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Fog Computing- An Overview

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***Abstract*--** In this paper we have given an overview about FOG COMPUTING with its history, introduction, merits demerits ,applications and conclusion .Fog computing, also known as fog networking or fogging, is a decentralized computing infrastructure in which data, compute, storage and applications are distributed in the most logical, efficient place between the data source and the cloud. Fog computing essentially extends cloud computing and services to the edge of the network, bringing the advantages and power of the cloud closer to where data is created and acted upon.

***Keywords*--** *Fog, Edge computing.*

I. HISTORY

On November 19, 2015, Cisco Systems, ARM Holdings, Dell, Intel, Microsoft, and Princeton University, founded the Open Fog Consortium, to promote interests and development in fog computing. Cisco Sr. Managing-Director Helder Antunes became the consortium's first chairman and Intel's Chief IoT Strategist Jeff Faders became its first president. [1]

II. INTRODUCTION

Fog computing is a term created by Cisco that refers to extending cloud computing to the edge of an enterprise network. It is also known as Edge computing or fogging. Fog computing facilitates the operation of compute, storage and networking services between end devices and cloud computing data centers. Fog computing, also known as fog networking, is a decentralized computing infrastructure in which computing resources and application services are distributed in the most logical, efficient place at any point along the continuum from the data source to the cloud.

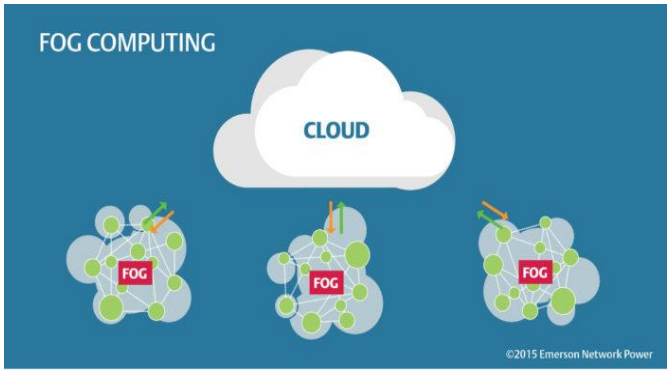

Figure 1: Fog Computing

III. WHAT IS FOG COMPUTING

Fog computing – a term originally coined by Cisco—is in many ways synonymous with edge computing. In contrast to the cloud, fog platforms have been described as dense computational architectures at the network's edge. Characteristics of such platforms reportedly include low latency, location awareness and use of wireless access. Benefits include real-time analytics and improved security. While edge computing or edge analytics may exclusively refer to performing analytics at devices that are on, or close to, the network's edge, a fog computing architecture would perform analytics on anything from the network center to the edge.

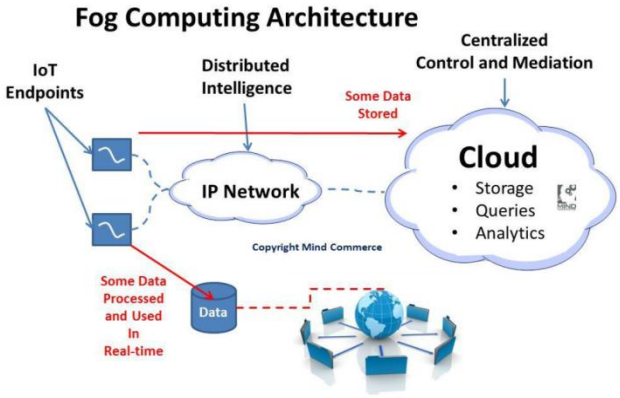

Figure 2: Fog Computer Architecture

One use case for fog computing is a smart traffic light system, which can change its signals based on surveillance of incoming traffic to prevent accidents or reduce congestion. Data could also be sent to the cloud for longer-term analytics.

Other cases described by Cisco might include rail safety; power restoration from a smart grid network; and cyber security. Prism Tech Vortex cite use cases with connected cars (for vehicle-to-vehicle and vehicle-to-cloud communication); and in smart city applications, such as intelligent lighting and smart parking meters. In the figure below, Cisco shows what kinds of analytics could be performed along a fog network. [3]

IV. HOW FOG COMPUTER WORKS:

While edge devices and sensors are where data is generated and collected, they don't have the compute and storage resources to perform advanced analytics and machine-learning tasks. Though cloud servers have the power to do these, they are often too far away to process the data and respond in a timely manner. In addition, having all endpoints connecting to and sending raw data to the cloud over the internet can have privacy, security and legal implications, especially when dealing with sensitive data subject to regulations in different countries.

In a fog environment, the processing takes place in a data hub on a smart device, or in a smart router or gateway, thus reducing the amount of data sent to the cloud. It is important to note that fog networking complements -- not replaces -- cloud computing; fogging allows for short-term analytics at the edge, and the cloud performs resource-intensive, longer-term analytics. [2]

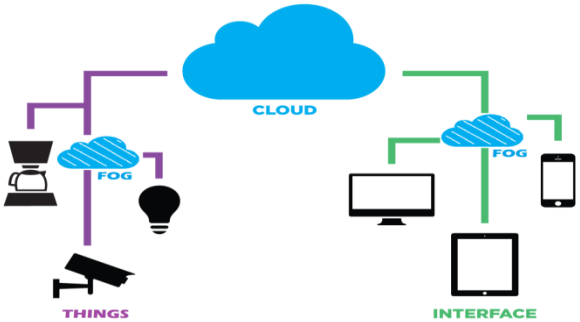

Figure 3: Cloud With Fog Computing

V. FOG COMPUTING AND INTERNET OF THINGS

Because cloud computing is not viable for many internet-of-things applications, fog computing is often used. Its distributed approach addresses the needs of IoT and industrial IoT, as well as the immense amount of data smart sensors and IoT devices generate, which would be costly and time-consuming to send to the cloud for processing and analysis. Fog computing reduces the bandwidth needed and reduces the back-and-forth communication between sensors and the cloud, which can negatively affect IoT performance. Although latency may be annoying when sensors are part of agaming application, delays in data transmission in many real-world IoT scenarios can be life-threatening -- for example, in vehicle-to-vehicle communications systems, smart grid deployments or telemedicine and patient care environments, where milliseconds matter. Fog computing and IoT use cases also include smart rail, manufacturing and utilities. Hardware manufacturers, such as Cisco, Dell and Intel, are working with IoT analytics and machine-learning vendors to create IoT gateways and routers that support fogging. [2]

VI. FOG COMPUTING VERSUS CLOUD COMPUTING

Many use the terms fog computing and edge computing interchangeably, as both involve bringing intelligence and processing closer to where the data is created. However, the key difference between the two is where the intelligence and compute power is placed.

A. Cloud Computing:

1. Data and applications are processed in a cloud, which is time consuming task for large data.
2. Problem of bandwidth, as a result of sending every bit of data over cloud channels.
3. Slow response time and scalability problems as a result or depending servers that are located at remote places.

B. Fog Computing

1. Rather than presenting and working from a centralized cloud, fog operates on network edge. So it consumes less time.
2. Less demand for bandwidth, as every bit of data's were aggregated at certain access point instead of sending over cloud channels.
3. By selling small servers called edge servers in visibility of users, it is possible for a fog computing platform to avoid response time and scalability issues.[2]

VII. MERITIS OF FOG COMPUTING:

1. Reduces amount of data sent to the cloud.
2. Conserves network bandwidth.
3. Improves system response time.
4. Improves security by keeping data close to the edge.
5. Supports mobility.
6. Minimizes network and internet latency.

VIII. DEMERITIS OF FOG COMPUTING:

1. Physical location takes away from anytime, anywhere, and data benefit of the cloud.
2. Security issues: IP address spoofing, man-in-the-middle attacks.
3. Privacy issues and authentication concerns.
4. Wireless network security.

IX. APPLICATIONS OF FOG COMPUTING:

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.

1. HEALTHCARE**:** Patient monitoring system in real time critical care units.
2. OIL & GAS**:** Pipeline monitoring for leaks, fire, theft etc.
3. ENERGY MANAGEMENT**:** Smart grid control with switching between alternative energy sources.
4. AGRICULTURE**:** Smart farms with crop monitoring and irrigation control systems.
5. TRANSPORTATION: Fleet management and vehicle health monitoring systems for trucks, buses.
6. RETAIL: Tracking of shopping carts and automatic billing systems.
7. SMART HOMES**:** Safety and comfort systems like fire alarms, climate control, intruder detection.

Table 1

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

Figure 4: Comparison Between Cloud And Fog Computing

X. FUTURE OF FOG COMPUTING

Antunes sees a number of new growth areas or even industries coming out of this initiative. "One very exciting potential is Fog-as-a-Service – FaaS — where a fog service provider, which could be a municipality, telecom network operator, or web scale company, deploys a network of fog nodes to blanket a regional service area," he explains.

Just as cloud has created new business models, growth and industries, "fog can eventually do the same," says Antunes, who foresees the "excitement of having new vendors, new industries, new businesses models come out of this as the industry, working together with academia to address the challenges and solve real business problems with these new architectural approaches."

Fog computing "will provide ample opportunities for creating new applications and services that cannot be easily supported by the current host-based and cloud-based application platforms," Antunes continues. "For example, new fog-based security services will be able to help address many challenges we are facing in helping to secure the Internet of Things." [3]

CONCLUSION

The Fog Computing or "fogging," is a computing model where data, processing, and apps are concentrated at the edge of the network rather than existing entirely (or almost entirely) in the cloud. The result is reduced service latency and a better end-

user experience. Fog computing accelerates awareness and response to events by eliminating a round trip to the cloud for analysis. Ultimately, organizations that adopt fog computing gain deeper and faster insights, leading to increasing business agility, higher service levels, and improved safely.

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