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FOG Computing and Its Real Time Applications

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***Abstract*-- Fog Computing is a technology that extends cloud computing and services to the edge of the network. It provides data, compute, storage and application services to the users like cloud.From kitchen equipment to aeroplane, started getting an IP address which has also been a part of internet. According to analyst their will 50 – 75 billion internet connected devices within five years. In the future all the computing data will be under the cloud. The data will be processed and sent back to the end device. Since there will be tsunami of data, cloud computing will have great hindrance like low service quality. To overcome the same, CISCO introduces a new technology called fog computing. The different characteristics of fog are low latency and location awareness, wide-spread geographical distribution, mobility, very large number of nodes, predominant role of wireless access, strong presence of streaming and real time applications and heterogeneity.**

***Keywords*— Fog Computing, Cloud Computing, Internet of Things.**

I. INTRODUCTION

Fog computing is an emerging technology that is basically used for Internet of Things .Fog computing fetches data and services from network centre to the network edge. Similar to Cloud, data, compute, storage, application services are given to the end-users by the fog. Fog computing is a distributed computing model that fetches centralized located data storage, processing and application and given to the network edge device(set top box, access point). Fog computing is a technique that is locally hosted where the user uses the service. To be simplified fog computing is a model that provides IOT data processing, storage instead of sending to cloud it is locally processed in smart devices. Both Cloud and fog structure are for compute, storage and networking resources.

In fog computing data collected by sensors are not sent to cloud server instead it is sent to devices like network edge or set top box, routers, access point for processing thus by reducing the traffic due to low bandwidth. Fog computing improves the Quality of service and also reduces latency.

Small computing works are locally processed and responses are sent back to the end users without the use of cloud.

So, fog computing is emerging as a better option than cloud computing for smaller computing works. Fog computing plays an important role by reducing the traffic of data to the cloud. Since fog system is placed near to the data sources computation and communication are not delayed.

CISCO gives us the example of jet engine. Whenever the jet engine is connected to the internet, half an hour running time of the jet engine creates 10 TB of data. This huge data itself will create a big traffic in the bandwidth which cannot be neglected. So comes the importance of fog computing. Fog computing is complementary to cloud. Certain features of fog computing differentiate it from cloud, Fog Computing is used for real time interactions but cannot totally replace cloud computing as it is preferred for high end batch processing. As the name suggests cloud system is placed at a distant where as the fog system is placed locally near to the end user.

II. IOX ARCHITECTURE

The idea behind transmitting data to network edge is the concept of fog computing and this has been made possible by CISCO iox platform. Open source software Linux and CISCO ios network operating system are combined to form the architecture of iox. There will be two Operating System for communication and computation in Cisco routers. The Communication and computing requirement for Internet of Things has been provided by a single platform called iox. Linux transforms routers to mini-computer by which we can run third party application.

The Cisco iox allows users to host their OS and application in its open and extensible environment. Thus we can develop our own smart application to capitalise on the power of fog computing. The Iox platform provides an SDK and middleware services by which we can host our application, interface and analyze data locally in real time. It has the capability to support and deploy users business logic in the network device nearby to the one next data for immediate action. It consumes lesser time by connecting your application with any protocol, device or interface. Iox platform analyze data in real time.

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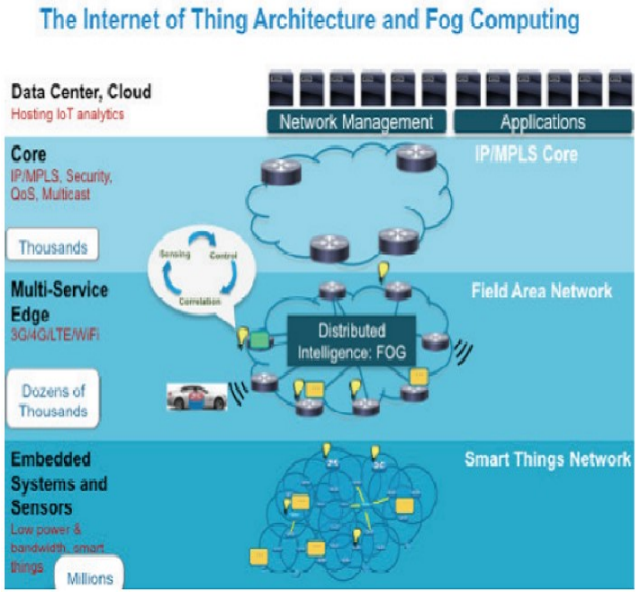

Figure 1 : Internet of Things and Fog Computing [6]

III. Characteristics Of Fog Computing

The different characteristics of fog computing are

1 Edge location, location awareness, and low latency **:** Fog computing support endpoints with finest services at the edge of the network

2 *Geographical distribution* **:** The services and application objective of the fog is widely distributed for example fog will play an important role in delivering high quality streaming to connected vehicles through proxies and access points positioned nearby.

3 *Support for mobility* **:** Using LISP protocol fog devices provide mobility techniques like decouple host identity to location identity.

4 *Real time interactions* : fog computing requires real time interactions for speedy service.

5 *heterogeneity* : Fog nodes can be deployed in a wide variety of environments

6 *Interoperability* : Fog components must be able to interoperate in order to give wide range of services like streaming.

7 *Support for on-line diagnostic and interplay with the Cloud* : The Fog is sited to play a vital role in the intake and processing of the data close to the source.

IV. Application Areas Of Fog Computing

According to CISCO the important areas where fog computing would play a vital role are the following

Connected car: Autonomous vehicle is the new trend taking place on the road. Tesla is working on software to add automatic steering, enabling literal "hands free" operations of the vehicle. Starting out with testing and releasing self-parking features that don't require a person behind the wheel. Within 2017 all new cars on the road will have the capability to connect to cars nearby and internet. Fog computing will be the best option for all internet connected vehicles why because fog computing gives real time interaction. Cars, access point and traffic lights will be able to interact with each other and so it makes safe for all. At some point in time, the connected car will start saving lives by reducing automobile accidents.

Smart Grids: Smart grid is another application where fog computing is been used. Based on demand for energy, its obtainability and low cost, these smart devices can switch to other energies like solar and winds. The edge process the data collected by fog collectors and generate control command to the actuators. The filtered data are consumed locally and the balance to the higher tiers for visualization, real-time reports and transactional analytics. Fog supports semi-permanent storage at the highest tier and momentary storage at the lowest tier.

Smart Traffic lights: Fog enables traffic signals to open lanes on sensing flashing lights of the ambulance. It detects presence of pedestrian and bikers, and measures the distance and speed of the close by vehicles. Sensor lighting turns on, on indentifying movements and vice-versa. Smart lights serves as fog devices synchronize to send warning signals to the approaching vehicles. The interactions between vehicle and access points are enhanced with WiFi, 3G, road side units and smart traffic lights.

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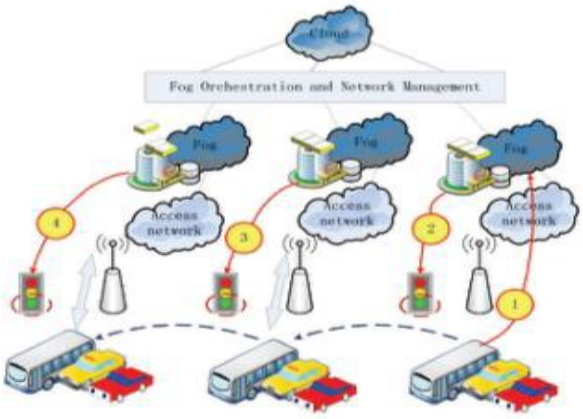

Figure 2.Fog computing in smart traffic lights and connected vehicles [4]

Self Maintaining Train: Another application of fog computing is self maintaining trains. A train ball-bearing monitoring sensor will sense the changes in the temperature level and any disorder will automatically alert the train operator and make maintenance according to. Thus we can avoid major disasters.

Wireless Sensor and Actuator Networks (WSAN) : The real Wireless Sensor Nodes (WSNs), were designed to extend battery life by operating at predominantly low power . Actuators serves as Fog devices which control the measurement process itself, the consistency and the oscillatory behaviors by creating a closed-loop system. For example, in the lifesaving air vents sensors on vents monitor air conditions flowing in and out of mines and automatically change air-flow if conditions become dangerous to miners. Most of these WSNs entail less bandwidth, less energy, very low processing power, operating as a sink in a unidirectional fashion.

Decentralized Smart Building Control : In decentralized smart building control wireless sensors are installed to measure temperature, humidity, or levels of various gaseous components in the building atmosphere. Thus information can be exchanged among all sensors in the floor and the reading can be combined to form reliable measurements. Using distributed decision making the fog devices react to data. The system gears up to work together to lower the temperature, input fresh air and output moisture from the air or increase humidity. Sensors respond to the movements by switching on or off the lights. Observance of the outlook the fog computing are applied for smart buildings which can maintain basic needs of conserving external and internal energy.

IoT and Cyber-Physical Systems (CPSs): Fog computing has a major role in IoT and CPSs. IoT is a network that can interconnect ordinary physical objects with identified address using internet and telecommunication. The characteristic of CPSs is the combination of system's computational and physical elements. The association of CPSs and IoT will transform the world with computer-based control and communication systems, engineered systems and physical reality. Fog computing is built on the concept of embedded system in which software programs and computers embedded. Examples are connected vehicles, medical devices etc. The object is to integrate the concept and precision of software and networking with the vibrant and uncertain environment. With the growing cyber physical systems we will be able to develop intelligent medical devices, smart buildings, agricultural and robotic systems.

Software Defined Networks (SDN): SDN is a growing computing and networking concept. SDN concept together with fog computing will resolve the main issues in vehicular networks irregular connectivity, collisions and high packet loss rate.SDN supports vehicle to-vehicle with vehicle-to-infrastructure communications and main control. It splits control and communication layer ,control is done by central server and server decides the communication path for nodes.

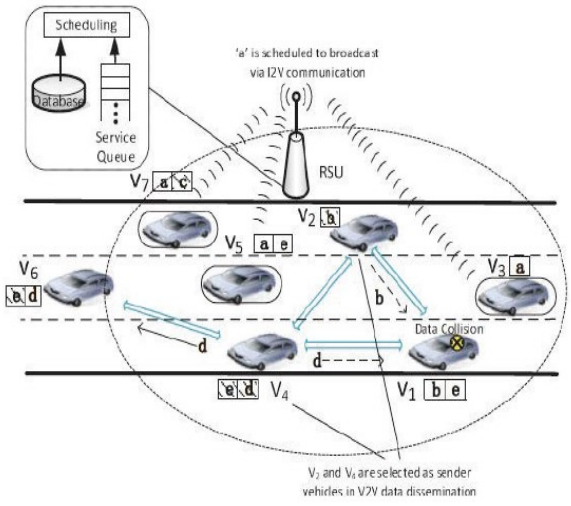

Figure 3. Fog computing in SDN in vehicular networks [12]

Health Care : The cloud computing market for health care is estimated to reach $5.4 billion by 2017, according to a Markets and Markets report and fogging would allow this on a more confined level[11].

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Mobile computing system:. Fog computing organize highly virtualized computing and communication facilities for mobile users. Fog computing explores the predictable service demand patterns of mobile users and typically provides desirable localized services accordingly. With low-latency and short-distance local connections Fog computing can provide mobile users with the demanded services. This significantly improves the service quality provided to mobile users and, it save bandwidth cost and energy consumptions. Fog computing enable the convergence of cloud based Internet and the mobile computing.

V. Conclusions And Future Scope

In this paper, we have analyzed Fog Computing and its real time applications .Fog computing has the ability to handle the data tsunami created by Internet of Things. The characteristics of fog computing like mobility, proximity to end-users, low latency, location awareness, heterogeneity and due to its real-time applications fog computing platform is considered as the appropriate platform for Internet of Things. From the above analysis, it can be seen that fog computing is entering an exciting time, where it can positively affect operational costs. Fog computing resolves problems related to congestion and latncy.Fog computing also provides an intelligent platform to manage the distributed and real-time nature of emerging IoT infrastructures. Developing these services at the edge through fog computing will lead to new business models and opportunities for network operators.

By using the concepts of fog computing, if the same device can be used for these kind of processing, data generated can be put to immediate use and deliver a much better user experience. Thus fog computing will play a big role in Internet of things applications.

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