Cloud, Fog, and Edge Computing paradigms have been introduced for data-driven organizations in order to facilitate data computation and processing in an easier manner. Considering that there has been a huge increase in the amount of data produced over the past couple of years, and it is expected that the amount of data produced will exponentially grow, recent research has focused on utilizing these paradigms in order to satisfy the growing demand of fast computation and data storage. In order to recognize the most suitable use for these models, this descriptive paper evaluates the differences in architecture and non-functional requirements associated with the three models and based on that, real-life applications are categorized based on suitability to the paradigms.

Cloud computing is an advancing paradigm in software development where it allows data and programs to be removed from PCs and organizations’ server rooms and installed into the compute cloud. In another sense, it refers to the general geographical shift of computation. Although cloud computing has many advantages and efficient uses, its centralized nature has proven to be inefficient for latency-sensitive applications in terms of transferring and processing the data. Due to the growing amount of data being produced every second, slow transmission rates are expected due to heavy traffic considering that processing occurs in the cloud.

To address these limitations, Fog Computing, allows for local processing of data by extending the traditional cloud computing architecture to the edge of the network. Reducing the degree of involvement of the cloud by bringing the processing units closer to the end-devices allows fog computing to improve the utilization of the computation power, task execution time, and processing time. The model can be divided into three major layers: cloud, fog, and terminal. The cloud layer, referred to as the cloud stratum, represents the data centers and servers with high storage and computation powers that manage, operate and process the data received from the fog layer. The fog layer is composed of multiple fog nodes, also referred to as fog cells, where each includes a set of network devices with sufficient processing and temporary storage capabilities. The fog nodes receive requests from the IoT or end-user devices and are responsible for recognizing their processing needs to decide whether it should be processed locally, or sent to the cloud. Following that, the terminal layer, also referred to as the device layer, consists of two domains: the IoT devices and the end user devices, where either is sufficient to complete the Fog Paradigm. These devices are responsible for sensing and collecting data from the physical world and sending the data to the fog layer.

Although fog computing is considered to be a huge improvement from cloud computing for real-time applications, its performance is still limited in terms of latency and bandwidth and its dependency on the cloud can still be considered a drawback. In an effort to maximize these resources and improve performance, Edge Computing was introduced. Edge computing is a novel computing model that places computing resources and storage at the edge of the network closer to the end user. It provides intelligent services by collaborating with cloud computing. Hence, edge computing can be described as a more localized version of fog and cloud computing. In edge computing, devices act as both data consumers and data producers. Besides collecting data from the existing database in the cloud and sending them to the user, nodes at the network edge perform many computing tasks including data caching, IoT management, computer offloading and privacy protection. Moreover, a distinct benefit of this paradigm is its distributed architecture which is why edge computing is driving the research of the Internet of Everything (IoE). One main reason edge computing is more capable to meet the requirements of IoE as it has a lower chance of data leaks since communication is closer to the users.

The comparative analysis was conducted based on non-functional requirements associated with each paradigm. The requirements are scalability, interoperability, mobility, heteroginity, geographical distribution, location awareness, performance, and QoS management. The analysis shows that besides scalability and interoperability, which are equally supported by all three paradigms, the remaining requirements gain increasing support as we go from cloud computing to fog computing and finally to edge computing. Location awareness appears more relevant in fog based models because as end-devices require sensing and locating abilities in order to make the decision of where the data needs to be processed. Also, this would facilitate preprocessing, filtering and caching at different

locations which also assists in reducing latency.

Considering that cloud, fog and edge computing are built on one another and each is developed in order to overcome some of the limitations faced in the preceding paradigm, there are some similarities in their properties. This made it challenging to clearly classify applications on more specific terms as overlap can occur. So rather than categorizing applications on a more specific terms, they are grouped into three based on their nature of data consumption. Real-time applications, where data is collected, analyzed and processed on a continual basis. It requires information that’s available for use immediately after being generated. Near-real-time applications, where the required data is a snapshot of historical data, so processing and analysis are based on situational information collected in the recent past rather than as it is now. Lastly, non-real-time applications, where data needed for the service is retrieved from databases and where the recency of the data collections doesn’t affect the quality of service provided.

Based on the comparisons, Cloud computing is well suited for non-real-time applications such as mobile commerce and learning since they do not require mobility, localization or real-time response, thus, the cloud resources can be fully utilized in these applications with less cost. On the other hand, Fog and Edge computing were found to be best suited for near-real time such as smart cities and smart grids, and real-time applications such as video-related uses, gaming and healthcare, respectively.