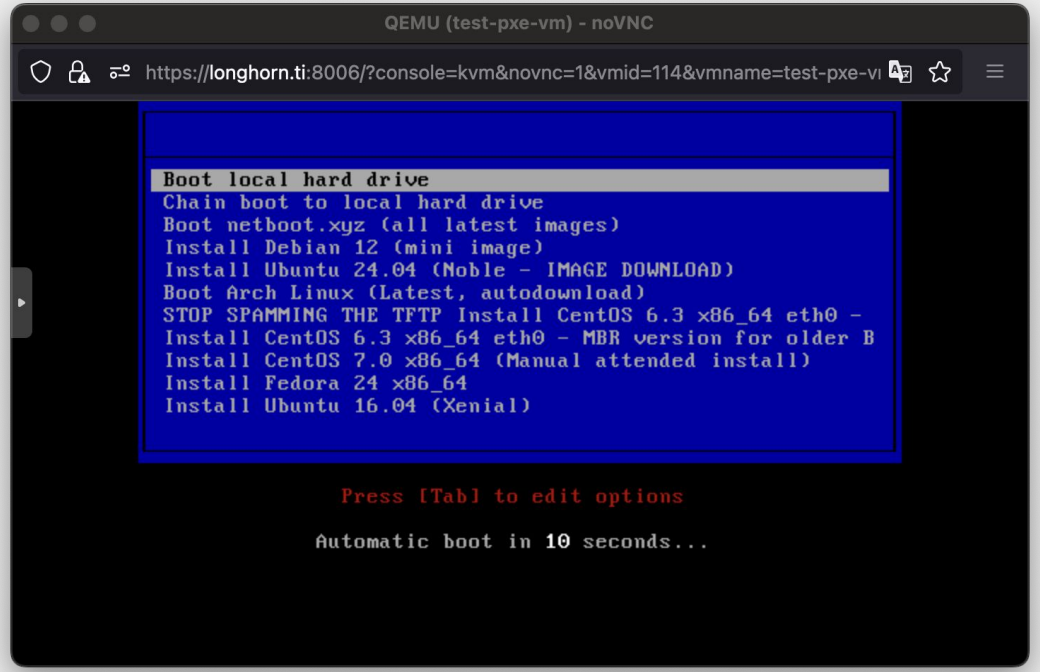


Network Boot: the difficult way (PXE)



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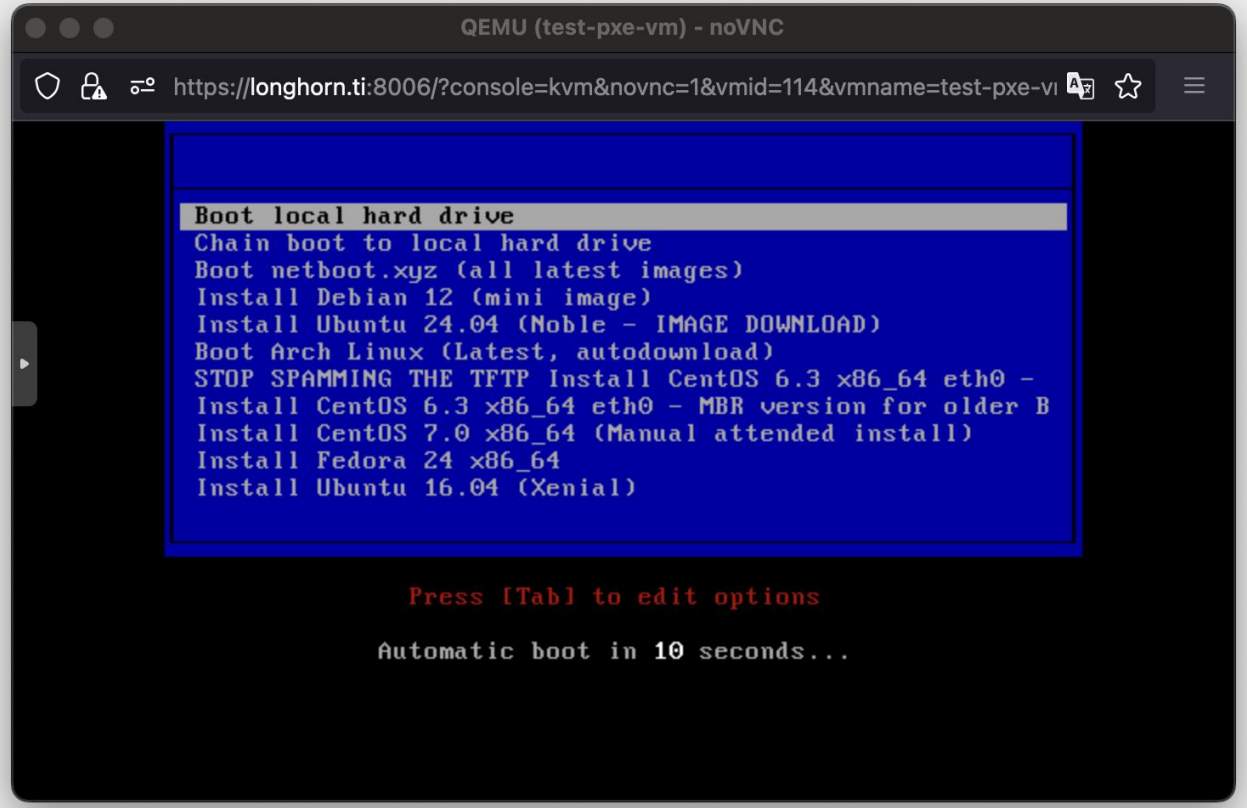

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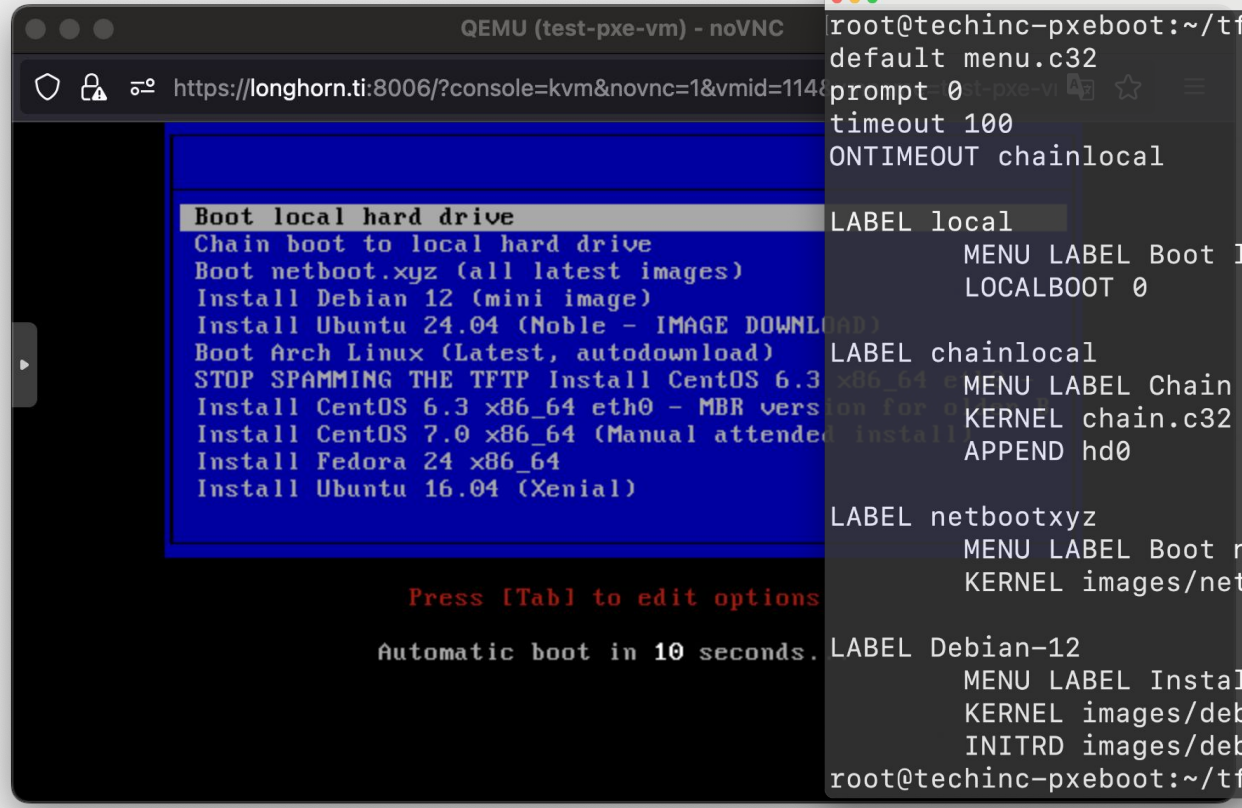

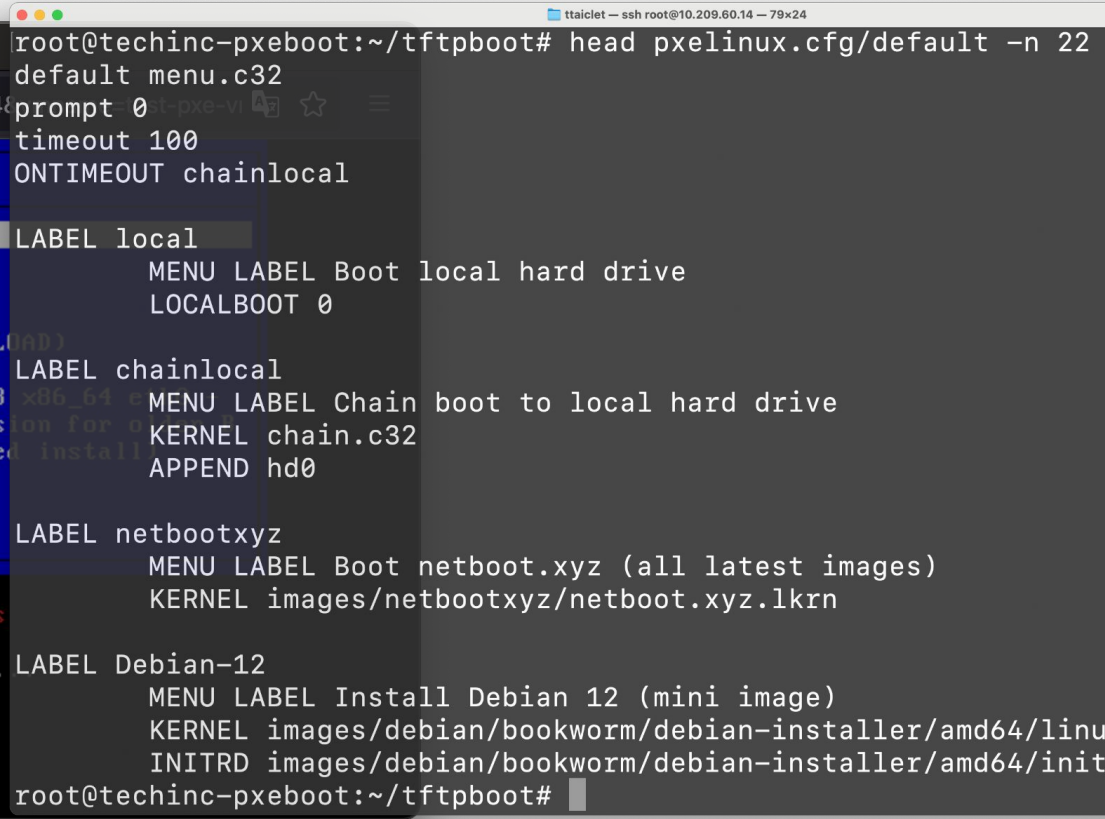

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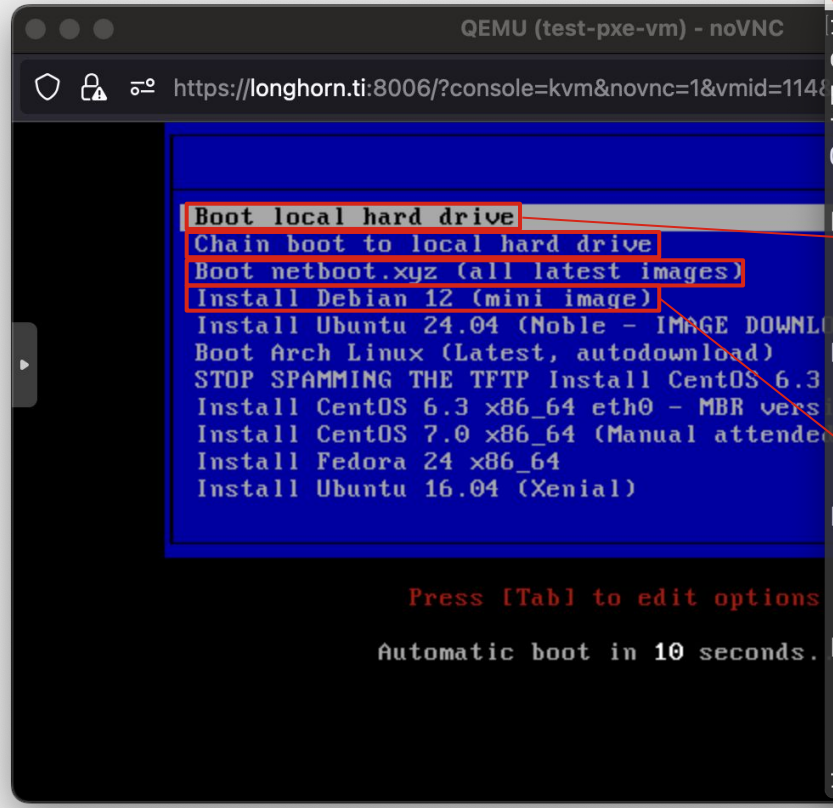
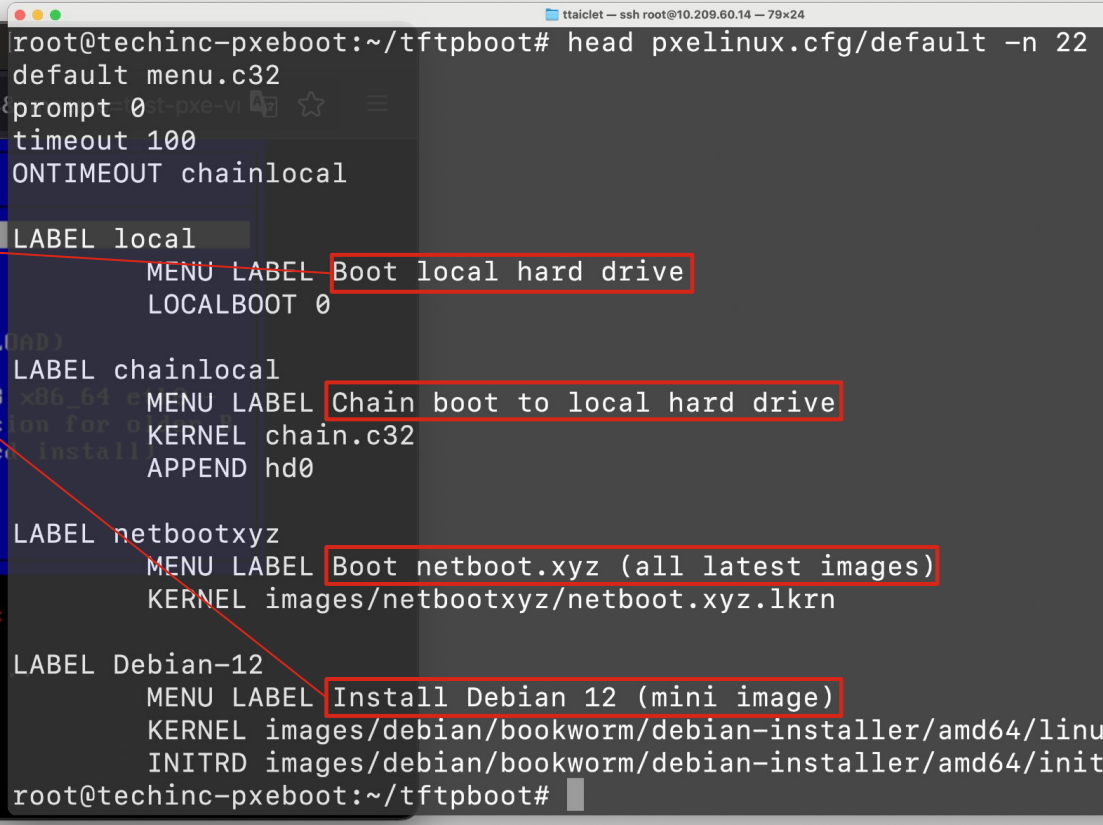




PXE: Setup (1)

Set up DHCP server

On the Server, we need to set up a DHCP server.

Current best practice seems to be to use the package isc-dhcp-server, which provides a daemor

Its configuration file is */etc/dhcp/dhcpd.conf*. Modify this file so that it contains about the following; a

```
default-lease-time 600;
max-lease-time 7200;

allow booting;

# in this example, we serve DHCP requests from 192.168.0.(3 to 253)
# and we have a router at 192.168.0.1
subnet 192.168.0.0 netmask 255.255.255.0 {
  range 192.168.0.3 192.168.0.253;
  option broadcast-address 192.168.0.255;
  option routers 192.168.0.1;            # our router
  option domain-name-servers 192.168.0.1; # our router has DNS functionality
  next-server 192.168.0.2;               # our Server
  filename "pxelinux.0"; # setting a default, might be wrong for "non defaults"
}
```

Set up TFTP server

Next, we need to set up a TFTP server on the Server.

Again, there are several packages that provide TFTP (trivial FTP, unsafe, to be used in LAN's only). It seems best practice to use the p
response to these questions goes into a configuration file, */etc/default/tftpd-hpa*. There should be no need to modify the following defau

```
TFTP_USERNAME="tftp"
TFTP_DIRECTORY="/srv/tftp"
TFTP_ADDRESS="0.0.0.0:69"
TFTP_OPTIONS="--secure"
```

Ignore older Web sites that instruct you to insert something like 'RUN_DAEMON="yes"'.

After each modification of the above configuration file, restart the TFTP server with

```
# /etc/init.d/tftpd-hpa restart
```

or

```
# systemctl restart tftpd-hpa
```

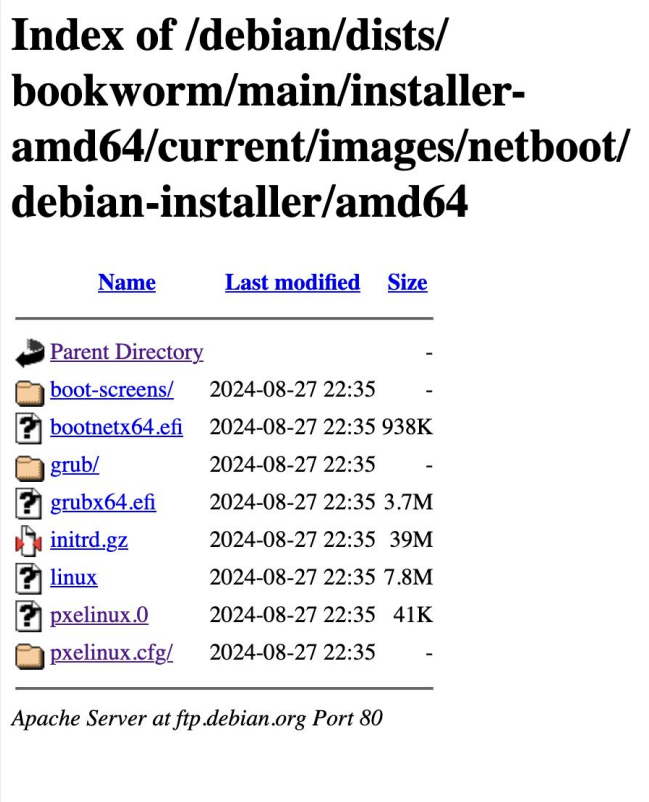
On Jessie, the directory /srv/tftp will be automatically created. This means the next two steps are not necessary if you use Jessie.

Initially, on pre-Jessie versions, restarting the TFTP server might fail with a message like

PXE: Setup (2)

"Simply put **these files** in your TFTP server, including all the **pxelinux** files"

OK, but I want to have **more control** over it



Index of /debian/dists/bookworm/main/installer-amd64/current/images/netboot/debian-installer/amd64

Name	Last modified	Size
Parent Directory		-
boot-screens/	2024-08-27 22:35	-
bootnetx64.efi	2024-08-27 22:35	938K
grub/	2024-08-27 22:35	-
grubx64.efi	2024-08-27 22:35	3.7M
initrd.gz	2024-08-27 22:35	39M
linux	2024-08-27 22:35	7.8M
pxelinux.0	2024-08-27 22:35	41K
pxelinux.cfg/	2024-08-27 22:35	-

Apache Server at ftp.debian.org Port 80

-> **Do it yourself**

PXE: Setup (3)

```
pxelinux/oldstable,now 3:6.04~git20190206.bf6db5b4+dfsg1-3 all [installed]
  collection of bootloaders (PXE network bootloader)

syslinux/oldstable,now 3:6.04~git20190206.bf6db5b4+dfsg1-3+b1 amd64 [installed]
  collection of bootloaders (DOS FAT and NTFS bootloader)

syslinux-common/oldstable,now 3:6.04~git20190206.bf6db5b4+dfsg1-3 all [installed,automatic]
  collection of bootloaders (common)
```

tmp — ssh root@10.209.60.14 — 50×6

```
cp /usr/lib/PXELINUX/pxelinux.0 ./
cp /usr/lib/syslinux/modules/bios/chain.c32 ./
cp /usr/lib/syslinux/modules/bios/menu.c32 ./
cp /usr/lib/syslinux/modules/bios/mboot.c32 ./
cp /usr/lib/syslinux/modules/bios/pxechn.c32 ./
                                        399,1         80%
```

PXE: Multiarch (x86_64 / aarch64)

Return a **different file**, depending on the **architecture option** (DHCP option)

4 Setting Up DHCP Services

Go into YaST and select **DHCP Server** from network services. Configure the IP range you want to use. After that, it is your choice on whether you use YaST or edit the configuration file (`/etc/dhcpd.conf`) manually. As with the other services, be sure to open the ports in the firewall. The end result needs to be a file that looks like the below:

```
option domain-name "my.lab";
option domain-name-servers 172.16.253.5;
option routers 192.168.124.1;
option ntp-servers 192.168.124.3;
option arch code 93 = unsigned integer 16; # RFC4578
default-lease-time 3600;
ddns-update-style none;
subnet 192.168.124.0 netmask 255.255.255.0 {
  range 192.168.124.100 192.168.124.199;
  next-server 192.168.124.3;
  default-lease-time 3600;
  max-lease-time 3600;
  if option arch = 00:07 or option arch = 00:09 {
   filename "/EFI/x86/bootx64.efi";
    } else if option arch = 00:0b {
   filename "/EFI/armv8/bootaa64.efi";
    } else {
   filename "/bios/x86/pxelinux.0";
    }
}
```

Note: `if option arch`

The `if option arch` sections allow the DHCP server to make the correct decision on which file to use for booting.

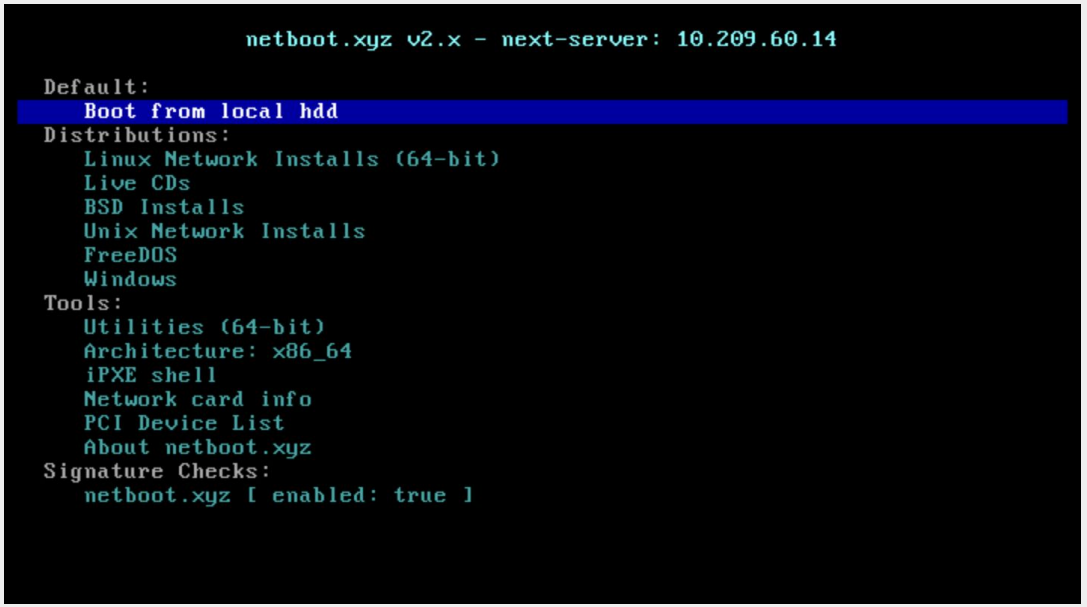
netboot.xyz

Image you boot into

→ **all the OSes** you might want
- Linux **installers**
- Linux **Live CDs**
- **BSDs** (FreeBSD, OpenBSD)
- Windows (needs setup, see docs)
  → uses Windows PE
  → needs SMB

→ allows you to boot **latest version**

→ can be put on **USB stick**



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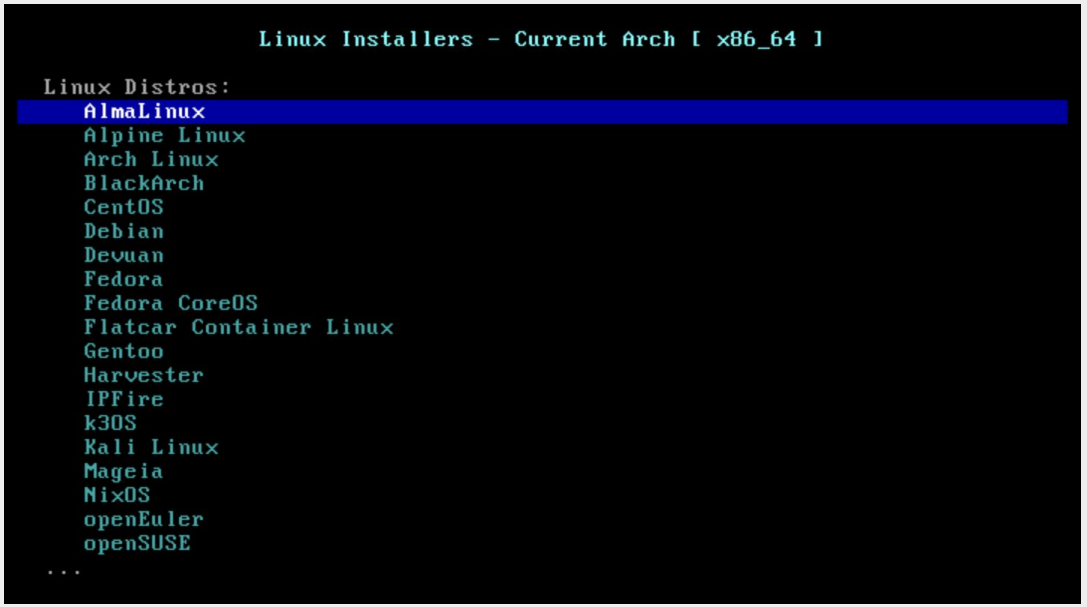

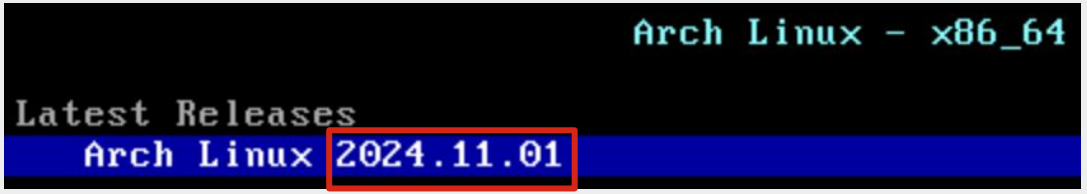

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Live demo ?

Questions & Comments

trix@c3l.lu

Appendix: Note to the reader

"And the result follows, **the intermediary steps** are **trivial** and **obvious** and as such, **are left as an exercise to the reader.**"

Appendix: Note to the reader

The simple (and dirty) steps to setup PXE are as follows:

1. Setup a TFTP server (slide 15)
2. Configure the DHCP server to return the TFTP server and pxelinux.0 path. (slide 15)
3. Install packages and copy over files to TFTP root (slide 17)
4. Create configuration file "`pxelinux.cfg/default`" at the root of the TFTP server. A full example at slide 13, basic example:

```
default menu.c32
prompt 0
timeout 100

LABEL local
        MENU LABEL Boot local hard drive
        LOCALBOOT 0
```