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Integration of IoT and Fog: Need of the Hour

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ABSTRACT

With the advancement in electronics & communication industry internet becomes part of our life. In this scenario it is required to connect each & every device using internet which gives the concept of "Internet of Things". It is a novel paradigm which is based on artificial intelligence and enhances the concept of Machine to Machine interaction. As millions of devices are connected together so there is a need of a platform that is used to handle the processing of dozens of data generated by these connected devices. Cloud remote centers are not suitable for this purpose because it takes a lot of time to transfer a large amount of data to cloud centers which increases the processing time. On the other hand cloud is not suitable for applications that need low delay. To solve this problem extension of cloud "Fog Computing" is used. In this paper we focus our attention on the integration of Fog and IoT. Many works in literature have surveyed Fog and IoT separately: their main properties, features, underlying technologies, and open issues. But these works lack a detailed analysis of the Fog and IoT paradigm. We start analyzing and discussing the need for integrating them, application areas that are benefitted from this integration the challenges deriving from such integration, and implementation of this integrated environment in the field.

Keywords**: **Fog, IoT, Smart device

1. INTRODUCTION

With the advancements in the Electronics and Telecommunication technology developments there are billions of devices connected to the Internet now a days. All the major sectors of society use Information and Communication Technology for fulfilling even routine tasks. Therefore, there is the need for a new paradigm which enables M2M communication. This paradigm is known by the term IoT.

Internet of Things (IoT) refers is a platform that integrates a large number of smart objects with the Internet in order to keep a continuous interaction in physical and the cyber worlds. The IoT enable these smart devices to communicate without human intervention and generate integrated data. This integrated data is of heterogeneous nature and requires intelligence for further processing. This processing is done using intelligent algorithms in Internet of Things environment. In order to handle large number of smart objects IoT uses a huge therefore needed high computational capabilities and storage systems. To meet these demands, IoT platforms must have low latency, high degree of mobility and real time data analysis with decision making abilities.

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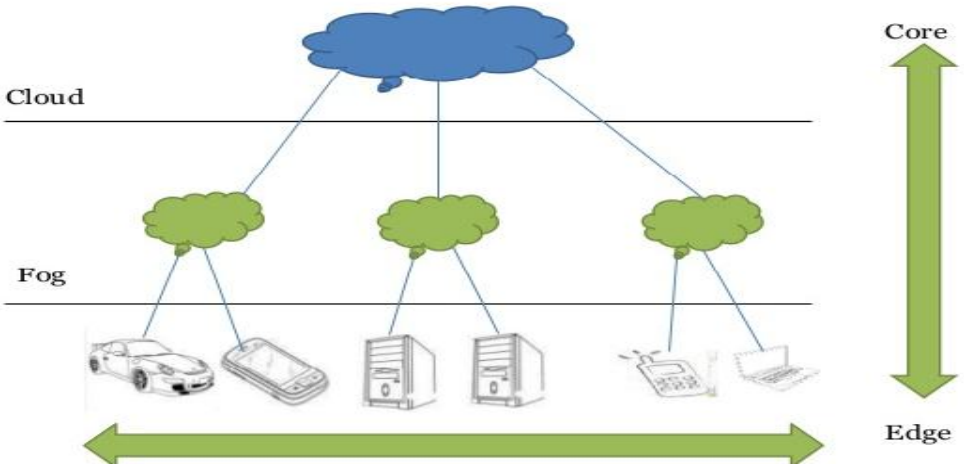
2. CLOUD & IoT

The Cloud can offer an effective solution to implement IoT service management and composition as well as applications that exploit the things or the data produced by them. On the other hand, the Cloud can benefit from IoT by extending its scope to deal with real world things in a more distributed and dynamic manner, and for delivering new services in a large number of real life scenarios [6].But the integration of cloud and IoT is unable to fulfill the demands of applications requiring low latency, high mobility and real time analysis.

3. FOG COMPUTING

Fog computing is an extension of cloud and suitable for applications needed low latency and real time analysis. It has distributed computing infrastructure that possess basic features of cloud computing along with some advanced ones. In Fog computing, services can be hosted at end devices such as set-top-boxes or access points. The infrastructure of this new distributed computing allows applications to run as close as possible to sensed actionable and massive data, coming out of people, processes and thing [1]. Fog and cloud uses same building blocks Compute, storage, and networking resources and share many of the same technologies (virtualization, multi-tenancy). The Fog vision was conceived to address applications and services that do not fit well the paradigm of the Cloud [4]. The goal of fogging is to improve efficiency and reduce the amount of data that needs to be transported to the cloud for data processing, analysis and storage. In Fog computing some application services are handled at the network edge in a smart device and some application services are handled in a remote data center in the cloud. Fog computing offers an attractive mixture of computational power, storage capability, and networking facilities at the edge of the networks.

Cloud Fog Architecture



4. ADVANTAGES OF FOG

1. Fog server uses IPv6 protocol to handle a large number of smart objects.
2. Fog server reduces latency to few milliseconds.
3. Use of GPS enables Fog server to use location based context while computing and providing required results for the applications.

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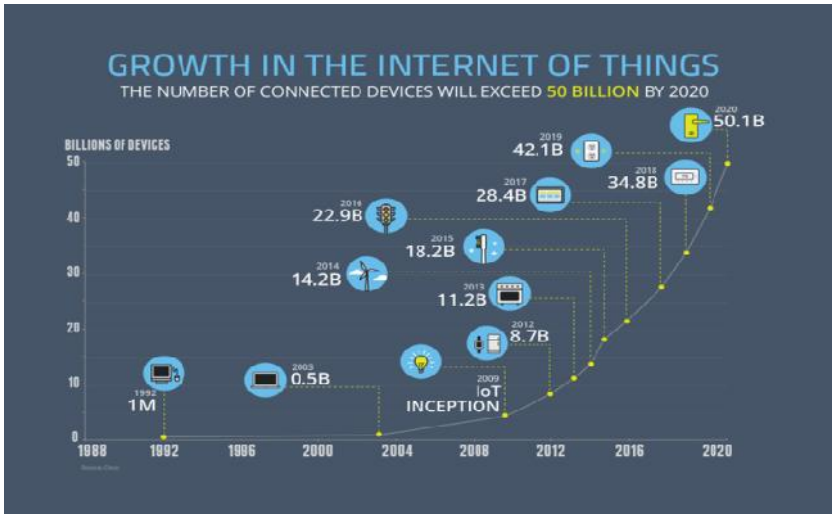
5. CLOUD V/S FOG

Requirements	Cloud Computing	Fog Computing
Latency	High	Low
Delay Jitter	High	Very low
Location of Service	Within the Internet	At the edge of the local network
Distance between client and server	Multiple hops	One hope
Security	Undefined	Can be defined
Attack on data enroute	High probability	Very low probability
Location awareness	No	Yes
Geo-distribution	Centralized	Distributed
No. of server nodes	Few	Very large
Support for Mobility	Limited	Supported
Real time interactions	Supported	Supported
Type of last mile connectivity	Leased Line	Wireless

6. NEED FOR INTEGRATION OF IoT & FOG:

As the number of devices connected to the internet is increasing day by day, it becomes difficult to handle data generated by these devices. The following figure shows the number of connected devices by 2020 will become 50 billion.



In order to tackle a great amount of data and make performance better “fog computing” has been introduced as a bridge between IoT devices in the field and cloud data centers. As IoT platform is a collection of smart sensors and there is a need to handle huge amount of data generated by these sensors. It is not possible to transmit all the data to the cloud for processing because it requires a huge bandwidth. In order to cater these needs the integration of IoT & Fog is required. With fog computing, some of the processing load can be handled by computing resources at the edge, by filtering and summarizing the data to reduce volume and increase value and relevance.

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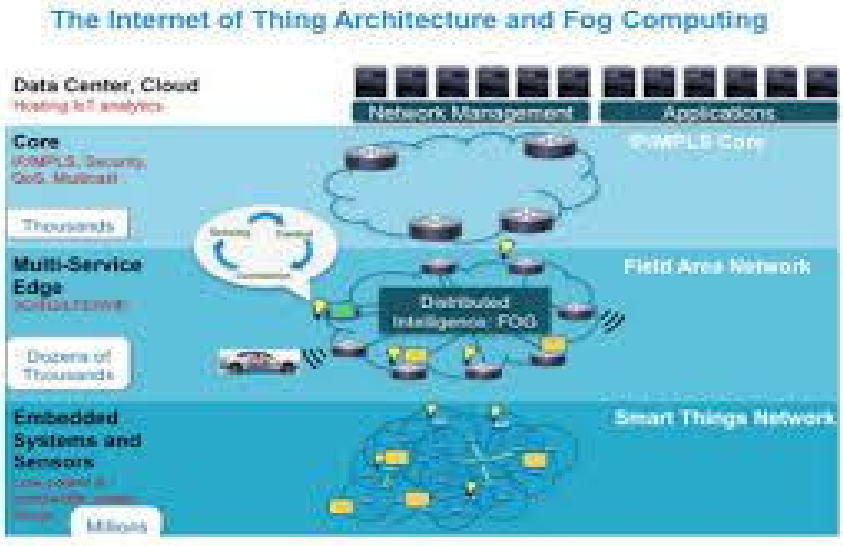


Fog computing benefits the business in the following ways:

● **Greater business agility**: Fog fulfills the needs of business or machine manufacturers by providing right tools for developing fog applications as per the needs of the customers.

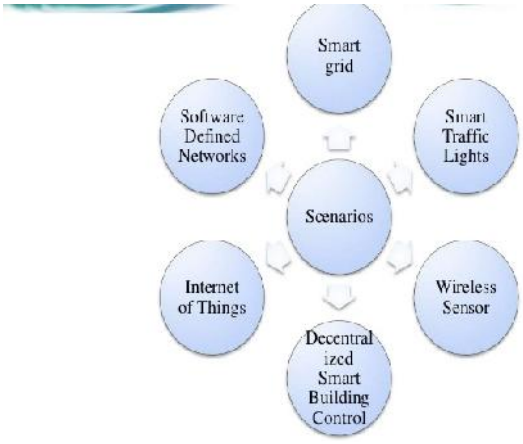
● **Better security**: Protect your fog nodes using the same policy, controls, and procedures you use in other parts of your IT environment. Use the same physical security and cyber security solutions.

● **Better privacy control**: In Fog almost all the processing is performed at the edge of the network, so it is easy to monitor and control the devices used to collect and analyze data.

● **Low operating cost**: Fog helps in decreasing operational expenses by processing selected data locally

7. ROLE OF FOG IN IoT:

Fog computing plays vital role in Internet of Things (IoT).



7.1 Vehicular Connectivity

Fog is ideal for connected vehicles because real time interactions will make communications between cars, access points & traffic lights more efficient. The Connected Vehicle deployment displays a rich scenario of connectivity and interactions: cars to cars, cars to access points (Wi-Fi, 3G, LTE, roadside units [RSUs], smart

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traffic lights), and access points to access points [3].The smart tra c light node interacts with the other sensor nodes and gather information about other approaching vehicles and pass on this information prevent accidents.

7.2 Smart grids

Fog computing allows fast, M2M and human to machine interaction, which makes Smart Grid a more effective technology. Based on energy demand, obtainability and the low price, these devices repeatedly switch to substitute energies like solar and winds.

7.3 Smart cities

Fog helps in creating smart city environment by connecting all the smart technology systems to improve the quality of life. Fog nodes gather sensor data available on different levels & integrate all the mutually independent entities with in the network.

7.4 Wireless Sensor and Actuator Networks (WSAN)

The Wireless Sensor Nodes (WSNs), were designed to operate at low power, uses less bandwidth, less energy, very low processing power, trivial memory motes, operating as sources of a sink (collector), in a unidirectional fashion. The characteristics of the Fog (proximity and location awareness, geo-distribution, hierarchical organization) make it the suitable platform to support both energy-constrained WSNs and WSANs.

7.5 Decentralized Smart Building Control

The applications of this development are enabled by wireless sensors positioned to measure temperature, humidity, or various levels of gases in the building atmosphere. In this case, information can be exchanged among all sensors in a floor, and their analyses can be combined to form unfailing measurements.

7.6 IoT and Cyber-Physical Systems (CPSs)

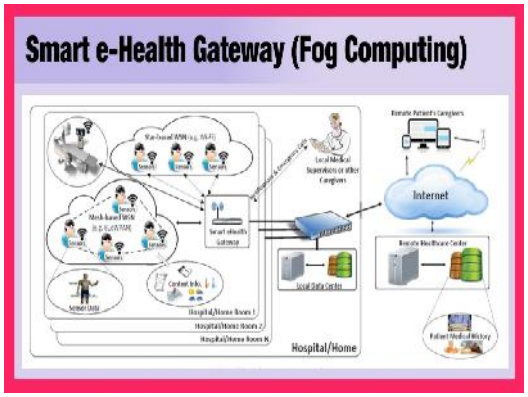
Fog computing based systems are becoming an important class of IoT and CPSs. Based on the traditional information carriers including Internet and telecommunication network, IoT is a network that can interconnect ordinary physical objects with identified addresses [2].

7.7 Software Defined Networks (SDN)

SDN concept along with Fogging will determine the main problems in vehicular networks, irregular connectivity, collisions and high packet loss, by supplementing vehicle-to-vehicle with vehicle-to-infrastructure communications and unified control.

7.8 Smart Health Care

Smart healthcare plays a significant role in healthcare applications through embedding sensors and actuators in patients and their medicine for monitoring and tracking purposes [7].Fog helps in taking responsibility for handling some burdens of the sensor network and a remote healthcare center by establishing a Smart e-Health Gateway which provides fast and efficient services in medicinal environment.



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8. IMPLEMENTATION:

Integration of Fog & IoT brings out a lot of benefits as compared to previous technologies. In order to prove the applicability of this new integration it is required to implement this approach on some sampled data. We have collected the data of 20 schools from P.S.E.B database to track out the basic efficiency of this integrated environment in comparison to cloud which is currently used by this organization. Initially we gathered the data from the database and apply queries to find the results of performance and processing speed from cloud centers without using smart gateways. To make sure that the network condition does not affect the performance, we conducted this implementation for four weeks during different times of the days. The results are shown in the table

Measures	Results
Efficiency	Low
Processing Speed	Moderate
Latency	High
Security	Low
Mobility	Yes

Next, we implemented the same data with smart gateways to bring out the deviations between both approaches. The data files are used to evaluate the communication of those IoTs which have heterogeneous types of sensors and multiple IoTs' data is collectively sent to fog nodes for processing. The following table shows the results after implementing integrated technology

Measures	Results
Efficiency	High
Processing Speed	High
Latency	Low
Security	Low
Mobility	Yes

After analyzing the results of both the tables we can say that implementation with Fog gives all the previously mentioned benefits along with better performance and quick results.

CONCLUSION:

With the growing needs of internet new development technologies came into existence. This paper discusses major drawbacks of cloud computing which gives rise to extension of cloud that is Fog Computing in which most of the processing is done at the edge of the network. According to the changing scenarios of IT industry there is also a need to integrate this new concept with internet of things in order to handle huge amount of data generated by internet. This paper also throws light on the application areas where this integrated platform can be used to achieve better communication in smart devices and increase performance by decreasing burden from cloud.

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