

Linux OS

Tuur Vanhoutte

February 10, 2021

Contents

1	Introductie	1
1.1	Verschil Server & Workstation	1
1.1.1	Server	1
1.1.2	Workstation	1
1.2	Extra information/resources	1
1.3	What is Linux?	1
1.3.1	What is an operating system (OS)?	1
1.3.2	What is a Kernel?	2
1.4	GNU Operating System	2
1.5	Linux, the kernel	2
1.5.1	Distributions	2
1.6	Open Source	3
1.6.1	Commercial distributions	3
1.6.2	In this course: Debian	3
2	Debian Installation	4
2.1	Networking in Linux (with VMWare)	4
2.2	Users in Linux	4
2.3	Disks, partition, filesystems	4
2.3.1	Partitions	5
2.4	MBR <> GPT	5
2.4.1	MBR	5
2.4.2	GPT	6
2.4.3	Bootstrap procedure	6
2.4.4	Linux boot process	7
2.4.5	BIOS <> UEFI	7
2.5	Filesystems	7
2.5.1	Windows	7
2.5.2	Linux	7
2.5.3	Swap	8
2.6	File structure	8
2.7	Configuration	9
2.7.1	Packages	9
2.7.2	Package management	9
2.7.3	Useful packages	10
2.8	Shutdown of VM	10
2.9	Basic network	10
2.9.1	Basic networking commands	11
2.10	Services	11

1 Introductie

1.1 Verschil Server & Workstation

1.1.1 Server

- Deliver services to (multiple) users
- Focussed: only this and nothing else
- Secure
- No GUI, everything happens through the commandline
- ⇒ as small a footprint as possible

1.1.2 Workstation

- Use services
- Create documents
- Look for information
- Consume multimedia
- GUI
- ⇒ Large footprint

1.2 Extra information/resources

- The Linux Documentation Project: <http://tldp.org>
- Pluralsight LPIC-1: Linux Professional Institute Certification: <https://www.pluralsight.com/paths/lpic-1>
- The Arch Linux Wiki is one of the most extensive sources of info about Linux: <https://wiki.archlinux.org>
 - In this module we will use Debian, not Arch, but many things are very similar
- Google

1.3 What is Linux?

1.3.1 What is an operating system (OS)?

Definitie 1.1 (Operating System) *An operating system, or OS, is software that communicates with the hardware and allows other programs to run.*

It is comprised of system software = the fundamental files your computer needs to function.

Linux is NOT an operating system: Linux = the kernel

1.3.2 What is a Kernel?

Definitie 1.2 (Kernel) *The kernel is software that is the core of a computer's operating system, with complete control over the system.*

It is the first program loaded on start-up.

It handles...:

- ... the rest of the startup
- ... input/output requests from software, translating them into instructions for the CPU
- ... memory
- ... peripherals

1.4 GNU Operating System

Definitie 1.3 (GNU) *GNU = GNU's Not Unix (recursive algorithm)*

Founded by Richard Stallman (ex-MIT, founder of the Free Software Foundation), 1984

Goal: completely free Operating System

1.5 Linux, the kernel

By Linus Torvalds (Finland), 1991

- Own personal development, not initially intended to distribute
- Interest from other developers, mainly to use with GNU OS
- Meanwhile contributions of over 12000+ developers
- 492 of top-500 supercomputers in the world run Linux
- Basis for Android, Chrome OS

Linux = the kernel

GNU = OS-tools around the kernel

⇒ **GNU/Linux**

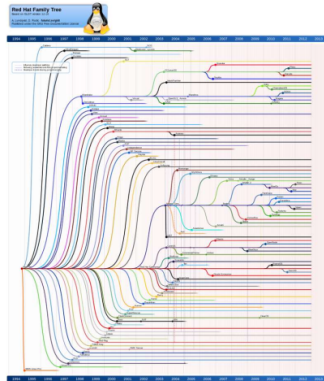
1.5.1 Distributions

Definitie 1.4 (Distribution) *A Linux distribution (or distro for short) is GNU/Linux + extra tools and applications to create a full-fledged OS.*

That distribution can be easily copied and installed to other computers.

- RedHat (CentOS)
- Debian (Ubuntu)
- Arch Linux
- Void Linux
- Gentoo
- Pop! OS

Red Hat family tree



Debian family tree

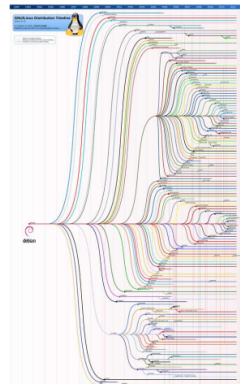


Figure 1: https://upload.wikimedia.org/wikipedia/commons/1/1b/Linux_Distribution_Timeline.svg

https://en.wikipedia.org/wiki/List_of_Linux_distributions

1.6 Open Source

Definitie 1.5 (Open Source) *Open source software is software of which the code is licensed to be open to everyone.*

Anyone can use, change, distribute the software. This allows code to be developed in a public manner.

OPEN SOURCE DOES NOT MEAN FREE

1.6.1 Commercial distributions

= Open source, non-free distributions

- SUSE Linux Enterprise Server (SLES)
- SUSE Linux Enterprise Desktop (SLED)
- Red Hat Enterprise Linux (RHEL)
- Oracle Enterprise Linux

Commercial distributions have official support channels.

⇒ You're not paying for the operating system, you're paying for the support.

1.6.2 In this course: Debian

- Current version: 10.7
- Forms the basis of many others: Ubuntu, Raspbian, Knoppix, Linux Mint
- Available on many platforms: Intel x86, AMD64, Intel64, ARM, MIPS, Power Systems, ...

2 Debian Installation

See Labs for detailed Installation tutorial

2.1 Networking in Linux (with VMWare)

- VMWare presents ethernet adapter
- During creation of virtual machine: MAC-address is created
- During installation: network configuration through DHCP
 - IPv4-address
 - Default gateway
 - DNS-server
 - Optional: proxy-server

2.2 Users in Linux

- Linux is multi-user from the ground up
 - Multiple users can be active at the same time
- 'Administrator'-user is called root
- Each user has a user-ID (uid)
 - root has uid=0
 - uid=0 has all rights
- Each user has a home-directory

2.3 Disks, partition, filesystems

- Our VM has 1 disk
 - Presented on the SCSI-bus
 - First disk on SCSI-bus: **sda**
 - Then sdb, sdc, ...
- Disk = concatenation of blocks
- Divide blocks in collections (=partitions)
 - 1st partition: sda1
 - 2nd partition: sda2
 - ...
- 2 types of partitions
 - Primary
 - Extended

2.3.1 Partitions

Primary partition

- A filesystem can be created inside this
- Up to 4 primary partitions

Extended Partition

- 'Logical' partitions can be created inside this

Our setup:

- sda1: primary partition
- sda2: extended partition
- sda5: 'logical' partition inside extended partition sda2



Figure 2: Our setup

2.4 MBR <> GPT

2.4.1 MBR

We use the MBR Partitioning scheme

Definitie 2.1 (MBR) *MBR, or Master Boot Record, is a special type of boot sector at the start of a disk.*

It contains:

- *a set of instructions necessary to boot operating systems.*
- *info about how partitions are placed on disk*

Limitations:

- Maximum disks of 2TB
- 32-bit for number of logical sectors
- Common sector size: 512 bytes
- $2^{32} \cdot 512 \text{ bytes} = 4294967296 \cdot 512 \text{ bytes} \approx 2\text{TB}$

BIOS can boot from a disk with MBR partitioning

2.4.2 GPT

Definitie 2.2 (GPT) *GPT, or GUID Partition Table, is a standard for the layout of partition tables on a disk. It's an alternative to MBR.*

It uses unique identifiers (GUIDs)

- BIOS cannot boot from a disk with GPT-partitioning: UEFI required when using GPT
- GPT allows disks larger than 2TB

Definitie 2.3 (UEFI) *UEFI, or Unified Extensible Firmware Interface, is a newer firmware interface by Intel (90's) that replaces the BIOS interface by IBM (70's).*

How does it work?

- Disk = collection of blocks
- Group of blocks together = sector
- Common sector size: 512 bytes
- Sectors indicated with Logical Block Addresses (LBA)
- MBR in LBA 0
- GPT headers in LBA 1
- Partition tabel right after that

2.4.3 Bootstrap procedure

1. Motherboard gets electricity
2. Mini-loader hardcoded in memory
 - BIOS gets loaded
3. Boot media are consulted
4. First boot medium, first sectors are being read \Rightarrow
5. MBR contains a bit-more-advanced loader: GRUB
 - GRand Unified Bootloader
6. This loader loads a more advanced loader (GRUB second stage bootloader)
7. The OS is loaded

2.4.4 Linux boot process

6 high level steps

- BIOS (Basic Input/Output System) - loads MBR
- MBR (Master Boot Record) - loads GRUB
- GRUB (Grand Unified Bootloader) - loads kernel
- Kernel - executes /sbin/init
- Init - executes runlevel programs
- Runlevel - programs from /etc/rc.d/rcXX.d are started

2.4.5 BIOS <> UEFI

- Recent systems use UEFI, not BIOS
- UEFI is required to boot from GPT-disk
- Linux has no trouble working with UEFI

So why will we use MBR?

- Virtualisation is the norm
- Virtual machines typically have small disks
- Small disks are MBR partitioned

2.5 Filesystems

2.5.1 Windows

- FAT (1977)
- FAT32 (1996)
- NTFS (1993)
- ReFS (2012)

2.5.2 Linux

- Ext (1992)
- Ext2 (1993)
- Ext3 (2001)
- Ext4 (2008)
- ZFS (2005)
- Btrfs (2007)

2.5.3 Swap

= Paging

- Free up physical memory (RAM) by moving pages to slower storage (storage disks instead of RAM)
- Page out = memory page moves to swap
- "Swapiness"
 - = parameter between 0 and 100
 - = how quickly linux will swap
 - * 0 = very conservative
 - * 100 = very aggressive
- Windows uses a swap file (pagefile.sys)
- Linux uses a swap partition

2.6 File structure

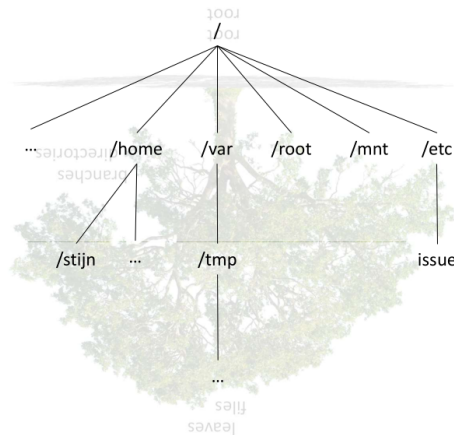


Figure 3: Linux uses a tree structure

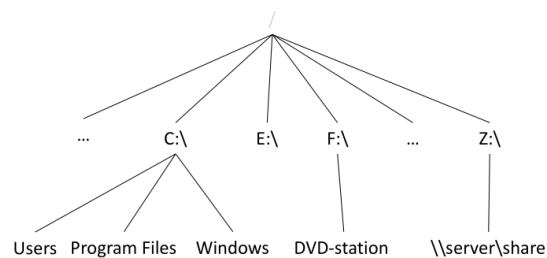


Figure 4: Windows uses a similar structure, but every volume uses a letter.

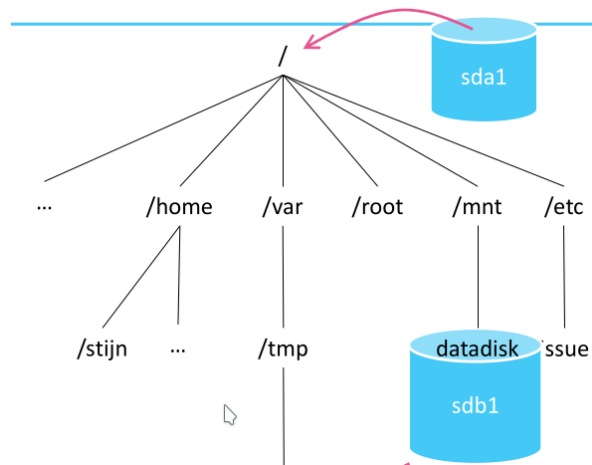


Figure 5: With linux, volumes are 'mounted' to folders somewhere under root /

2.7 Configuration

2.7.1 Packages

- Tools and applications are build up by files
- All files belonging to 1 application are bundled in a package
- Packages in debian have the .deb extension

Repositories

- Packages are collected in repositories
- Are made available through the internet
- Packages have dependencies

2.7.2 Package management

Debian: dpkg & apt (Advanced Package Tool)

- dpkg: Install, remove, give info about .deb packages
 - dpkg -l = lists packages
- apt: Get packages from a repository and install, remove, give info, ...
 - apt update
 - * Contact the repositories
 - * Get most recent list of packages and versions
 - apt upgrade
 - * Of the packages which are more recent in the repositories compared to what is installed: install newest version
 - apt install <xyz>
 - * Download package <xyz> from the repository

- * Check the dependencies and download depending packages
- * Install package <xyz> and all corresponding dependencies

Which repositories? See /etc/apt/sources.list for the list of repositories. You can add/remove/change repositories in this file.

2.7.3 Useful packages

- open-vm-tools
- vim
- sudo
- tcpdump

Install multiple packages in one command: `apt install vim sudo tcpdump ntp`

2.8 Shutdown of VM

- Power button (=ACPI shutdown)
- Shut down operating system only
 - = halt
- Shut down operating system and VM, multiple ways:
 - `shutdown -P now`
 - `init 0`
 - `poweroff`
- Reboot
 - `reboot`
 - `init 6`
 - `shutdown -r now`

2.9 Basic network

- No GUI ⇒
- Layer 1: Physical (VMWare virtual network)
- Layer 2: Datalink (Ethernet & MAC address)
- Layer 3: Network (IPv4)
- Layer 4: Transport (Transport Control Protocol (TCP), User Datagram Protocol (UDP))
- Layer 5: Application (SSH, HTTP, ...)

2.9.1 Basic networking commands

- arp
- ping
- route
- bmon

2.10 Services

- Processes that 'listen' on the network
 - TCP or UDP port
- Overview of currently running / listening services: ss command
 - ss -tulpn
 - t: show TCP
 - u: show UDP
 - l: show listening
 - p: show process ID
 - n: no name-resolving