

CLOUD VS EDGE PROCESS MANAGEMENT: ADVANTAGES AND DISADVANTAGES OF DIFFERENT IT INFRASTRUCTURE ARCHITECTURES

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Abstract: *The choice of IT infrastructure type has an overwhelming impact on the productivity, innovation and customer experience of a business. Thus, it is essential that organizations invest in the design and implementation of an IT infrastructure that meets current and future needs regardless of the size of the organization. Today's IT infrastructure is very complex including many technical elements ranging from computers, servers, applications, data, network and security equipment to security policies, access levels, data encryption, etc. Cloud infrastructure has the great advantage of being accessible from anywhere, which gives it a big advantage over on-premises infrastructure. The use of virtual systems has simplified the very easy scaling of the architecture and brought great versatility in the use of resources as they allow the same hardware resources to be shared by virtual machines as needed. Knowing the advantages and disadvantages of these types of IT infrastructures is very important for an organization because IT infrastructure has a significant role and impact in all processes of the organization both from a technological and economic point of view.*

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1. Introduction

IT infrastructure in today's digital world is the foundation layer of any small, medium, large and very large organization. Practically, to function properly any type of organization relies on the efficiency of an IT infrastructure for its operations; be it customer management, payments, suppliers, logistics, etc., information flow management relies on an ecosystem of hardware and network equipment all managed by software applications running on this equipment and providing different services to the organization.

The choice of the type of IT infrastructure has an overwhelming impact on the productivity, innovation and customer experience of a business. Thus, it is essential that organizations invest in the design and deployment of an IT infrastructure that meets current and future needs regardless of the size of the organization. Today's IT infrastructure is very complex including many technical elements ranging from computers, servers, applications, data, network and security equipment to security policies, access levels, data encryption, etc.

IT infrastructure is the system of hardware, software, facilities and services that support the delivery of the organization's business processes.

The management of IT infrastructure of an organization can be reduced to the management of the three main components: hardware, software and network. Each of these components has a very important role to play in the whole as shown in Figure 1..

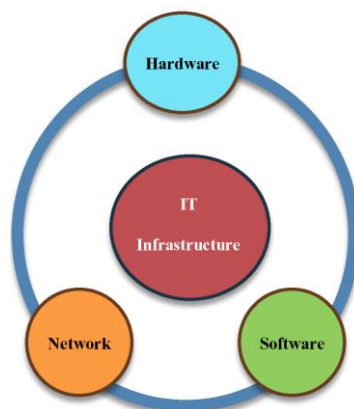


Figure 1. IT infrastructure components

2. Types of IT infrastructure

The IT infrastructure is currently divided into 3 main categories, depending on where the computation takes place and implicitly the response to the information request (Figure 2). Thus, the most important types of hardware infrastructure are:

- On-premises (traditional) infrastructure – This type of IT infrastructure is preferred by large and very large organisations or organisations that have a legislative requirement that data must not go to the cloud or to locations that cannot be controlled. These organisations can afford the up-front costs of purchasing the hardware and software as well as the human resources to manage the IT infrastructure, while also maintaining the systems.
- Edge infrastructure – Edge infrastructure is used to manage decentralised systems where response time is critical and you cannot send data to a central server to process the data and then transmit the response, as the time taken to transmit/receive the data would make the response arrive too late.

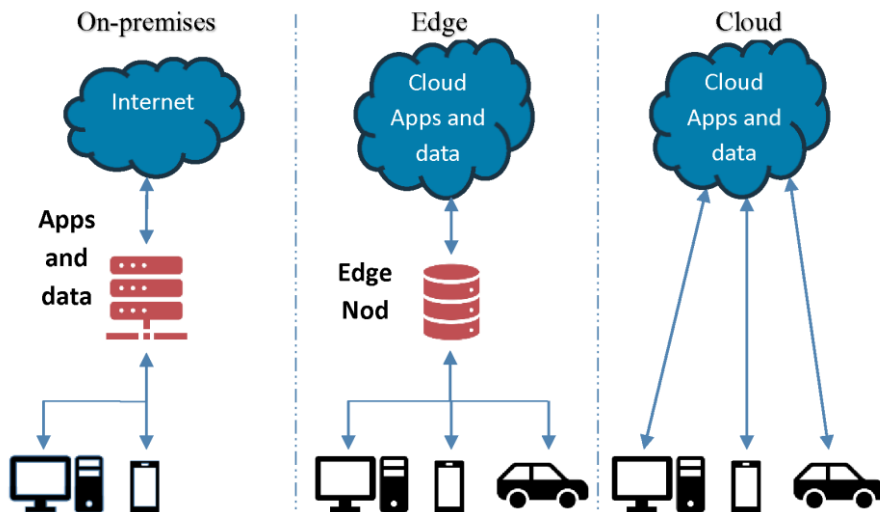


Figure 2. Types of IT Infrastructure

- Cloud infrastructure – This type of infrastructure is preferred by organisations as they have no upfront costs to purchase, no need for maintenance staff and using this type of infrastructure they pay as and what they use. Cloud infrastructure management has the great advantage of being accessible from anywhere, which gives it a great advantage over on-premises infrastructure.

Each type of infrastructure has advantages and disadvantages depending on the specifics of each organization, its needs, etc. In practice we often find a mix between the 3 types of architectures. Technological development over the last decade and the advent of virtualization has led to the emergence of cloud systems. The use of virtual systems in the on-premises infrastructure of an organization will allow it to own a private cloud with all the benefits and technological advantages brought by cloud technologies. In this case, the organization is in charge of maintenance and development but the advantages of the technology are very high: automated backup/restore procedures, short installation, setup and deployment times, standardization and easy integration with all systems, very good security and resilience, automation, etc.

The use of virtual systems has simplified the very easy scaling of the architecture and brought great versatility in the use of resources because they allow virtual machines to share the same hardware resources as needed. For example, if at a certain time of the month, in order to solve a task faster (generating customer invoices, calculating salaries, etc.), several machines are needed to solve this task, they can be created and started on the virtual systems, and after the task is solved, they can be stopped and the respective hardware resources reallocated to other machines. This is done very easily and fully automated using virtual systems. A group of systems that aim to accomplish a specific task form a cluster, and its role is to take over and process a request as quickly as possible so that response time is minimised, often having a direct impact on the user experience. Clustering and virtualization enable optimal resource management, facilitating the rapid addition of hardware resources that serve users optimally so that the user experience does not suffer.

3. Edge IT infrastructure

The basic idea of Edge infrastructures is that it moves some of the cloud infrastructure components from a central location (data centre), distributed across multiple local locations close to where the information is generated and used (Figure 3) to minimize response time. Edge infrastructure management requires providing a very good communication path between edge devices and edge nodes with low latency, for fast information processing and to be able to respond in the shortest possible time so that the user experience is not interrupted or blocked, and the cloud part remains only for analysis and reporting. The main components of the Edge architecture are:

- Edge equipment;
- Edge processing nodes;
- Cloud layer;
- Communications infrastructure.

All this is distributed and deployed at the edge of the network as close to the source as possible, linked via the communications infrastructure to the main data centre or the cloud where the data is gathered for analysis, reporting and optimisation.

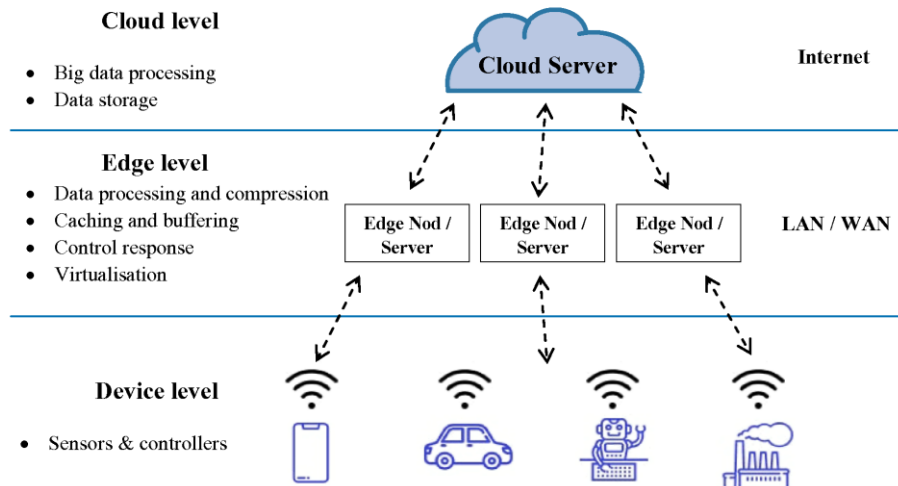


Figure 3. Edge architecture

4. On-Cloud IT Infrastructure

In cloud infrastructure the user does not own the hardware equipment or the software applications that manage the hardware equipment, the user who is also the customer has to focus on deploying business applications. As his business grows or needs more resources a cloud infrastructure user will need to rent more cloud resources/components. *Cloud computing has brought the idea of utility computing. Cloud computing provides IT (information technology) services on demand. Cloud computing reshaped the ways in which IT infrastructures and services were used by companies. Today, companies do not need to invest large capital in IT infrastructure and human resources to take care of it; instead, they can get IT services using cloud computing.* (H. J. Syed, 2018)

The user of the cloud infrastructure does not need to own servers, storage equipment, virtualization equipment or other computing resources as they will use them from the cloud. The user needs computing equipment – computers, tablets, phones through which he will access the cloud services and of course networking equipment through which he connects to the cloud via the internet. Cloud infrastructure is of several types: public cloud, private cloud, hybrid cloud and multi-cloud. The main differences between private cloud and public cloud are ownership and accessibility, another important difference is related to security. In public cloud any person can access the information because it is exposed through the internet. In the case of the private cloud, it is operated by an organization that has compound control over it, most of the time the private cloud is located in the organization's private data centres. Hybrid cloud which has a hybrid architecture of public cloud combined with private cloud most of the time combines the advantages of the two hardware infrastructures.

Cloud Edge technology is great a way to manage data in a distributed computing architecture. The main advantages of this architecture are low latency and very good response times because the data is processed close to the source where it is produced, and only the data analysis part of the data goes to the cloud.

At the core of this edge technology are actually a set of devices (edge nodes) connected to the cloud. These devices process data in real time and send to the cloud only the data needed for the analysis and post-processing or reporting part – Figure 4. By filtering out essential data, it does not bottleneck communications to the central node over the network, it lowers data traffic costs.

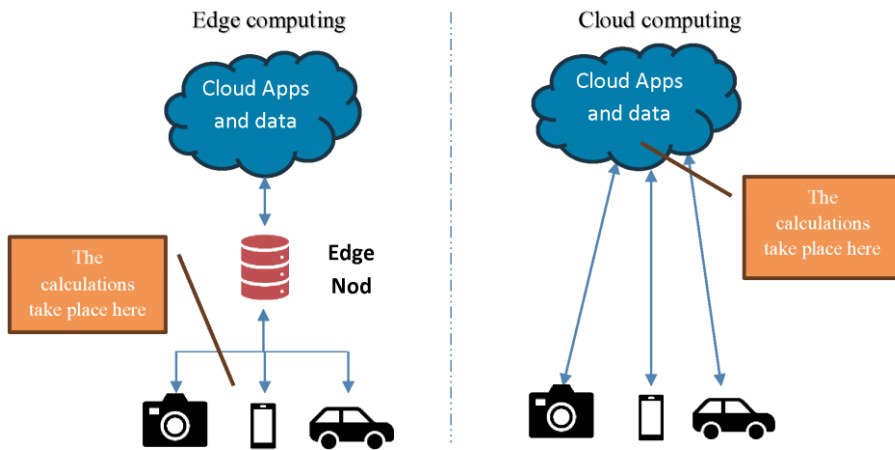


Figure 4. The difference between Edge Computing and Cloud Computing

5. Advantages and disadvantages of Edge IT infrastructure

There are several advantages of cloud edge technology such as data can be analysed and processed in real time even when bandwidth is lower or connectivity is reduced. Data that is transmitted to the cloud is filtered as close to the source as possible.

The distributed computing architecture makes it very easy for organizations to develop and deploy new technologies or new services, which simplifies adoption, improves performance and provides a much better user experience. The ability to help develop new services gives cloud edge technology an undeniable advantage.

By combining cloud and edge technologies, organizations can increase their data processing and analytics capabilities, providing a great user experience for users who benefit from these technologies that have low latency on the communication side and offer fast response time due to optimized data processing.

Cloud-edge technology is the integration of cloud computing resources with edge computing devices. Providing cloud services on the other hand is the provision of services based on an infrastructure of computing equipment such as servers, storage systems, networking and software applications such as operating systems, various applications, databases, etc. with access from anywhere via the internet at no upfront cost to organizations.

Organizations that use both edge and cloud technologies have the advantage of the scalability and flexibility of the cloud and the benefits provided by the distributed architecture of the edge infrastructure, low latency and high performance of edge technology. Thus we have the rapid data processing and real-time decision making capabilities and the large data transfer capacity of edge networks as well as the data processing and post-processing provided by the cloud for easy storage and access, analysis and reporting.

Cloud-edge technology enables organizations to benefit from the accessibility and scalability of the cloud while providing a powerful data processing resource with a distributed edge architecture that uses a low latency, making it ideal for widespread use in IoT, autonomous vehicles or 5G networks. Cloud edge technology enables the management of a large number of devices being preferred when it comes to IoT, smart devices or automation.

Some disadvantages of Edge technology are:

- Complexity – Edge distributed systems are much more complex and difficult to manage than systems using a centralised cloud architecture. An Edge architecture is made up of components from different vendors communicating through different interfaces and is much more difficult to manage than single vendor platforms that are centrally managed.

- Security – IoT equipment transmits a lot of seemingly trivial information such as temperature, humidity, status of different devices, etc. These devices often do not have strong security measures in place so they quickly become easy targets for attackers and can introduce security breaches for users.
- Less robust infrastructure – distributed centres do not have all the resilient power or communications infrastructure in place so that in the event of a power outage or communications disruption these centers are sometimes unavailable.

6. Advantages and disadvantages of cloud infrastructure

When using cloud-based IT infrastructure, the organization does not own the hardware or software applications to manage the hardware, the user, who is also the customer, must focus on implementing business applications. As the business grows or needs more resources, the organization that uses the cloud infrastructure has to manage more data included, rent more machines and therefore has to manage more cloud resources.

The main advantages of using cloud-based IT infrastructure are primarily the low upfront costs of both hardware, software and human resources. In a public cloud, all hardware, software and other supporting infrastructure is owned and managed by the cloud provider.

- Security – By using both private and public clouds, organisations can better protect their data while benefiting from the scalability and cost savings associated with public clouds. Having multiple levels of security provides increased data protection for organizations using private and public clouds, and the ability to create backups in the public cloud provides added data security.
- High availability – Availability of data, applications and services is a necessity for any organization. Cloud systems offer high availability by reducing downtime due to outages or possible local disasters. The availability of applications and services can also be ensured by using

cloud services from multiple providers so that the risk of simultaneous outages is minimized.

- Flexibility – Cloud-based IT infrastructure offers much greater flexibility over computing resources. Computing resources can be easily added on an as-needed basis and when they are no longer in use they can be reduced or adjusted so that organizations that occasionally have a greater need for resources can quickly and easily add them and then, after the computing processes are completed, they can be removed without incurring additional costs.
- Lower operating costs – By using the cloud, organizations eliminate the initial need to purchase hardware and software licenses, as well as specialized personnel to ensure maintenance. At the same time, over time it is no longer necessary to purchase new hardware to keep up with technological progress, most of the time cloud service providers make available the new resources which significantly reduces operating costs.
- Improved performance – By managing all resources from one place, the cloud offers much better performance compared to systems distributed in different locations that must be managed very well in order to work without interruptions so as not to block the organization's processes. The management of computing resources from a safe place ensures fast and efficient data access for applications and eliminates interruptions or other problems related to the unavailability of communications in certain areas.
- Greater control – Organisations also have greater control over their data when using a private cloud as all resources are hosted on their own servers. This ensures legal requirements in many cases and also provides total control over the data and over those who have access to the data.
- Access to new technologies – By using a public cloud system, organizations can rapidly deploy new applications and services with minimal effort and expense. As I stated above, cloud technology providers integrate new technologies much faster, being thus much faster available for use without additional investments on the part of organizations.

- Scalability – Organizations can adapt quickly as needed, if they need additional resources, they can be added quickly without the purchase of hardware infrastructure or software applications. Thus, organizations can focus on business growth without having to channel their effort on hardware and software resources.

Disadvantages of the cloud:

- Data access control – When the data is stored in the public cloud, it can be exposed to cyber attacks, being thus more vulnerable. Cloud service providers do not have a control over the people who access their services, so malicious people can gain access to sensitive data of the organization if it is not properly protected. To reduce this risk, organizations must use the most secure authentication methods and ensure that stored data and communications are encrypted.
- Compliance – Ensuring compliance with data protection legislative requirements can be a limitation to using the public cloud. This can be solved by using a private cloud most of the time, but organizations need to ensure that these legislative requirements are met, such as the protection of personal data such as GDPR legislation. Failure to comply with these legislative requirements can result in additional penalties and costs for organizations.
- Vendor lock-in – By using the services of a single cloud service provider an organization can become dependent on its technology platform and become captive in the long term with direct impact on costs and services. In the long term this can affect the organization's ability to change public cloud service provider due to the high costs generated by the changes required to switch from one provider to another and the associated costs.

7. Conclusions

Choosing the type of IT infrastructure an organisation has powerful implications for its business, the management of which makes the difference between a successful business or one that cannot meet modern challenges. There is currently no recipe for choosing the type of

IT infrastructure for large organisations. Cloud service providers promote their IaaS, PaaS and SaaS products which have as their main advantages 24/7 access to their online platforms, access from anywhere via an internet connection with no upfront costs of purchasing hardware equipment and the software applications running on it, with only the cost of using it. The expansion of IoT has been meteoric in recent times and the need for connectivity and control means that Edge technologies are being widely utilised. The main objectives of IT infrastructure management be it Edge or on-cloud remain to ensure seamless IT operations, security and optimal utilization of technology resources.

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