Edge of Things: The Big Picture on the Integration of Edge, IoT and Cloud in a Distributed Computed Enviroment

Pablo Acereda
Computer Science Degree

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Abstract

As the usage of wireless networks and the Internet of Things (IoT) raise in popularity, that involves the risk of latency and traffic in the network. With the objective of the suppression of those obstacles the Edge Computing (EC) paradigm has been developed. With its integration the processing is carried in the edge of the network devices. EC is to increase the response time in the applications that previously used the cloud. The scope of this article is to prove the efficiency and resourcefulness of EC. As an addendum, the EC paradigm is compared with the rest of Cloud Computing Systems.

Keywords: IoT, cloud computing, edge computing, fog computing, multi-cloud.

1 Introduction

The Edge Computing (EC) new paradigm has incredible performing capabilities, providing to most of the fields it is applied to a great improve in performance. As mentioned in the article [4], the demmand for network and IoT connected devices will increase at a great rate [1] , as will its economic impact [2] .

One of the advantages EC provides is the data processing before it is sent the connection to the cloud takes place. That has a positive effect on the network overhead, as well as in the security and privacy.

This new paradigm can be connected to many types of networks (MANETs, VANETs 1 or ITSs).

The original authors of the article [4] claim that EC cannot completely replace the cloud computing paradigm, as some applications still need the support from the cloud or centrilized server. Furthermore, EC has problems on its own, as there are part within its basis which need to be reconfigured or redesigned.

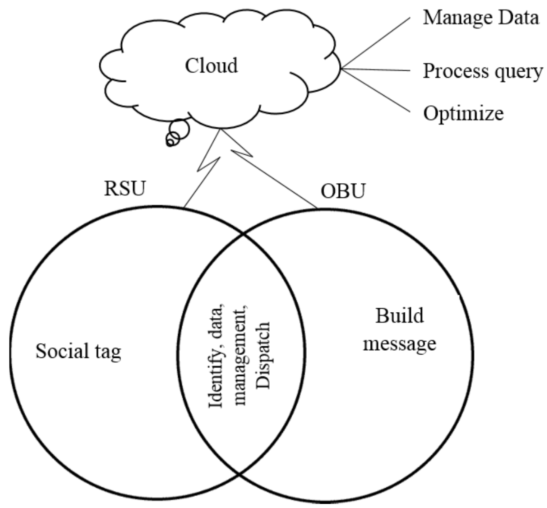

Figure 1: EC in VANETs

2 Overview of edge computing

The demand on IoT services has been increasing for the past years and the Cloud services cannot handle such a demand of that many users. It is therefore a revolutionary idea to push the computing of the data to the edge of the network.

2.1 Challenges Facing EC

Some of the challenges faced when designing the EC architecture are introduced in the following section [4].

- Device preferences must be chosen depending on the network requirements. Thus, to manage resources is a key point in the EC devices plan development.
- How devices fit within the network is a priority, not to overload their workload and drain their battery.
- In order not to waste the resources power, a schedule must be set to divide task among the edge (end-systems) and the cloud.
- The lack of a protocol to standarize communication among devices helps to reduce communication overhead (QoS).
- Connection shall be other key challenge in EC management. All the devices with high mobility experience desconnections or delayed communication.

- The edge of the network makes information more vulnerable to attacks. Therefore, the EC system shall implement a security system to handle such intrusions/attacks.

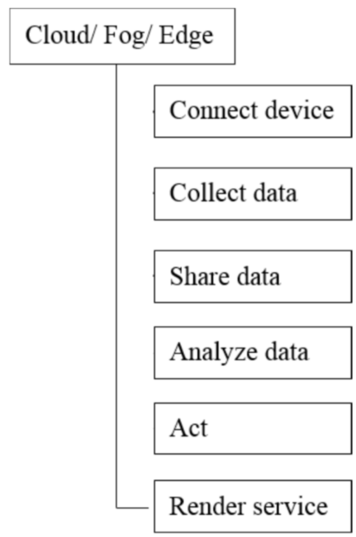

Figure 2: EC topographues

3 An Overview of Computing Architecture

Having EC provide a better quality-of-experience (QoE), the outcome of these systems shall be compared to other architectures in order to prove its better performance (comparison with fog computing (FC), cloud computing (CC) and multi-cloud computing (MCC)).

One of the aspects to take into account with EC is its multi-device compatibility, as the end devices filter information (not sending to the centralized server). Just as EC, FC pushed data treatment to the data source, but in this case it is not the end device, but the Local Area Network (LAN). FC is also used for IoT and real-time applications.

Other technology is the CC architecture, where the computations occurs in a centralized server. The problem with this approach is the high latency and the heavy bandwidth usage between the server and the end devices (first and second layer respectively). As the server has to process huge quantities of data they suffer from processing delay. In a similar way, MCC distributes servers. Therefore, it has the same problems as CC, along with complexity and portability issues.

Compared to EC, the presented paradigm counts with greater scalability and availability, as well as low latency and packet delay or jitter. On the other hand, as the computing power is pushed to the edge, the end devices set the bottleneck of the architecture. [4]

3.1 Research View on EC

In academic and research backgrounds the EC algorithm has been used for its numerous advantages, such as for example Augmente Reality (AR) processing [5]. It has also been used for smart-cities applications [3] to prevent terrorist threats, natural calamities, etc [4].

After all these projects, a necessity came forward: the securitation of EC urges. As the end nodes of the paradigm are directly the devices, where data is treated firsthand, leads to potential insecurities.

3.2 Service Benefits of EC

The usage of the end nodes as edge servers brings a mitigation on the stress bore by the network; increases performance for real time applications; also reduces costs in the architecture, as the server does not need to be so high-speced as in a, p.e., CC paradigm; among other advantages.

3.3 Computing vs Storage Service of EC/FC/The Cloud/MCC

The next section is better summarized in the following table 1.

	Edge Computing	Fog Computing	Cloud Computing	Multi Computing
Computing Service	Response time in milliseconds	Response time in seconds to minutes based on the application	Response time in minutes	Response time in minutes
Storage Service	Temporary storage, does not support huge data collections	Data can be stored for hours up to days	Permanent storage, supports huge data collections	Permanent storage, supports huge data collections and data protection

Table 1: Comparative analysis on computing services and storage services.

3.4 Computing in Heterogeneous Distributed Networks

The past decade CC and MCC paradigms have been used as computing schemes, but the exponential growth of the demands on the services produce an increase of the network load, added to the already heavy traffic (due to the centralization of servers), and the distance between end devices and server; new paradigms have evolved for smart applications: EC or FC.

This paradigms allow to reduce data transfer (filterin and processing of data). Thus, the avoidance of accidents and congestion in transportation is achieved.

3.5 Privacy and Security Issues Relating to EC

The architecture followed by EC also includes vulnerability problems, as the data is treated at the edge of the network. EC needs a realiable system by which edge server and end nodes can authenticate each other.

But, as data is so exposed, and specialiced (coming from end device), it also shall be protected.

4 Integration of IoT with Edges

Nowaday, billions of IoT devices are constatly working (and expected to increase in numbers), interconected, communicating, etc. To this devices, the CC paradigms are quite obsolete, not being able to respond to those requests. With this objective, EC is much more efficient as data transsion, processing and storage is carried out by the end devices.

5 Related Work

The list of researches carried out with the use if IoT and EC is growing larger by the day. For instance, Ali and Simeone developed a energy-efficient resource allocation scheme for AR (Mobile EC); Amjad created a resour allocation framework for IoT applications based on EC; Beraldi developed a cooperative load balancing scheme (CooLoad) to reduce executation delay [4]. And many other examples that do not need to even be mentioned in this article.

6 Future Developments on EC

IoT is extending, and it is being incorporated everywhere, threfore, a EC scheme has to be able to process and communicate properly. Thus, it will need to incorporate most of the specifications here discussed (offloading model; upgrade in resource allocation; and effective scheduling algorithm).

7 Conclusion

It is true that Cloud Computing has experienced an increase in its current usage over the past years, but saying its influence is over would be extremely foolish of the reader. A more accurate representation of the future technological landscape would be one where Edge Computing starts being the most used paradigm for IoT application sees a considerable increase while Cloud Computing is still in use. Let's keep in mind, the fact that EC and FC have changed how data should be treated for IoT, reducing the need of powerful resources, it has experienced a deep rooting process since its inception. Explained in layman's terms, EC might be good, but CC isn't out of the game yet.

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