

Booting Palacios/Kitten Over the Network Using PXE

Yuan Tang, Lei Xia

February 21, 2010

PXE allows us to boot Kitten/Palacios (and a test guest) remotely from a network server, which makes testing Palacios on physical machines much easier. The following gives instructions on how to set up the PXE server and client. Although we explain this specifically in the context of Kitten/Palacios, PXE can be used to network boot most operating systems.

In the following, we will assume there are two machines:

- *Server*: This machine will serve Kitten/Palacios kernels over the network to client machines.
- *Client*: This machine will request Kitten/Palacios kernels from the server machine.

1 How does it work?

When the client machine starts up, PXE will first make a DHCP request to retrieve a temporary IP configuration. The server will respond to this request. Part of the response will indicate that the client should reconnect back to the server (this time using TCP or UDP) to retrieve more data using FTP. The client will do so. The server will respond by sending a small bootloader, the kernel, and additional files. The client copies this content into relevant memory locations and jumps to it. The bootloader then boots the kernel. In the typical case with Palacios/Kitten, the kernel contains Kitten and Palacios, while the additional file contains the init task, which in turn has the guest image that's being tested embedded in it.

2 What will we boot?

PXE can be used to build quite complex boot paths. For testing Palacios/Kitten, there are typically only two files involved, however:

- *bzImage*: This is the Kitten/Palacios kernel, typically located at `your_kitten_path/arch/x86_64/boot/bzImage`.
- *init_task*: This is the Kitten init task. It also contains the guest image that will be used for testing. It is typically located at `your_kitten_path/init_task`.

For booting, we copy these files into `/tftpbboot` on the server.

3 Client requirements

PXE is a service that is implemented in the client machine's BIOS or on a network card's BIOS extensions. Most modern machines, even inexpensive desktops and laptops, support it but have it turned off by default. To turn it on, power cycle the client and enter the BIOS. There may be an option to enable it here, probably under local devices/networking. If you can't find an option there, power cycle again and wait for the BIOS bootstrap message about your network card. There should be an option to hit a key to go into its configuration screen, in which you should be able to turn on PXE.

4 Server requirements

- DHCP server. DHCP enables the client get an IP address, and other configuration data automatically from the server.
- TFTP server. After the client has an IP address, it will connect back to the TFTP server it to download the kernel and other files from the server.
- Firewall rules that allow access from the client to the DHCP server and TFTP server. DHCP typically requires ports 67 and 68, while TFTP typically uses port 69.
- PXELINUX boot loader (`pxelinux.0`) installed in `/tftpboot`. You may also want to have `memdisk` in the same directory if you need to boot more ancient things.

5 DHCP setup on the server

Install the DHCP service, and configure the file `/etc/dhcpd.conf`. You want to add the client's Ethernet MAC address to config file, allow the client to get an IP address/config from DHCP server at boot time. Here is an example configuration:

```
option domain-name "cs.northwestern.edu";
default-lease-time 600;
max-lease-time 7200;

allow booting;
allow bootp;

<-- Change below section according to your network configuration --->
subnet 165.124.184.0 netmask 255.255.254.0 {
    range 165.124.184.90 165.124.184.95;
    option broadcast-address 165.124.184.255;
    option routers 165.124.184.1;
    option domain-name-servers 165.124.180.10;
}

group {
    <--- In which IP address the booting machine can find the booting image -->
```

```

next-server 165.124.184.209;
host v-test-intel-lab {
    <-- Replace below with the IP address assigned to the booting machine -->
    fixed-address 165.124.184.92;
    <--- Replace below with the MAC address of the booting machine -->
    hardware ethernet 00:1B:21:41:CF:4C;
    filename "pxelinux.0";
}
}

```

Notice that you can readily add additional client machines by adding new host entries.
Now you can start the DHCP server.

```
[jdoe@newskysaw test]$ service dhcpd restart
```

6 TFTP Setup

After installing the tftp service, enable it by editing the file `/etc/xinetd.d/tftp` so that it looks similar to the following. Typically you can just delete the line `disable = yes`.

```

service tftp
{
    socket_type          = dgram
    protocol            = udp
    wait                = yes
    user                = root
    server              = /usr/sbin/in.tftpd
    server_args         = -s /tftpboot
    per_source          = 11
    cps                 = 100 2
    flags               = IPv4
}

```

You can now the Kitten/Palacios kernel and init task to the tftp boot directory, which typically is `/tftpboot/`:

```

[jdoe@newskysaw test]$ cp your_kitten_path/arch/x86_64/boot/bzImage \
                        /tftpboot/bzImage
[jdoe@newskysaw test]$ cp your_kitten_path/init_task /tftpboot/init_task

```

You will also want to be sure that you have copied `pxelinux.0` and `memdisk` to `/tftpboot/`
You can now start the TFTP service:

```
service xinetd restart
```

7 PXE Configuration

We will now set up the PXE boot configuration. Create the directory *pxelinux.cfg* in */tftpboot*. In *pxelinux.cfg*, create a new file with the filename as the client's MAC address, prefaced with *01-*:

```
[jdoe@newskysaw test]$ cd /tftpboot
[jdoe@newskysaw test]$ cd pxelinux.cfg
[jdoe@newskysaw test]$ touch 01-00-1b-21-41-cf-4c
```

Edit this new configuration file (*01-00-1b-21-41-cf-4c* here), to set up a boot option for the machine. For Kitten/Palacios testing, the option typically looks like this:

```
default kitten
label kitten
    kernel bzImage
    append serial.baud=115200 console=serial initrd=init_task

prompt 1
timeout 20
```

Notice that your kernel *bzImage* file, and the init task file are both referenced. These are the copies that are */tftpboot*. You can have multiple options in the configuration file, each with a different label. You can learn more about these configurations by reading about PXELINUX.

You can readily add additional machines simply by creating files reflecting their MAC addresses. This allows for one PXE server to support numerous test machines and developers.

8 Testing

At this point things should be ready to go. Power on the client machine, select network booting if prompted. PXE should then go searching for the DHCP server, find our server, configure, and then continue the boot process via TFTP. Within seconds, you will see the Kitten/Palacios kernel start to boot.

If the client fails to connect to the PXE server, you should check the firewall settings, making sure they allow the client's connection requests. Also, make sure the DHCP and TFTP services are actually running.

9 Serial

For testing, it is usually a good idea to connect the client machine to some other machine via the serial port. Palacios and Kitten produce debugging and logging output via serial communication. To connect two machines, you will want a null modem RS232 cable. Palacios and Kitten typically use 115200 bps communication. If your machine's serial port is */dev/ttyS0*, then execute the following to see the output:

```
stty -F /dev/ttyS0 115200
cat /dev/ttyS0
```

Typical machines with a single port on the machine typically actually have a dual UART. If you have such a machine, you may want to try */dev/ttyS1* if */dev/ttyS0* doesn't work.

We have also experienced some challenges using SIIG multiport serial interfaces, but these can usually be cleared up by configuring them using:

```
setserial /dev/ttySn uart 16950 baud_base 115200
```