WHAT IS A DATA CENTER?

Authors and date

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WHERE DOES THE NEED COME FROM?

In computer science, several types of materials (equipment) are mobilized:

- equipment intended to consult resources, compose text, prepare presentations, write electronic messages, for example on social networks. These devices are in our pockets or on our desks. They are usually small and connected to the network. They are occasionally switched on. These devices are called **terminals**.
- at the other end of the network, there is equipment that handles large volumes of data -- images, sound, video, banking information -- that is bulky and noisy and is always on. These devices are called **servers**.

Due to the massive interconnection of computers on the planet and our needs, the exchange of data is increasing around the world.

Although the architecture of the Internet network allows direct exchanges between computers, a very large part of the applications we use, use intermediate servers to function. This is known as a **client architecture (terminals)/server**.

For many years now, the evolution of these architectures has also been called **cloud computing** or **cloud**, which means using servers located outside one's home or business to store data and perform processing. Major global players, such as Google, Amazon, Facebook, Apple, offer digital cloud services.

In fact, the number of servers in the world is increasing considerably. Between 2016 and 2021, the number of resources used in the cloud has tripled, which translates into an increase in the hardware required ("physical" servers). Between 2020 and 2025, the number of physical servers is expected to rise from 11.3 to 13 million in European data centres alone. Finally, according to Ademe, there are 45 million servers in the world.

Given the characteristics of servers (power consumption, need to operate in a rather cold or warm environment, noise), it is necessary to install these servers in specialised premises, the **datacenters**. To illustrate, 10 standard servers (500 watts each) consume as much as a 40m2 flat, in 40 times less space...

Examples of data centers

CHARACTERISTICS OF A DATA CENTER

A data centre is a building with technical and IT areas. In the technical areas you will find:

- air-conditioning units, in various forms, to deal with the heat generated by the IT equipment
- high-powered electrical distribution boards
- batteries associated with inverters to provide power in the event of a power failure of the energy distributor (*sector* failure)
- generators, which are large engines used to produce electrical power
- fire detection and suppression systems
- automatic regulation mechanisms to control the whole system

To ensure high availability of the data centre, this equipment is often deployed in excess to provide redundancy in the event of a failure. For example, if the power of 4 air conditioning units is required to cool the data centre, it is likely that 5 units will be deployed to operate despite the possible failure of one of the first 4 units.

The same is true with a large number of components.

In the IT areas, there will be:

- computer cabinets, specialised furniture for installing computer equipment
- a large number - up to several thousand - of computer servers, storage servers and network equipment
- possibly cold distribution units produced in the technical areas

Apart from the cabinets, this equipment is usually also redundant.

The large commercial data centres occupy areas of several thousand square metres, for example in the Paris region, where many of them are located[4]. The estimated electrical power of these sites can reach 120 MW, the equivalent of 20,000 homes.

Therefore, the location of a data centre must therefore be considered in the light of the capacity of the energy transport networks and the associated infrastructure requirements (road access).

In addition to electricity consumption, these data centres are a **source of noise** for local residents. The noise is related to the technical and IT installations.

ENVIRONMENTAL IMPACTS OF DATACENTERS

ORIGIN OF THE IMPACTS

The environmental impacts of the data center are related to the consumption of the technical and IT equipment installed there.

In 2015, the digital sector accounted for 4% of global greenhouse gas emissions, while aviation accounted for 2.5%[5]. Among these 4%, 25% are related to the datacenter[3].

The electrical consumption of data centers represents about 3% of global consumption. To reduce this consumption consumption, we try to limit the overconsumption linked in particular to the cooling needed by the servers. Indeed, the total electrical consumption (*Pt*) of a datacenter comes from:

- a useful part, corresponding to the consumption of IT equipment (servers, storage and network) (P_*IT*),
- a portion related to cooling, the operation of inverters and inverters and generators. We try to reduce this component, called P_Facilities in the following.

To measure the efficiency of a data center, we often use an indicator called Power Usage Effectiveness (PUE), defined by:

PUE = (P_*IT* + P_*Facilities*) / P_*IT*

This means that the PUE is always greater than 1. The best possible PUE is 1, which means that all the electrical power consumed by the entire data centre is used by the servers. A PUE of 2 means that as much power is consumed by the air conditioning as by the servers. Nowadays, a good PUE is less than 1.5 or even close to 1.2.

However, PUE has its limits, as the power consumed by the servers varies over time. Therefore, in a data centre, increasing the computer power can lower the PUE, without any efforts being made to limit the consumption of technical facilities (Pfacilities).

REDUCE THE ENVIRONMENTAL IMPACT OF DATA CENTERS

A good way to reduce environmental impacts is to reduce the energy consumption of the data centre, both the IT component and the component related to technical installations. For

this, there are a large number of good practices. These best practices are referenced in a document published and maintained by the European Commission, the European Code of Conduct on Energy Efficiency in Datacentres[6]. This document mentions about 200 best practices, ranging from the use of servers to the layout of computer rooms. This document is updated by a college of experts including representatives from the public sector and private industry.

Participating in the code of conduct means having an internal audit carried out by the European Commission, and an annual update of consumption data. The internal audit is very rigorous. Thus, recognition as a *participant* in the code of conduct, for a data centre operator, is a guarantee of quality and consideration of environmental aspects.

One of the main aspects of reducing the environmental impactof data centers is the re-use of heat.

SO MUCH HEAT!

Inevitably, the activity of computer servers generates heat. There are methods of data centre organisation (aisle containment, airflow separation, etc.) to increase the efficiency of heat dissipation from servers. Nevertheless, some of this heat must be expelled from the data centre, into the air or ambient water. This heat contributes to the heating of the data centre environment. Ideally, this heat should be reused for buildings or services near the data centre, through the interconnection of heat networks, to homes or swimming pools. The closer the consumers are to the data centre, the more energy efficient this operation is.

DATA CENTER DEVELOPMENTS

To date, large data centres have been established, with a high concentration of energy and heat generation. However, in order to improve processing times (pre-processing leading to reductions in data volume) by reducing the transit time in the networks, there is a tendency to install smaller data centres (called Edge data centres) scattered over the territory. These datacenters allow pre-processing of data, for example in connection with connected objects or autonomous vehicles. These Edge Datacenters can then be supported by larger datacenters.

The problem of heat recovery remains. Some companies offer computers integrated into radiators that can be deployed at home.

SOURCES

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