

CIA Lab Assignment: Booting*

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Feedback deadline:
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Abstract

The coming weeks you will be working with your own experimentation server. You will first install an Ubuntu distribution, and then you will look at the way it boots and initializes the system. For the installation we will use UEFI and PXE booting.

1 Introduction

This assignment include topics not covered during the lectures. We want you to try to find the right information yourself in order to complete the assignments. Choose your sources of information carefully and reference them to support your answers.

You are to keep a log of your progress on your Wiki (one page per assignment), including choices or assumptions made, problems encountered and answers to the questions posed. You must hand in this assignment at the end of the first week, such that the lab teachers can provide you with early feedback on your log, to ensure the answers are readable and of sufficient quality for the next labs.

2 Experimentation Servers

Each student will use an experimentation computer during the year. You can find out which is yours in the list in Figure 1.

3 Installation

You will be installing Ubuntu using PXE using the following instructions. You should connect to your machines remotely using the iDrac. While you are waiting for the install to finish you should answer some questions out about booting and partitioning.

*Based on earlier work by E.P. Schatborn, A. van Inge, N. Sijm, J. van der Ham. Version September 5, 2017.

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3.1 Using the Drac

You can reach the Drac of your experimentation computer by visiting the web page at `drac.$name.studlab.os3.nl`. From there you can open a Java program which will give you a window to the console of the computer.

Question

1. (a) What is a Drac?
(b) How does it work?

3.2 Installation Instructions

Connect to the console of your experimentation machine using the iDrac. Reboot the machine and use the firmware option to start a PXE boot, then use the “Install Ubuntu 16.04.3 Server (amd64)” option to install Ubuntu. Note that after selecting this option the screen just shows a blinking cursor while the firmware loads the Linux kernel, be patient. Make sure you install the `ssh` daemon for remote access. And make sure you have access to it from only trusted networks (`man hosts.allow`).

Questions during Install

2. (a) What is UEFI PXE booting?
(b) How does it work?
3. (a) What is a GPT?
(b) What is its layout? Explain each element
4. What is a Protective MBR and why is it in the GPT?

4 Partitions

Boot into Ubuntu and use the `dd` utility to dump the Protective MBR and GPT into a file in your home directory. If you have been assigned a Dell R210 II (UK city names), you should make the dump on a desktop, as your system does not use UEFI, and hence a GPT.

Use a hex dump utility to look at the raw data in the file.

5. Copy and dump the Protective MBR in hex format on your Wiki page, and fully annotate all their fields. This means you must describe the purpose of every field, and translate all fields that have a numerical value into human readable, decimal format.
6. (a) Do the same for the GPT header.

- (b) And for the first partition table entry.
 - (c) At what byte index from the start of the disk do the real partition table entries start?
7. If you wanted to add a (1 + *your table number*) GiB FreeBSD ZFS partition, called ØŚ3 (U+00D8 U+015A U+0033) to the table by hand, what values would you have to use for the entry (including the name) in the raw table on disk? Assume this partition comes after the first partition on the disk.

5 Loading the OS

Now that we have Ubuntu installed, we will look at the booting process.

8. What is an UEFI OS loader and where does the Ubuntu OS loader reside on the system? *Hint: See the UEFI specification.*

Ubuntu uses the UEFI OS loader to load and run the GRUB boot loader

9. What is the purpose of the GRUB boot loader in a UEFI system?
10. How does the Ubuntu OS loader load the GRUB boot loader?
11. Explain how the GRUB boot loader, in turn, loads and run the kernel by answering these 3 questions:
- (a) What type of filesystem is the kernel on?
 - (b) What type(s) of filesystem does UEFI support?
 - (c) What does the GRUB boot loader therefore have to do to load the kernel?
12. Do you need an OS loader and/or boot loader to load a Linux kernel with UEFI? Explain why or why not.

6 Initializing the OS

After the machine has booted up, the chosen OS is started and goes through a (large) number of steps before you end up at the login prompt. We will be looking at the startup procedure of Ubuntu 16.04 in the default installation.

The startup sequence of Ubuntu can be different per version, and definitely different from other flavors of UNIX. Be sure not to copy other people's mistakes...

Questions

13. (a) What is the first process started by the kernel?

- (b) Where is the configuration kept for the started process?
 - (c) It starts multiple processes. How is the order of execution defined?
14. As a final installation step, make your experimentation server reachable over IPv6.

Machine	Student
Bristol	Kotaiba Alachkar
Derby	Peter Bennink
Edinburgh	Tomas Billum
Hull	Kevin Csuka
Ipswich	Tim Dijkhuizen
Liverpool	Henk van Doorn
Nottingham	Dirk Gaastra
Oxford	Cas van Gijtenbeek
Plymouth	Luc Gommans
Sheffield	Rick van Gorp
Torquay	Sjors Haanen
Wakefield	Bernardus Jansen
York	Rik Janssen
Arras	Isaac Klop
Avignon	Chris Kuipers
Bastia	Joost van Oorschot
Bordeaux	Péter Prjevara
Brest	Adrien Raulot
Caen	Swann Scholtes
Calais	Henri Trenquier
Dijon	Max Wong
Foix	Shahrukh Zaidi
Grenoble	Tim van Zalingen
Lemans	Kees de Jong
Lyon	Robin Klusman
Metz	Sander Lentink
Mulhouse	Marko Spithoff
Nancy	Anas Younis
Nevers	Alexander Blaauwgeers
Nice	Vincent van Dongen
Nimes	Ivo van der Elzen
Orleans	Bart Hermans
Pau	Jeroen van Heugten
Reims	Fouad Makioui
Rouen	Mick Cox
Toulouse	João De Novais Marques
Tours	Rick Lahaye
Amsterdam	Sandino Moeniralam
Belgrade	Patrick de Niet
Berlin	Jorian van Oostenbrugge
Bern	Marcel den Reijer
Brussels	Willem Rens
Copenhagen	Kenneth van Rijsbergen
Dublin	Andrey Afanasyev

Figure 1: Studlab machine ownership.