

# Computer System Design and Administration

Topic 1. Basics concerning «Data Centers» and the system administrator



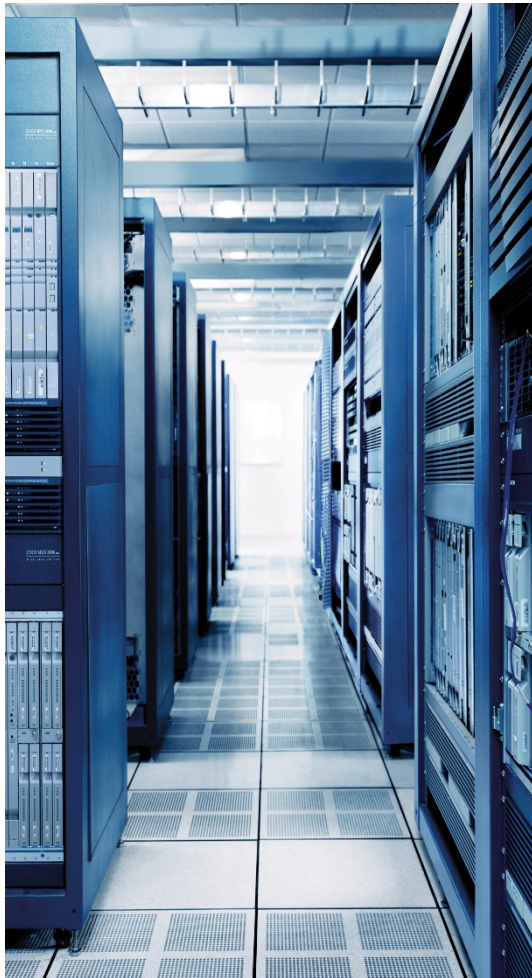
**José Ángel Herrero Velasco**

Department of Computer and  
Electrical Engineering

This work is published under a License:

[Creative Commons BY-NC-SA 4.0](https://creativecommons.org/licenses/by-nc-sa/4.0/)

## Definition of “Data Center”: the concept



- *“It’s a specifically adapted **“facility”** to accommodate and manage both the **hardware & software resources** which are needed to **organize, process, store and disseminate large amounts of data in an organization”**.*
- A service is **only as reliable** as the data center that houses it.
- A service in the *cloud* sometimes seems to be in a virtual world:
  - ...but every cloud resource ultimately lives in a **mundane reality**.
- Understanding where the computer resources and data actually live is an important part of being a **system administrator**.

## The Data Center components

- It is **composed** of:
  - A physically **safe and secure space** (*the facility*):
    - Location, perimeter and facility access.
    - Firefighting systems, access control, video surveillance.
  - **Racks** that hold computers, networks, and storage devices:
    - Standard sizes; EIA-310 19in (600x1060x2181mm) and 42U (102 Kg).
    - And others:
      - **Storage and networking specific.**
  - **Electric power** sufficient to operate every device:
    - Power sizing (Kw), UPS, *on-site* power generation, redundant power feeds.
  - **Cooling**, to keep the devices within their operating temperature ranges:
    - ASHRAE recommendations: 18°-27°C (TEMP) and 8%-60% (HUM).
    - Cooling estimation (facility features) and **design strategies**:
      - **Hot aisles and cold aisles.**
    - Energy efficient:
 
$$\frac{\text{Total Power consumed}}{\text{IT Power consumed}}$$
      - **Power Usage Effectiveness (PUE).**
  - **Network connectivity** throughout the data center:
    - Enterprise and admin network, services (clients), partners, vendors, Internet.
  - **On-site Operational staff.**

## Human organization around the “Data Center”

- A “*Data Center*” is not only a real place which harbors computer systems:
  - There are **people** too (**work teams**).
  - A good human organization is **essential** for a proper operation.
  - It’s the natural “*home*” for system administrators:
    - Although it can (remotely) work on a virtual computing infrastructure in the cloud.
  
- Its **structure** is usually strongly coupled to its *aims* and *purposes*:
  - Not only in terms of computer technology, but also in terms of **organizational aspects**.
  - Types of DC, according to its *aims* and *purposes*:
    - DC for **internet service** providers (ISPs):
      - **Telefónica, Arsys, CIC...**
    - DC for **supercomputing** – HPC/HTC services (I+D+i):
      - **BSC, CESGA, IFCA (UC), 3Mares (UC).**
    - DC for **clouds environment**:
      - **Google, Amazon...**
    - DC **specific services**:
      - **Santander Bank CPD “bunker”, locals...**

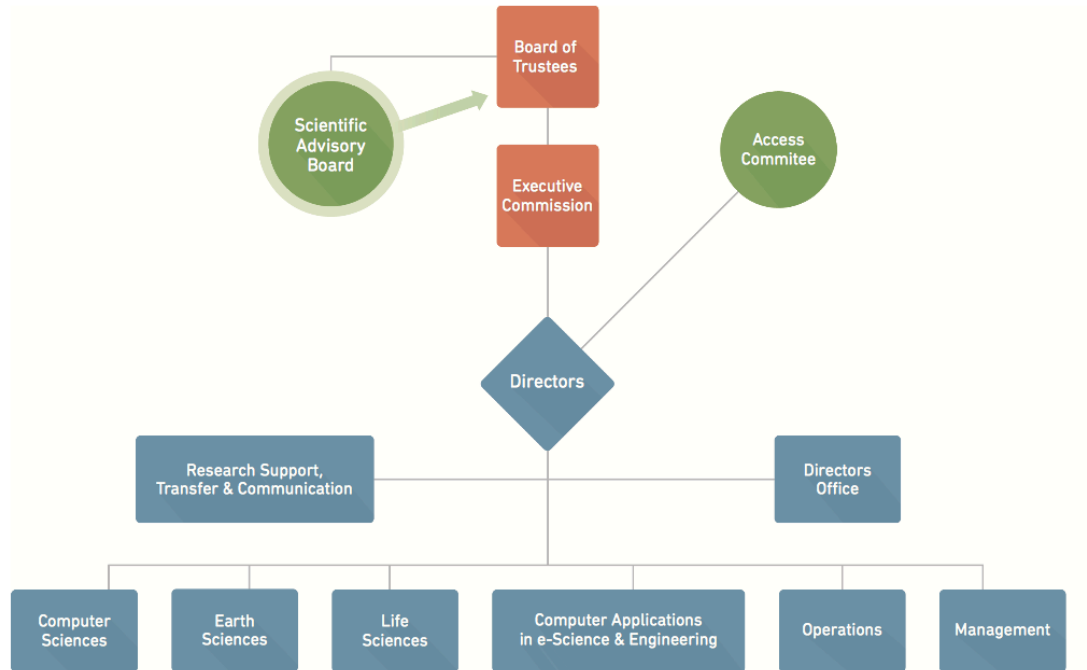
## Human organization around the “Data Center”

- **Organic schema (hierarchy) for the “data center”:**
  - **Managing director:**
    - Managing director or **Board of trustees.**
  - *Attached to director (or expert committee):*
    - Science director or science committees:
      - **Scientific advisory board.**
      - **Computer resources access committee:**
        - » Main task: defining the user profiles (clients) for the DC.
  - Area/department directors.
  - Departments and work areas:
    - **Infrastructure** department (*“unidad técnica”*):
      - **DC infrastructure:**
        - » cooling, power, security, *building* maintenance, etc.
    - **System engineering** department:
      - **Hardware & software:**
        - » Hosting, storage, networking, *cloud*, etc.

## Human organization around the “Data Center”

- **Operations** department (NOC):
  - **Monitor everything (computers, networks, infrastructure).**
  - **User support (*front line*):**
    - » Reception and redirection of incidents.
- **Development** department (Projects & apps → software):
  - **According to each area of knowledge:**
    - » Software and user apps.
    - » E.g.: Computer science, Earth science, biology and human sciences, etc.
- **Training and Learning** department:
  - **Technical training for users and DC staff:**
  - **e-learning.**
- **Others:**
  - **Human Resources:**
    - » Staff management, purchases, agreements, etc.
  - **Accounting.**
  - **Marketing and Sales.**
  - **Press, communications and disclosure.**

## Human organization in the BSC: case of use



Barcelona Supercomputing Center 2017

José Ángel Herrero Velasco

## The system administrator (sysadmin)

- **Definition:** this is the person responsible for the **deployment, start up, administration and proper operation** of a computer or computer environment:
  - There is not really a “super sysadmin” or unique system administrator:
    - The administrator usually becomes specialized.
    - As part of **work teams** (Multidisciplinary):
      - **However, at least one person should understand all the components and ensure that every task is performed correctly.**
  - **System administrators’ roles:**
    - Computer system administrator:
      - **Operating systems (UNIX, Linux, MS...).**
      - **Computer systems:**
        - » By and large.
        - » Specialized:
          - Banking, Heavy Industry, Robotic, Research (**HPC**)...
      - **Virtualization and “Cloud Computing”.**
    - Database administrator.
    - Networking administrator.
    - Security systems administrator.
    - Specialized APP administrator (ERPs → SAP).



## Essential tasks, duties and responsibilities (sysadmins team)

- The system administrators must be able to deploy policies, take actions and define rules for making sure that systems are:
    - Usable.
    - Reliable.
    - Safe.
    - Efficient.
- Main premise
- 
- **Monitoring** the use and state of the computer systems:
    - Know what is happening (at all times) with systems like:
      - Hardware:
        - **Networking + Storage + Computers.**
      - Virtualization infrastructures (“cloud computing”).
      - Software:
        - **OS, services, user apps.**
    - System accounting:
      - Servers(hw), OS and services.
    - Perform periodic performance reporting to support capacity planning.
  - **DC environment support:**
    - Monitor equipment:
      - Cool systems, power supply, security devices, etc.
    - Deploy control mechanisms for a good operation:
      - Contingency actions.

## Essential tasks, duties and responsibilities (sysadmins team)

- **Hardware support:**
  - Administrators who work with physical hardware (**on-site staff**):
    - Not cloud or hosted systems.
  - Installation and configuration of:
    - Racks, servers, store devices, backup systems (drivers and robots).
    - Networking drivers and devices (routers, switches, computer network devices).
  - Apply patches and update *firmwares*.
  - Deploy control mechanisms for a good operation.
- **Software support:**
  - Installation and configuration of **operating systems**.
  - Installation and configuration of “**cloud**” (**virtualization**) **environments**.
  - Customization (and *tuning*) of systems to particular requirements.
  - Installation and management of **file systems**.
  - Installation and management of **services and user apps**.
  - **Updating** all the software.
  - System **Accounting**.
- **Security support:**
  - Deploy **security polices**.
  - Develop **contingency actions** and well defined protocols.
  - Deploy and use **security control tools**:
    - Physical security, security in networking, premises security (servers and services).
  - Deploy and oversee “**backups**”.
- **Tuning** performance.

## Essential tasks, duties and responsibilities (sysadmins team)

- **Access control:**
  - User/group account provisioning.
  - Define user/group profiles.
  - Help users in their daily tasks:
    - User support.
  - Elaboration of user manuals and tutorials.
- **Incident management (detection and resolution):**
  - By themselves or third party maintenance tools/companies:
    - Hardware, software and services.
- **Documentation management:**
  - About operating systems, services, DC infrastructure, protocols, user manuals, etc.
- **Planning of new equipment purchases**, according to each moment...:
  - Working with vendors.

- **Actually... “fire fighting”:**

- Troubleshooting!!



«...although most of the time they spend their time creating scripts to automate tasks».

Evi Nemeth.



## Good practices

- **Do not improvise:**
  - Everything you are going to do in the system must be **planned** in advance:
    - Always **plan** ahead.
- **Reversible actions:**
  - Every action in our system must be reversible.
  - You must provide “**undo**” procedures.
- **Incremental actions:**
  - You should apply the changes **gradually**, step by step.
- **“First test then do”:**
  - **Test, test and test** before making any changes to the system:
    - Especially if it’s a system running in a *production environment*.
  - **Very useful!!:**
    - **Use lab environments** (develop and test).
    - Virtualization/container environments.



## Good practices

- **Have knowledge about what is going to be done:**
  - Foresee the consequences of your changes (as far as possible).
  - **Get ready** (studying) before any action is taken.
- **Automate tasks:**
  - Backups.
  - Regular monitoring.
  - User account maintenance.
  - Disk space maintenance.
  - **Routine tasks...**
- **Document everything:**
  - Policies, process, changes, **incidents...**
- **Report** (to users) whenever possible:
  - System power off, application of patches and updates, etc.

## Ethical code (by SAGE)

- «We as professional System Administrators do hereby commit ourselves to the **highest standards of ethical and professional conduct**, and agree to be guided by this code of ethics, and encourage every System Administrator to do the same»:
  - Professionalism.
  - Personal integrity.
  - Privacy.
  - Laws and policies.
  - Communication.
  - System integrity.
  - Education.
  - Responsibility to computing community.
  - Social responsibility.
  - Ethical responsibility.

According to **SAGE** (USENIX System Administration Guild)  
[https://www.usenix.org/system/files/lisa/books/usenix\\_22\\_jobs3rd\\_core.pdf](https://www.usenix.org/system/files/lisa/books/usenix_22_jobs3rd_core.pdf)

“Hippocratic oath”

## Knowledge and skill levels (by SAGE)

According to **SAGE** (USENIX System Administration Guild)  
[https://www.usenix.org/system/files/lisa/books/usenix\\_22\\_jobs3rd\\_core.pdf](https://www.usenix.org/system/files/lisa/books/usenix_22_jobs3rd_core.pdf)

- **Novice:**

- Responsibilities and tasks:

- Routine **monitoring and management** tasks.
- “*front-line*” of interface to users:
  - **Accepting trouble reports and dispatching them to appropriate system administrators.**
- Minor incident resolution:
  - **1st level of incident resolution.**
  - **Performing routine tasks under direct supervision.**

- Knowledge and skills:

- Strong interpersonal and communication skills:
  - **Ability to explain simple procedures in writing or verbally; good phone skills.**
- Strong ability **to learn.**
- Familiarity with an operating system and its commands/utilities at a **user level.**
- Ability to identify/locate shared resources and perform simple tasks.

- No professional experience.

## Knowledge and skill levels (by SAGE)

- **Junior:**
  - Responsibilities and tasks:
    - Manages a **small, uniform site** alone or assists in the administration of a larger or more complex site:
      - **100 computers, 100 users (Multiple versions of one operating system).**
    - Works under the general supervision of an advanced system administrator.
    - Most typical incident resolution:
      - **2nd level of incident resolution.**
  - Knowledge and skills:
    - Strong skills in most operating system commands/utilities.
    - Familiarity with the principles and practices of system configuration using modern declarative tools.
    - Familiarity with networked/distributed computing environment concepts:
      - **User account management, backup procedures...**
    - Ability to write scripts in some administrative language:
      - **Shell scripting, perl, python.**
    - **Works well alone or in a team.**
  - Professional experience: up to 3 years.



## Knowledge and skill levels (by SAGE)

- **Advanced:**
  - Responsibilities and tasks:
    - Administers a complex site alone or assists in the administration of a **larger site**:
      - 1000 computers, 1000 users (Multiple versions of one operating system).
    - Helps **to plan for the future of the site/network**.
    - Manages novice system administrators and operators.
    - Evaluates and/or recommends purchases.
  - Knowledge and skills:
    - Strong interpersonal and communication skills.
    - Ability to write purchase justifications.
    - Ability to train users in complex topics.
    - Ability to make presentations to an internal audience.
    - Is comfortable with most aspects of operating system administration and hardware (multiarchitectural).
    - A solid understanding of the operating systems and network services:
      - **Web and e-mail services, information services, distributed storages, virtualization, cloud.**
    - **Independent problem-solving**, self-direction.
  - Professional experience: 3 to 5 years.

## Knowledge and skill levels (by SAGE)

- **Senior:**
  - Responsibilities and tasks:
    - Manages a large and complex site or network:
      - **Designs/implements complex local and wide-area networks of machines.**
    - Establishes/recommends policies on system and service use.
    - Provides **technical lead and/or supervises** system administrators.
    - Has **purchasing authority** and responsibility for purchase justification:
      - **Organizational skills.**
  - Knowledge and skills:
    - Ability to write proposals or papers, act as a vendor liaison, make presentations to customers or clients:
      - **Planning policies and strategies.**
    - Ability to solve problems **quickly** and organize automatic processes.
    - A solid understanding of an **operating system.**
    - A solid understanding of **networking/distributed** computing environment concepts.
  - Professional experience: 5 years and **more and more...**

## Professional regulation and protection

- **In Spain and Europe, our own agencies:**
  - <https://www.cci.es/normas>.
  - <http://ictprofessionalism.eu>.

# Information resources and tools

- When system fails and the admin needs information and help...

### • Procedure:

- Step 1: thoroughly analyze the issue:
  - Run daemons/process in **debug level** (*foreground*).
  - Outputs from console and **system log files**.

- Step 2: first level of information:
  - Have a look at system reference manuals (`$ man`)
  - Run new tests.

- Step 3: second level of information:
  - **Specialized:** (manuals and tutorials):
    - RFCs (Request for Comments documents).
    - Linux Documentation Project (tldp.org).
    - Technical manuals and developer “*howto’s*”.
  - **Generic:** essential books:
    - Bibliography of this course.
    - **O’Reilly** series:
      - » From “Unix in a Nut-shell” to...

- Step 4: third level of information:
  - Massive “*on line*” sources:
    - Google.
    - Blogs and Forums.

«When stuck, Google!!!»  
Apply filters in searches (distributions, versions...).

1	User-level general <a href="#">commands</a> and apps
2	<a href="#">System calls</a> and kernel error codes
3	<a href="#">Library</a> functions and calls
4	Device <a href="#">drivers</a> and network protocols
5	<a href="#">Standard file formats</a> and conventions
6	<a href="#">Games</a> and demonstrations
7	Miscellanea
8	System administration <a href="#">commands</a> and <a href="#">daemons</a>



```
$ man [-options] [command]
-a: display all the manual pages
that match "command", not just the first.
-k: search for the specified string
in all man pages.
<n>: section
```

```
$ man ls
$ man 3 gethostbyname
```

## Information resources and tools

- System administrator *on-line* **bibliography**:
  - Webs about **system administration**:
    - ✓ <http://systemadmin.es/>.
    - ✓ <http://www.linuxfoundation.org/>.
    - ✓ <https://www.usenix.org>.
    - ✓ <http://linux.slahdot.org>.
  - Webs about **computer system security**:
    - ✓ <http://www.securityfocus.com/archive>.
  - Webs about “**data centers**”:  
    - ✓ <http://www.datacentremangement.com/>.
    - ✓ <http://whitepapers.datacenterknowledge.com/>.
    - ✓ <http://www.datacenterjournal.com/category/facilities/>.
  - **Press** and research papers & conferences:
    - ✓ <http://www.admin-magazine.com>.
    - ✓ <http://www.linuxpromagazine.com>.