

Putting Ubuntu server onto a Mac Pro cylinder

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Abstract

Ubuntu 15.04 Vivid Vervet server off the daily-live pending web site was successfully installed on a Mac Pro cylinder of late 2013 vintage. The process of creating a dual boot with OS X Yosemite is described. Building upon that standard Ubuntu installation to support additional hardware of the Mac Pro is then described.

The Mac Pro cylinder was the latest Macintosh computer released by Apple in its Mac Pro series. As such it was one of the fastest desktop computers available to the general public. However, the Mac OS X operating system provided with the system appeared not to provide levels of service which matched the potential of that hardware, at least from the viewpoint of computing research. Linux, by contrast, could provide such services. The problem was getting Linux to install, load, and function on this hardware.

Mac OS X provides useful services. As a result, dual booting of the Mac Pro into either OS X or native Linux was required.

Here Ubuntu server was used. This was considered a distribution with greater flexibility than the corresponding desktop distribution. An example of that flexibility was the server distribution did not load a desktop environment as was part of the desktop distribution. After the server distribution was installed, a desktop environment of choice could be loaded if required.

A difficulty was since OS X Lion, the supplied `Boot Camp` utility only supported creation of dual booting with Microsoft `Windows` on a Mac, and then only specific versions of `Windows`. Virtual machine software could be run under OS X and Linux under the virtual machine. But the virtual machine would take something out of the processing power of the Mac Pro which should be available under Linux. The problem was to find a means of installing, booting and running Linux on the Mac Pro in a native mode.

1 Environment used

Ubuntu server 64-bit AMD was downloaded from cdimage.ubuntu.com/ubuntu-server/daily/pending/vivid-server-amd64.iso. This was a pre-release of Ubuntu Vivid Vervet 15.04 server. This ISO image was processed using the `unetbootin-linux-608` program under Linux, having been downloaded from unetbootin.sourceforge.net. This processing was performed on a 32-bit Toshiba Satellite Pro laptop running Linux. It produced a USB thumb drive containing the installation image. This image was used in all installations attempts.

It was believed that boot loading using `systemd` would be beneficial to loading and operation of Ubuntu. The parallelization capabilities claimed in www.freedesktop.org/wiki/Software/

`systemd` particularly looked appropriate to Linux running on the Mac Pro cylinder. However, Ubuntu only switched to its use instead of `init` after March 9, 2015. So Ubuntu server Vivid Vervet distributions produced after that date were used.

The Mac Pro used in all trials was a standard production. It had 16 GB of memory, a 256 GB SSD, 6 cores, and two D500 graphics processors. A Macintosh keyboard for control was connected by one of the USB ports. A 4K 28 inch Samsung UHD monitor provided the display screen.

2 Path taken to a solution

The approach take to finding a solution to the problem consisted of three phases. First the Internet was scanned to find an existing solution. Then an approach was explored using USB connected devices external to the Mac Pro. Finally the Mac Pro internal SSD was used with success.

2.1 Approaches taken by others

Dual booting of Linux with OS X on Macintosh computers was well established. www.howtogeek.com/187410/how-to-install-and-dual-boot-linux-on-a-mac gave a detailed description of installing a *64 bit mac version* of Ubuntu on a Mac laptop. However, a corresponding dual boot on the Mac Pro cylinder had proved more allusive. The URL help.ubuntu.com/community/MacPro described installing Ubuntu desktop on a Mac Pro cylinder replacing OS X as a single boot, but was one of the few reported success. Another URL askubuntu.com/questions/411940/installing-ubuntu-on-mac-pro-black-cylinder-fails described difficulties in repeating that success. By contrast, the blog christianhuening.de described installing Ubuntu server on the SSD of the Mac Pro for dual booting. This was an acceptable solution, but by 11 March 2015, that blog had disappeared from the web to enable further reference.

Each of the two successful approaches had used the `rEFInd` boot manager.

2.2 Unsuccessful approach

The approach taken here was to install Linux on an external drive and connect it to a USB port on the Mac Pro. No boot manager other than that supplied standard with OS X was used. By using external devices, no change in the OS X environment was required.

A series of install and boot trials were performed. A 32 GB thumb drive and a 1 TB portable disk, each with USB 3 capabilities were used. Each of those drives was selected in turn and had Ubuntu server installed onto it from the installation thumb drive. The Mac Pro was used for this installation between USB ports. After completion of the Ubuntu installation process, the installation thumb drive was removed from the Mac Pro as requested by the Ubuntu installation script, then the script booted the new installation. The output from `systemd` scrolled down the screen and then stopped. The power to the Mac Pro was removed and then power re-applied. A second attempt to boot the installation was then made using the `grub` boot menu which then appeared upon power restoration. Same result. Then that menu was interrupted and forced into the `grub` command line. The `grub` command combination of `set root` and `configfile` with appropriate parameters was then used to initiate a boot. Again the same result.

Both the 32 GB thumb drive and 1 TB portable disk were initialized using `fdisk` with MBR partitioning table for one trial. Then `gdisk` was used to replace it with a GPT partitioning table. In

all cases, a single partition was placed on the device covering its whole storage. These `fdisk` and `gdisk` operations were performed on a Linux system different to the Mac Pro. The process above was then repeated for both devices in both configurations.

Although Ubuntu was successfully installed on each drive configuration, none of the installations completed their `systemd` boot script to yield a functioning Ubuntu system.

Booting Ubuntu from an external USB drive appeared unavailable.

2.3 Successful approach

A successful installation used Ubuntu server and the `rEFInd` boot manager, together with minor manipulation of the OS X Yosemite installation of the Mac Pro. The SSD on the Mac Pro was used for holding both OS X and Ubuntu. Not only did this provide a solution to the dual booting problem, it also gave Ubuntu the potential for improved processing speed.

Space to contain Ubuntu was made on the Mac Pro SSD by resizing. This resizing was done using the sequence `Go` → `Utilities` → `Disk Utility` under OS X on the Mac Pro. From this utility, the 251 GB `APPLE SM0254F` Media device was selected (the only device shown) then the `Partition` button clicked. The display produced of the partition layout on this device showed approximately 20 GB in use. Since the Mac Pro had not been used, this storage must be due to the software of Yosemite. Reducing this partition to 128 GB (half of the storage on the 256 GB SSD) appeared reasonable space for OS X usage. The resize tag on the partition visualization was dragged up to 128 GB, with 128.45 GB being the result achieved. The new partitioning was then established by clicking the `Apply` button. The created free space on the device was not touched.

The binary of the latest version of the `rEFInd` boot manager was downloaded from sourceforge.net/projects/refind/files/0.8.7/refind-bin-0.8.7.zip/download and copied into a terminal window on the Mac Pro under OS X. Version 0.8.7 of `rEFInd` was used as it was claimed by its author to fix issues `rEFInd` had with the Yosemite release of OS X. The command:

```
unzip refind-bin-0.8.7.zip
```

was given to unpack the boot manager. Then the commands:

```
cd refind-0.8.7
./install.sh
```

installed the `rEFInd` boot manager into the proper place on the Mac Pro to control boot source selection. The Mac Pro was then shutdown.

With the installation thumb drive in a USB port of the Mac Pro, power was applied to the Mac Pro. The `rEFInd` menu was displayed. From this menu the *four square diamond* was clicked and installation onto the Mac Pro SSD started. From the Ubuntu installation menu, manual partitioning of the installation target was selected. Into the 128 GB free space shown to be available on the drive (corresponding to the space created using the OS X `Disk Utility`) the allocations shown in Table 1 were made.

No swap space was allocated. The 16 GB of memory on the Mac Pro was thought not to warrant it.

Installation followed the standard script supplied with the Ubuntu distribution. In addition to assigning storage partitions, other parameters such as using Macintosh a keyboard, TCP/IP addresses for the primary ethernet interface, no HTTP proxy to be used, and to include Open SSH server and Samba file server were given while following the standard installation process. Upon completion, the installation script was used to boot the new installation. Booting briefly showed the grub menu and proceeded to boot. This was followed by `systemd` output scrolled down the display before coming to a halt. The boot failed.

Table 1: Storage assignments used and their usage

Partition number	Mount point	Size [GB]	Ubuntu usage [MB]
1	/	20	487
2	/usr	3	606
3	/home	60	52
4	/tmp	20	44
5	/usr/local	20	45

Upon restarting the Mac Pro the `rEFInd` display with its selections did not appear despite it having appeared previously. The Mac Pro was again rebooted by cycling the power to it while pressing the *option* key on the keyboard. From the standard Macintosh boot option display which resulted, OS X was booted. A terminal window was then used to install `rEFInd` again, using the same key sequence as before. OS X was then used to reboot the Mac Pro. The `rEFInd` then appeared.

The new `rEFInd` display contained the standard buttons, an OS X select button, and two Ubuntu select buttons. Clicking one of those Ubuntu buttons (left hand one) booted Ubuntu but the `systemd` install stopped. Clicking the other Ubuntu button (right hand one) resulted in the `systemd` install running to completion, the background colour of the display turning green, and the text:

```
Ubuntu Vivid Vervet (development branch) linuxPro tty1
linuxPro login:
```

appeared in white characters in the top left of the screen. In that text `linuxPro` was the name assigned to the computer as a parameter during execution of the installation script. After the display went through its screen-saver blackout, the screen background colour went to black. This *green behaviour* appeared to be a peculiarity of the Samsung display used.

After logging into the new Ubuntu installation, the storage taken up by the installation in the assigned partitions were as tabulated in Table 1.

2.4 Cleaning up

The `rEFInd` display resulting from the above installation contained the Apple boot icon, two Ubuntu boot icons, and a Tux icon. The `rEFInd` display showed those icons as representing:

```
Boot Mac OS X from Macintosh HD
Boot EFI\ubuntu\grubx64.efi from EFI
Boot grubx64.efi from 55 GiB ext4 volume
Boot boot\mlinuz-3.19.0-7-generic.efi.signed from 18 GiB ext4 volume
```

The `Boot EFI\ubuntu\grubx64.efi` from EFI related icon led to a boot not completing. It was linked to the file `/boot/efi/EFI/ubuntu/grubx64.efi`. Deleting this file removed the

associated icon from the `rEFInd` boot options. The remaining icons presented useful boot options.

3 Customizing Ubuntu for the Mac Pro

Table 2 is a summary of the hardware on the Mac Pro listed by executing the command `lspci`. Two identical chips to support each of the VGA and audio were shown as being present.

Table 2: Components making up a Mac Pro cylinder

Hardware	Manufacturer	Chip
ethernet	Broadcom Corporation	NetXtreme BCM57762
wireless	Broadcom Corporation	BCM4360
audio	Advanced Micro Devices	Tahiti XT HDMI Audio
VGA/GPU	Advanced Micro Devices	Tahiti LE
SSD	Samsung Electronics	Apple PCIe SSD
CPU	Intel Corporation	Xeron E5
USB	Intel Corporation	C600/X79 series

The Ubuntu server distribution did not provide full support for the Mac Pro cylinder. The automated installation provided support for most parts. However further support could be obtained using the contents of the distribution media and the Ubuntu archive server as indicated in Table 3. In Table 3, VGA and GPU capabilities have been separated.

Table 3: Mac Pro hardware supported by Ubuntu Vivid Vervet server distribution download

Standard install	On media	From web	Not working
Ethernet	ALSA sound system	WiFi networking	keyboard caps lock
SSD		GPU	keyboard beep
USB 3			
VGA			
keyboard and mouse			

Actions to go beyond a standard Ubuntu server system were also performed. These are considered in the following.

3.1 Wifi

The Broadcom BCM4360 chip which provides WiFi with the feature set given in www.broadcom.com/products/Wireless-LAN/802.11-Wireless-LAN-Solutions/BCM4360 was not supported under Linux, but the `wl` modules which was, provided a close substitute. The commands:

```
sudo apt-get install linux-headers-generic
sudo apt-get install --reinstall bcmwl-kernel-source
sudo modprobe wl
```

installed the modules from the Ubuntu web archive and produced the identifier `wlan0` for the wifi on the Mac Pro. Then the standard command `ifconfig` was used to assign an IP address to `wlan0` on the wifi network, while `iwconfig` was used to assign the `essid` to which `wlan0` was to be linked.

3.2 ALSA audio

Module support for the audio system was part of the standard distribution. Control was available from `alsa-utils` included on the Ubuntu server distribution. The `aptitude` package management could be used to install it using the installation thumb drive. Initially the audio system was turned off, but the `alsamixer` program, which was part of the `utils` package, this could be to make a change. Also `alsamixer` indicated the audio system was composed of a Cirrus Logic CS4208 chip on a HDA Intel PCH card which differed from what `lspci` as shown in Table 2.

3.3 Graphics processors

VGA support for screens, including larger screens such as the 4k Samsung, was available as standard, without GPU consideration.

GPUs were considered in relation to X Window. The X Window System was not part of the standard Ubuntu server distribution but was available for download and installation by `aptitude` using the Ubuntu web site. However X Window functioned without further GPU consideration.

Better graphic performance was available by the use of drivers specific to the AMD GPUs on the Mac Pro. There were two drivers available; one open source and the other proprietary. The open source `xf86-video-ati` was available from www.freedesktop.org. Binary only driver `fglrx`, or `catalyst`, was available from support.amd.com/en-us/download/desktop?os=Ubuntu+x86+64 but it did not support Ubuntu 15.04 (Vivid Vervet).

3.4 Keyboard caps lock

Pressing the keyboard `cap lock` key did not set the LED on the key indicating it was in use. This occurred when using the shell interface to the Linux kernel. If X Window window was in use, the LED behaved normally. However, whether the LED was lit or not, the purpose of the `cap lock` behaved as expected.

3.5 Keyboard *beep*

Keyboard actions such as a *left arrow* key at the start of a line, or a *down arrow* key are errors which should result in a warning *beep*. This *beep* should be produced by the speaker on the Mac Pro. Some users consider this absence of such audible warnings to be a feature and not an oversight.

4 Where to next

Untapping the processing power in the Mac Pro cylinder requires a lot more work. Exposing its *nuts and bolts* is only the first step. Faster peripheral handling and SSD storage is secondary to the processing potential. With GCC 4.9.2 now supporting OpenMP 4.0 and Cilk Plus, software making use of available multi-cores and GPUs of the Mac Pro cylinder needs attention. In this respect, the stream processors of the GPUs should be harnessed to provide mainline parallel processing alternating with their graphics function. Decreases by orders of magnitude in software speed is available from the Mac Pro if its hardware is exploited. Linux is currently the environment in which bleeding edge

software is developed. There in is the link for installing Linux on a Mac Pro. The Mac Pro cylinder is a super computer at desktop pricing but head of its time with respect to software for its use.