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Study on Fog Computing

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Abstract: *Fog computing is a paradigm that expands cloud computing and services to the edge of the network. Similar to cloud Fog computing implement data, compute, storage, and relevance services to end users. In this paper elaborate the advantages of Fog computing and analyze its relevance's of real scenarios, such as smart traffic lights in vehicular networks, smart grid etc. Security and privacy issues are further impart according to current Fog computing paradigm. As example a typical barrage, man-in-middle barrage in Fog computing.*

Keywords: *Fog computing, Internet of things, Cloud computing, Smart streetlights, Latency*.

I. Introduction

CISCO delivered the vision of fog computing to enable relevance's on linked devices, Also known as edge computing or fogging, already linked in Internet of Things (IoT), to run directly at the network edge. Internet of Things (IoT) is the merging of connecting people, things, data and processes is to mold our life, business and everything in between. The term Fog computing is also termed as edge computing , which essentially means that somewhat than hosting and working from a centralized cloud, Fog systems operate on network ends. That concentration referred that data can be processed locally in smart devices rather than being sent to the Cloud for processing. It's one access to dealing with the Internet of Things (IoT). Fog computing places a few of transactions and resources at the edge of the Cloud, rather than establishing channels for Cloud storage and utilization, it lessen the need for Band width by not sending every bit forepart bygone Cloud channels, and instead aggregating it at certain connection points. By using this kind of distributed scheme, we can lower costs and improve efficiencies. In Fog computing, services can be hosted at end devices such as set-top-boxes or connection points. Both Cloud and Fog provide data, estimation, storage and relevance services to end users. Fog can be distinguished from cloud by proximately to end users, the dense geographical distribution and its support for portability. As Figure 1 Each smart thing is linked to one of Fog devices. Fog devices could be linked and each of them is linked to the Cloud.

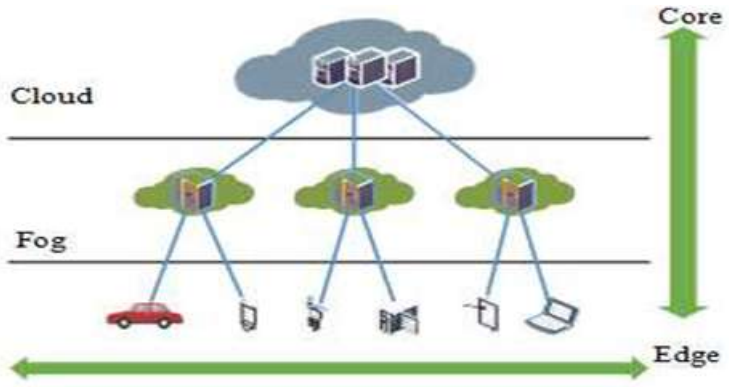

Figure 1: Fog between edge and cloud

II. Internet Of Things

Internet of Things (IoT) is the intelligent environment that allows mutual communication between users and things and things and things by connecting all things through wired or wireless networks, based on Internet Communication Technology (ICT). In other words, the IoT makes things that are working under different operation systems, network environment and hardware environment interoperable through the Internet. Figure 2 shows the concept of IoT.

Figure 2 *Concept of the Internet of Things*.

Internet of Things at the top of its list of best popular technologies. The IoT can be classified into three major areas: device area, network (wired and wireless) area and service interface (platform and application) area. The device area transfers data collected or drawn from a certain object to other objects, using the built-in communication functions of an object. The network area is a wired or a wireless path for data transmitted between users and things or things and things. The service interface area processes data to create information and control and manage the various devices.

III. When To Consider Fog Computing?

- Data is collected at the extreme edge: vehicles, ships, factory floors, roadways, railways, etc.
- Thousands or millions of things across a large geographic area are generating data.
- It is necessary to analyze and act on the data in less than a second.

IV. How Does Fog Work?

Developers either port or write IoT applications for fog nodes at the network edge. The fog nodes closest to the network edge ingest the data from IoT devices. Then—and this is crucial—the fog IoT application directs different types of data to the optimal place for analysis.

- The most time-sensitive data is analyzed on the fog node closest to the things generating the data. In a Cisco Smart Grid distribution network, for example, the most time-sensitive requirement is to verify that protection and control loops are operating properly. Therefore, thefog nodes closest to the grid sensors can look for signs of problems and then prevent them by sending control commands to actuators.
- Data that can wait seconds or minutes for action is passed along to an aggregation node for analysis and action. In the Smart Grid example, each substation might have its own aggregation node that reports the operational status of each downstream feeder and lateral.
- Data that is less time sensitive is sent to the cloud for historical analysis, big data analytics, and long-term storage (see sidebar). For example, each of thousands or hundreds of thousands of fog nodes might send periodic summaries of grid data to the cloud for historical analysis and storage.

V. Why Iot Needs Fog Computing?

1. Time: Real time processing and cyber physical system control. Edge data analytics as well as the actions it enables through control loops, often have stringent time requirement and can only be carried out on the edge, "here and now." This is particularly essential for internet: the visionof millisecond reaction time on networks that enable virtual-reality-type interfaces between humans and devices.

2. Cognition: Awareness of Client-centric objectives. Following the end-to-end principle, some of the applications can be best enabled by knowing the requirements of the clients. This is especially true when

privacy and reliability cannot be trusted in the Cloud, or when security is enhanced by shortening the extent over which communication is carried out.

3. Efficiency: Pooling of local resources. There are typically hundreds of gigabytes sitting idle on tablets, laptops and set-top boxes in a household every evening, or across a table in a conference room, or among the passengers of a public transit system. Similarly, idle processing power, sensing ability and wireless connectivity within the edge may be pooled within a Fog network.

4. Agility: Rapid innovation and affordable scaling. It is usually much faster and cheaper to experiment with client and edge devices. Rather than waiting for vendors of large boxes inside the network to adopt an innovation, in the Fog world a small team may take advantages of smart phone API and SDK, proliferation of mobile apps, and offer a networking service through its own API.

VI. Architecture Of Fog Computing

Edge computing is a concept that contrasts with cloud computing. Cloud computing is a way to communicate directly with a central data center, whereas edge computing communicates primarily with the so-called "edge data center," which is located near the device, and leaves secondary work to the central cloud. In other words, edge computing is a computing topology concept. Fog computing seems to be a way to handle where data is generated from where it is stored. Edge computing is simply to be processed near the point where the data was generated. Fog computing includes not only its edge processing but also the network connections necessary to import that data from the edge to the endpoint". Fog computing refers to the network connections between edge devices and the cloud. Therefore, fog computing includes edge computing as well as networks that are required to send processed data to the final destination. In other word, it is a standard that defines how edge computing should work. It creates a rapid control loop, using a fog computing model1, because data is processed at the device.

The structure of fog computing is shown in following figure 3

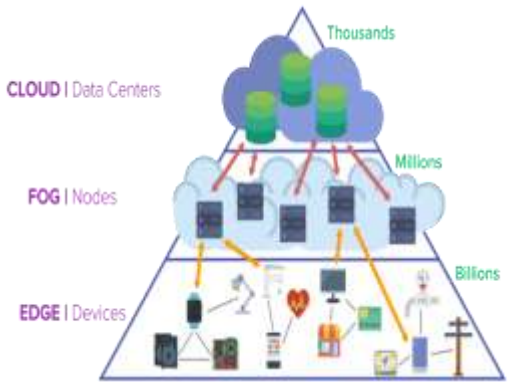

Figure 3: *The Structure of Fog Computing*

Fog computing is a virtual platform that provides processing, saving and networking service between a device and a cloud computing data center. However, it is not exclusively located at the edge of network. Processing, saving and networking resources are building blocks of cloudand fog. The cloud layer, which is the core of fog computing, performs data virtualization, analysis, machine learning, and updates rules and patterns in the fog layer's proxies. The proxy server serves as a simpler cloud server. Concentrated data storage provides creditability and easy access to data by computing resources in a cloud. A data storage that is located at the center of the fog computing structure can be accessed by both device layer and fog layer.

VII. Benefits Of Fog Computing

Extending the cloud closer to the things that generate and act on data benefits the business in the following ways:

● **Greater business agility:** With the right tools, developers can quickly develop fog applications and deploy them where needed. Fog applications program the machine to operate in the way each customer needs.

● **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.

● **Deeper insights, with privacy control:** Analyze sensitive data locally instead of sending it to the cloud for analysis. Your IT team can monitor and control the devices that collect, analyze, and store data.

● **Lower operating expense**: Conserve network bandwidth by processing selected data locally instead of sending it to the cloud for analysis.

VIII. Application Of Fog Computing

Smart Traffic Lights: Video camera that senses an ambulance flashing lights can automatically change street lights to open lanes for the vehicle to pass through traffic. Smart street lights interact locally with sensors and detect presence of pedestrian and bikers, and measure the distance and speed of approaching vehicles. Intelligent lighting turns on once a sensor identifies movement and switches off as traffic passes. Neighboring smart lights serving as Fog devices coordinate to create green traffic wave and send warning signals to approaching vehicles. Wireless access points like Wi-Fi, 3G, road-side units and smart traffic lights are deployed along the roads. Vehicle-to-Vehicle, vehicle to access points, and access points to access points interactions enrich the application of Fog computing.

Connected car: Autonomous vehicle is the new trend taking place on the road. A software is used 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. 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.

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.

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.

IX. Security And Privacy In Fog Computing

There are security solutions for Cloud computing. Yet they may not suit for Fog computing because Fog devices work at the edge of networks. The working atmosphere of Fog devices will face with many threats which do not exist in well managed Cloud.

Man-in-the-Middle Barrage

Man-in-the-Middle barrage has potential to become a typical barrage in Fog computing. In this barrage, gateways serving as Fog devices may be settled or replaced by fake ones. The connection between 3G and WLAN needs a gateway to translate the data of different protocols into the suitable formats. Therefore, all the communication data will firstly appear at the gateway and then be forwarded to other receivers.

X. Conclusion

Fog computing gives the cloud a companion to handle the two Exabyte's of data generated daily from the Internet of Things. Processing data closer to where it is produced and needed solves the challenges of exploding data volume, variety, and velocity. Fog computing accelerates awareness and response to events by eliminating a round trip to the cloud for analysis. It avoids the need for costly bandwidth additions by offloading gigabytes of network traffic from the core network. It also protects sensitive IoT data by analyzing it inside company walls. Ultimately, organizations that adopt fog computing gain deeper and faster insights, leading to increased business agility, higher service levels, and improved safety. Future work will expand on the Fog computing paradigm in Smart Grid. Independent Fog devices consult directly with the Cloud for periodic updates on price and demands, while interdependent Fog devices may consult each other and create coalitions for further enhancements.

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