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A Comprehensive Method on Fog Computing using Internet-of-Things

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Abstract*: *The Internet of Things (IoT) characterizes a significant transformation of the way in which our today's world is expected to interact. IoT is an emerging technology connecting the users towards number of things namely smart phones, smart TV, smart electronic goods like Air Conditioners, and etc. and many smart things. These things involves many processes that has large data, which can be transformed in our daily life .Moreover, it should be analyzed in real-time. These devices collects data and upon processing these data grows exponentially. The Cloud computing provides a space to store the data and it takes long time to deliver to the users. The responses in real time requires very fast access. The Fog Computing accomplishes the solution in getting the greater response especially in the field of Internet of Things. The Fog computing using IoT can be used to sense the environment and work for the requirements. For example connected cars analyzes the surroundings which improves the vehicle maintenance. The fog computing has components like smart devices, sensors and more. Further, Fog computing is the extension of Cloud Computing and it facilitates the applications that uses the cloud computing. This paper presents the methods of fog computing that meets the requirements of IoT that can be used in real-time applications.

Keywords*: *Connected Cars, Heterogeneity, Internet-of-Things, Interoperability, Real-time analytics, Smart Grids.

I. INTRODUCTION

Nowadays it could be observed that the fastest growth from the past ten years that the traditional technologies, software models are moving to the Internet, also focusing to attain stable trust over the Internet. Basically, cloud computing could be a kind of outsourcing of programs, the users are able to access software and applications from anywhere at any time. Actually, the third party writes computer programs, and then it is hosted to store within the cloud. This implies that users do not bother about storage, power; simply they may joyously perceive the end-results what they expect.

1.1 Life at the earlier stage of cloud computing

At the earlier stage cloud computing business always has complexities and more expensive. Hardware and software requirements to run these process was overwhelming. To install, configure, test and run these process knowledgeable professionals was required and quite tough to maintain.

1.2 Cloud Computing: A better approach

The client of cloud computing avoids the bottleneck moment in storing their data. The reason behind was that in the client side hardware and software was not maintained and it was the responsibility of vendors. The client merely obtains their requirements, automated upgrades, scaling up or down and this was very simple. Cloud-based apps [1] will provide these resources and runs in days or weeks and which offers with less cost. In cloud-based application, the step in working was so simple. At first open the browser, login, customize the app, and start working on it.

The applications that are supported by cloud help to run the business process successfully. This cloud technology facilitates the applications like CRM, HR, accounting, payment, logistics and more. In the current scenario many companies' uses cloud for their software needs. The cloud processing has some demerits like security, privacy, reliability, legal issues, migration from legacy systems, business continuity, and disaster recovery.

The IoT [3] has many ideas are innovative and that improves the quality of life. It generates unexpected amount of data that are difficult to process in traditional methods. Even cloud, and edge computing are unable to handle these data, Fog computing is designed is such way that can handle large amount of data.

Fog computing is designed to handle architectures of computing. Storage, control and networking. It not only works on mobile but also in the wire line services. It can work on the hardware, software and network on the data plane like cloud and control pane. This architecture includes Internet-of-Things, Fifth-Generation wireless systems, and embedded artificial intelligence. Fog computing [4] reshapes the industries like End-user experience providers, Network Operators, Network equipment vendors, cloud service providers, system integrators and like.

In the today's environment mobile internet and computing applications plays the major role in our life. Fog computing [5] is the combined resources of cloud and mobile computing. Fog server has three-dimensions as three-tier services. These dimensions are storage, computing and communications. The computing services can provides solution to the network management, big data. In the near future fog computing envisions the life of the human.

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II. NEED FOR FOG COMPUTING

Brandon Butler defines the Fog Computing as the extension of cloud computing to the network edge, which was best suited for the internet of things and other real time applications. This has the decentralized form of structure and the resources like data and applications were placed in logical locations between data source and the cloud.

The main goal of Fog computing was to facilitate efficiency [2] and reduce amount of data that are transported to the cloud processing, analysis and storage. That is to provide the basic analytic services for the network edge, improving performance by positioning computing resources closer to the needs. This reduces the distance that the data transported on the network and this increases the network strength and performance. Fog computing can be deployed as it has the ability to measure the segment bandwidth and can further firewalls be introduced to the network for better security. The various characteristics of Fog are Geographical distribution, mobility, Real time interactions, Heterogeneity and Interoperability.

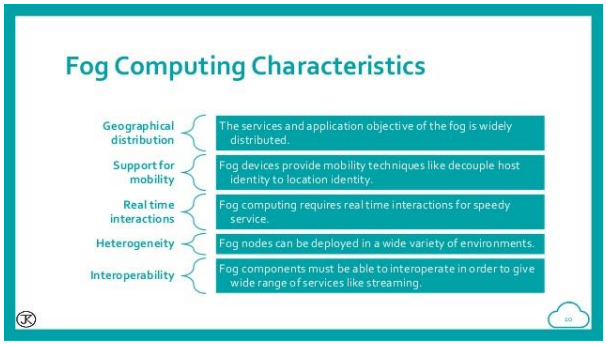

Fig. 1 Characteristics of FOG computing

III. COMPONENTS OF FOG COMPUTING

Fog computing is the extension of cloud computing in such a way that to own information, store data and applicable on the remote server. The client in the cloud can get the services like service, maintenance and upgrades from the service providers, which can be accessed anywhere.

The Fog computing aims to improve the efficiency and reduce the amount of data needed. In Fig 2, a layer called Fog Layer is added as a middle layer that connects the mobile, IoT and vehicle control systems, which makes the provision to access the data in the cloud.

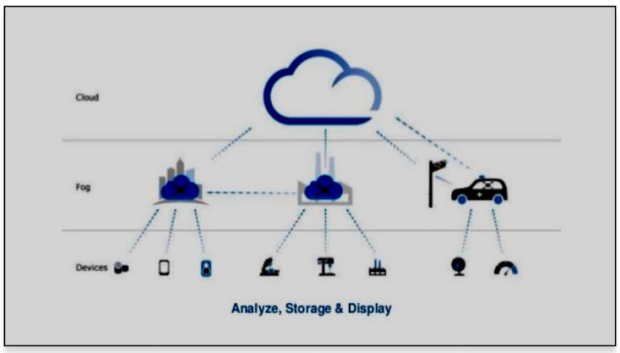

Fig 2: FOG Networking

According to Brain Wheeler, "Fog Computing" was the combination of "Edge Networks" and "Analytics". It means that, Fog computing addresses data resources and cloud services to the end-users in terms of providing infrastructure, tools and applications. It deals with searching the location of availability, and analyzing the services at data centers for the immediate retrieval of end devices. Demanding increase in responsive time in the cloud, all local centers are searched in a nearby location, connected with necessary end-devices in fog network. So that it can serve the required resources for immediate needs without any delay.

Hence, the number of research has entered towards IoT is integrated with Cloud computing to connect numerous smart devices, sensor nodes, IoT devices via global networks. The IoT model is depicted in Fig.3 extends from the data source to the data center in the cloud. The fog layer is the analytics-driven decision making layer. Actually, fog computing consists of all the data, tools and essential resources that resides in the cloud. In the cloud larger data set is analyzed with quick turnaround analytics tool becomes the foundation for the fog layer. Fog depicts clear visual view of cloud affords with up to date supports and services.

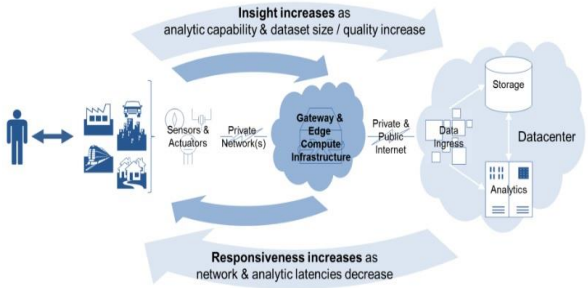

Fig 3: Significance of Fog Layer

IV. APPLICATIONS OF FOG COMPUTING

A. Connected Cars

The connected cars can operate independently with the capability of analyzing the data like surroundings, driving conditions and directions. In case of getting other information like improving the vehicle maintenance, this requirement would sent to the manufacturer to track the status of the vehicle. Fog computing would lead in getting the suitable information.

B. Smart grids and smart cities

Like connected cars, utility systems are increasingly using real-time data to more efficiently run systems. Sometimes this knowledge is in remote areas, so processing close to where it's created is essential. Other times the information must be mass from an oversized range of sensors. Fog computing architectures can be devised to give a solution to each of those problems.

C. Real-time analytics

Fog computing deployments can help to facilitate the data transfer between the creation and need of data.

V. RESULT AND DISCUSSION

Table 1 recites the significant of Fog over Cloud computing whereas the latency, server nodes existence, security issues are directed towards the better solutions in Fog-network.

Table 1 Cloud and Fog Computing comparisons

Issues	Cloud Computing	Fog Computing
Latency	High	Low
Components	Scalable storage and computing power	Limited storage and computing power
Server nodes	Within the Internet	At the edge of the local network
Security issues	Defined	Hard to define
Deployment	Centralized	Distributed
Location awareness	No	Yes

In Table 2, IoT addressed the issues like latency, bandwidth, service availability, maximum resources utilization, security which increases responsive time among the number of connected IoT devices. Those issues are analyzed and proposed in Fog computing.

Table 2 Fog Provisions for IoT issues

IoT Challenge	Fog Provisions
Latency	Fog computing is involved in creating the low-latency network for the devices and its endpoints.
Network bandwidth	The data can be traversed to the other end without any additional bandwidth.
Resource-constrained devices	Provide the basic analytic services for the network edge, improving performance by positioning computing resources closer to the needs.
Routine services	Cloud and fog computing offer end users data, storage, computation and application services, fog computing is in much closer proximity to end users and better supports mobility
Security Issues in IoT	Fog server has three-dimensions as three-tier services. Fog computing can be deployed as it has the ability to measure the segment bandwidth and can further firewalls be introduced to the network for better security

From Table 1 and 2, Fog Computing is prominent research area to discuss the issues arisen from cloud and IoT related services.

VI. CONCLUSION

In the current scenario mobile or wireless networks cannot meet the tomorrow data sources and its operations. The data travelling in the dropped, bottlenecked network are common. A deputed effort have to be taken to ensure the tools to be open accessed in the upgraded network structure. Fog computing is involved in creating the low-latency network for the devices and its endpoints. This further reduces the amount of bandwidth required in the cloud. The data can be traversed to the other end without any additional bandwidth. With the Fog computing decision making and action-taking can be done with IoT techniques. Though, cloud and fog computing offer end users data, storage, computation and application services, fog computing is in much closer proximity to end users and better supports mobility. Consequently, fog computing will not replace cloud computing altogether; it is a supplement to the cloud. The applications like the connected cars operate independently with the capability of analyzing the data. These systems uses the real time data to facilitate the users.

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