Operating System Installation

René Serral-Gracià[1]

[1]Universitat Politècnica de Catalunya (UPC)

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Lectures

1. System administration introduction
2. **Operating System installation**
3. User management
4. Application management
5. System monitoring
6. Filesystem Maintenance
7. Network services
8. Security and Protection
9. Introduction to Public Cloud

Outline

1. Introduction
2. Equipment Life-cycle
3. System installation
4. Disk Partitioning and filesystems
5. System Init/Shutdown

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1. Introduction
   - Goals
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Goals

Abilities

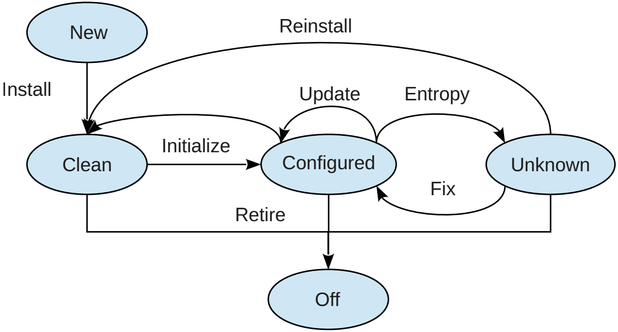
- Installation scheduling
  - Disk Partitioning
  - File System creation
  - Swap area dimensioning
- Basic configuration
  - System Startup and Shutdown

Configuration Commands and files

- `fdisk`, `mkfs`, `mkswap`, `mount`, `swapon`
- `shutdown`, `halt`, `reboot`, `poweroff`
- `systemd`, `/etc/systemd`, `/etc/fstab`

Outline

Equipment Life-cycle[1]



- Sysadmin goals:
  - Understand the existence of the states and their transitions
  - Maximize the amount of time in the *"Configured"* state

[1] Rémy Evard. *"An analysis of UNIX system configuration"*. 11^{th} Systems Administration Conference (LISA 97)

Equipment Life-cycle

States

- **New:** new equipment
- **Clean:** equipment with the installed OS but without any maintenance task
- **Configured:** configured equipment according to the environment requirements
- **Unknown:** unconfigured or outdated equipment
- **Off:** discarded equipment due to its age or hardware failure

Equipment Life-cycle

Transitions

- **Install:** OS installation
- **Initialize:** Initial set of required changes to have the equipment configured in the work environment
- **Update:** Insert new functionalities, apply patches and security updates
- **Entropy:** Gradual degradation process leaving the equipment in unknown state
- **Fix:** take the necessary actions to set the equipment back to configured state
- **Reinstall:** massive update of the OS. Usually forced by an attack, goal shift in the equipment, or configuration errors
- **Retire:** final retirement of the equipment

Outline

System installation

1. Goals
2. Dimensioning
3. HW Acquisition
4. Disk preparation
5. Protected network setup
6. Install / OS & Software update
7. Service configuration / adaptation
8. Security policy enforcement
9. Final location network setup
10. Label / Document the followed steps
11. Monitor. . . goto 5

Previous tasks

1. Goals

Which is the purpose of the new equipment?

- Desktop
  - Document editing?
  - Compiling?
- Server
  - E-mail? Web? Proxy? DNS? Files?
  - Primary? Secondary?
- Amount of expected users
- Security requirements

Previous tasks

2. Dimensioning
    - CPU
    - Memory
    - Disk
    - Redundancy
3. Buy HW
    - OS Compatibility (drivers!)
    - List of features
        - IRQs, DMA, and/or ports...

Installation

4. Disk preparation
    - Partitioning
    - Swap area preparation
    - Format and prepare the filesystems
5. Connect the equipment into a secure network
    - So during the installation the machine is protected
6. Install / Update OS & Software
    - Choose OS / Distribution
    - Select the package update list

Installation

7. Service configuration
   - Adapt them to the work environment
8. Implement security policies
   - Offer only the necessary services
9. Connect to the network
   - To the final location
10. Label / Document the followed steps
    - In case it is necessary to repeat them, to apply them on other machines, . . .
11. Monitoring. . . goto 6

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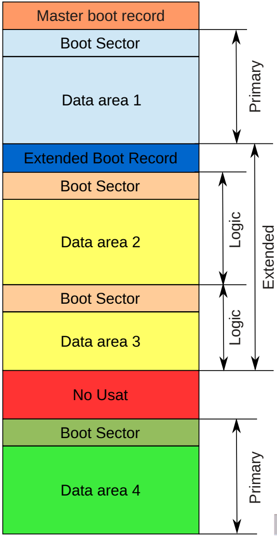
4. Disk Partitioning and filesystems
   - Filesystem preparation/format
   - Swap area
5. System Init/Shutdown

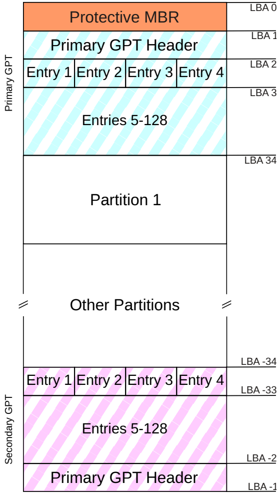
Master Boot Record (MBR) – Outdated

- Up to 4 “primary” partitions in the Master Boot Record
  - Or 3 primary and 1 extended
- Primary partition
  - May contain a filesystem
- Extended partition
  - Can only contain logical partitions
- Logical partitions
  - May contain a filesystem



Types of partitions – GUID Partition Table (GPT)

- Up to 128 partitions with the default size of GPT
- There is no disctintion of primary and extended partitions anymore, now it is identified by UUID
    - The partition type is determined by the Operating System, which assigns its own IDs



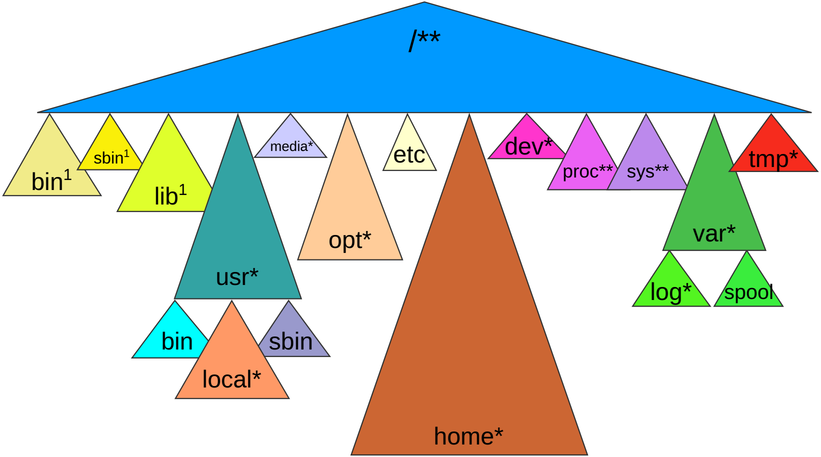
Partitions: concept and justification

Divide one disk into several independent disks

- Each partition is completely isolated from the others
  - Error isolation
  - More security
- Backup management different for each partition
  - Faster
  - More convenient
  - *Read-only* or not much changed partitions
- Information reuse among OS

Problem: hard disk fragmentation

Filesystem structure in UNIX



* Can be mounted filesystems

** Must be mounted filesystems

[1] Deprecated (backwards compatibility)

Filesystem structure in UNIX

- `/bin` and `/sbin`
  - Executables needed during boot time
  - `ifconfig`, `mount`, `ls`, `cat`, ...
- `/usr/bin` and `/usr/sbin`
  - Operating system applications
  - `man`, `apropos`, ...
  - `adduser`, `deluser`, ...
- `/usr/local/bin` and `/usr/local/sbin` (or `/opt`)
  - Specific applications
- `$HOME/bin`
  - End-user applications

Filesystem structure in UNIX

`/var`

- Dynamic content
  - Accounting
    - Information about end-user activity
  - Spool
    - Mail
    - Cron/at
    - cups
  - Run
    - Pid's of running daemons
  - Log
    - System logs

Filesystem preparation/format

- `mkfs` *-t tipus [opcions] dispositiu*
  - type: ext3, ext4, reiserfs, vfat, brtfs,. . .
  - options (filesystem dependent)
    - block size
    - number of inode
    - number of blocks (usually autodetected)
    - . . .
- `tune2fs` *[-l] [-j]* . . .
  - Filesystem ext[234] parameter configuration
    - Filesystem check interval
    - Journal creation
    - . . .

Exercise – En grup

- If we put all the directories labelled with $\ast$ and $\ast\ast$ in their own partition. Determine a correct size for each partition
- Why the rest of the directoris cannot be on a partition by themselves

Exercise – En grup

- If we put all the directories labelled with $\star$ and $\star\star$ in their own partition. Determine a correct size for each partition
  - Such size normally depends of the particular needs for that installation. Usually a regular Linux installation needs around $15GB$
- Why the rest of the directoris cannot be on a partition by themselves
  - The content is necessary during the boot process. Potentially before mounting the filesystems

Mount

- `mount` *[options] device directory*
    - -t <filesystem type>
        - Indicate the type of the filesystem
    - -a
        - mount all the filesystems in /etc/fstab
    - -o <FS options>
        - ro = read-only
        - remount
        - noexec, nodev, nosuid
        - user

/etc/fstab

- Indicates how to mount the filesystems

Device	M. point	FS	Options	D	F
/dev/sda1	/boot	vfat	defaults	0	2
/dev/sda2	/	btrfs	defaults	0	1
/dev/sda3	/var	ext4	defaults	0	2
/dev/sda4	/home	ext4	defaults	0	2
/dev/sda5	swap	swap	defaults	0	0

Exercise – In group

- We have a server with 100 users, with a disk quota of 5Gb per user. The system has a 1TB harddisk. Indicate how can you partition it and the size of each partition.

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- We have a server with 100 users, with a disk quota of 5Gb per user. The system has a 1TB harddisk. Indicate how can you partition it and the size of each partition.
  - The users need a total of $\sim 500GB$. $\sim 5GB$ for the base system[2], then lacking more information we leave a total of $\sim 10GB$ for applications.
    Then we will have 3 different partitions, the root partition `/dev/sda1` with $6GB$, the user's partition `/dev/sda2` using $600Gb$, $12Gb$ for applications `/dev/sda5`, and finally $8GB$ for the swap partition `/dev/sda6`. We leave the rest of the disk unpartitioned
    For safety we leave a threshold of $10-20\%$ in terms of space for each partition

[2] Assuming a Linux Debian installation

Exercise – In group

- List the required commands in order to be able to mount the filesystems indicated in the previous exercise, knowing that the application partition must be read-only.

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  - `/dev/sda5` → `mount -o ro /dev/sda5 /usr`

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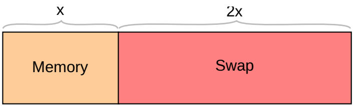
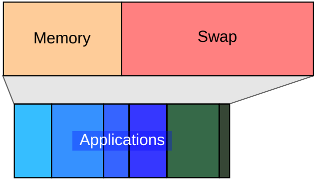
- Can you devise any situation where more partitions could be necessary?
  - If the server had some specific requirements, for example a very large web page, we could be interested in having `/var/www` in a different partition

Swap area

- Rule of thumb
  - Swap = 2 * physical memory



- Realment
  - Foresee memory requirements and choose it accordingly



Swap area implementation

- As a disk partition
  - Better if divided into multiple devices
- Special file
  - Pre-created and completely reserved. . . it cannot have any "holes"
    - Holes??? in a file???

      `dd if=/dev/zero of=swapfile bs=1024 count=65536`
  - **Be careful!**
    - File protections
    - The is sensible information from the swapped out processes

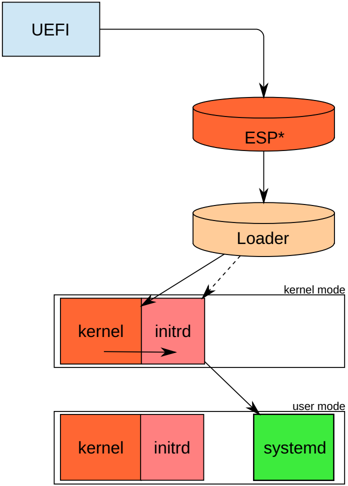
Swap area Creation/Preparation

- `mkswap` *device | file*
  - Creates a swap area — is equivalent to swap area “format”
- `swapon` *[options] [device | file]*
  - -p *priority*
    - The swap with more priority is used before
    - Round-Robin if equal priority
  - -a
    - Activates all the swaps defined in /etc/fstab
- `swapoff` *[options] [device | file]*
  - Disables a given swap area
  - -a
    - Disables all the ones defined into /etc/fstab

Outline

System initialization

- ROM
  - Hardware initialization
    - CPUs,. . .
- kernel
  - Hardware detection
  - Kernel mode configuration
- initrd
  - Device configuration
- init
  - User space configurations



* EFI System Partition (ESP)

Inicialització del sistema (I)

System-V (Linux Deprecated)

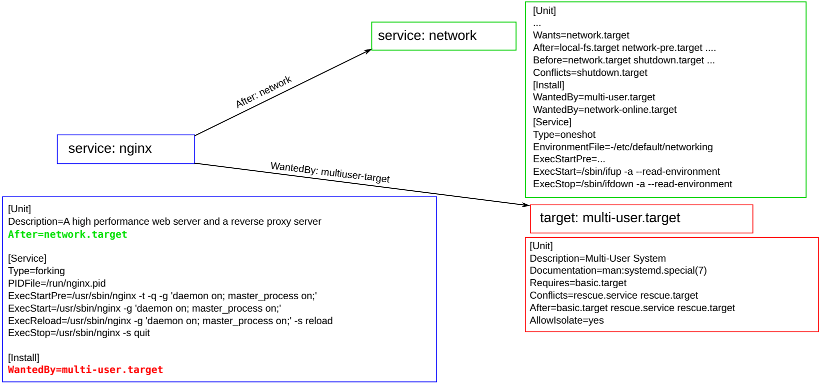
- Legacy UNIX
- Sequential and synchronous system boot
- Based on `bash` scripts
- Driven by the OS distribution itself
- Very easy to configure
- Default on most BSD and Slackware
- Unused nowadays by most Linux distributions

System initialization (II)

systemd

- Only available for Linux
- Built-in hardware management through `udev`
- Boot based on dependencies and targets
- Tight control over service state:
  - active
  - inactive
  - activating
  - deactivating
  - failed
  - not-found
  - dead

`systemd` - target based execution



`systemd` - the services

`systemctl`: service handling

- `systemctl`: List all services and their state
- `systemctl [start|stop|restart] <services>`: Starts/Stops/Restarts the `<service>`
- `systemctl reload <services>`: Reread service configuration without stopping
- `systemctl [enable|disable] <services>`: Enables/Disables the service to be started on boot
- `systemctl status <services>`: Service status
- `systemctl [mask|unmask] <serveis>`: Masks/unmasks the service execution
- `systemctl daemon-reload`: Self-reload of the service

System shutdown

Actions to perform

- Stop all services — Network + locals
- Stop all the processes
- Sync all buffer caches
- Umount all the filesystem
- Stop/reboot the system

Commands

- `shutdown`: allows shutdown/reboot at a given time
- `reboot`, `halt`, `poweroff`, ...
  - Currently all optiosn use ACPI extensions
- `systemctl reboot`, `systemctl poweroff`

Personal work

- Privileges and protection
  - Owners and groups
  - Privileges (r, w, x)
  - Umask
  - Setuid, setgid
- User management related commands
  - `chmod`, `chown`, `id`, `newgrp`
  - `useradd`/`adduser`, `userdel`
  - `chfn`, `chsh`, `passwd`
  - `groupadd`, `groupdel`