Fogging: The cloud-IOT/IOE middleware paradigm

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Abstract: Today, innovation and communication are happening at a remarkable rate. Now days, Internet has become the most important aspect of our life. Starting from desktop late 90s when one use to go to the device to resolve the problem to the era of smart devices early 20s when everybody carry the devices in its pocket to the new emerging era of internet of everything where we are going to connect each and every non connected device present on the planet. Even though cloud computing has played an efficient role in the computation and processing of these data, however, challenges, such as the security and privacy issues still cannot be resolved by using cloud computing. To overcome these limitations, the term fog computing has emerged to provide computing resources at the edge of the network.Fog Computing is a paradigm that extends Cloud computing and services to the edge of the network. Similar to cloud computing but with distinct characteristics. In this paper, I have given the brief description about the Fog computing elaborate its complicated architecture, highlighted few feasible applications and mentioned about the current security and privacy issues with the recommended security measures which we are going to face while deploying internet of things in to live environment.

Keywords: Fog computing, Internet of Things (IOT), cloud computing

Introduction

Fog Computing [1,2,3] refers to the decentralized computing environment whereby the computations, storage, applications and data analytics are implemented between remote data centre based cloud and the local edges(nodes or systems).Fog computing, also known as fogging/edge computing. It is a model in which data, processing and applications are concentrated in devices at the network edge rather than existing almost entirely in the cloud. Fog Computing is an intermediate layer between the remote cloud and the end systems so that the issues of latency, network bandwidth, delay, jitter can be avoided and the elevation in performance can be done[4,5].

Fog=Cloud + Internet of Things (IOT)

The Fog will be able to deliver high quality streaming to mobile nodes, like moving vehicles, through proxies and access points positioned accordingly, such as long highways and tracks. The fog suits applications with low latency requirements, emergency and health-care-related services, video streaming, gaming and augmented reality, among others. For smart communication, fogs are going to play an important role. Context-aware computing can also be made possible with a fog MDC. The gateway is the device that gathers the data from the underlying nodes. There are certain situations when the gateway is required to do some sort of preprocessing- or interoperability-related tasks, which it cannot do if it is standalone. In that case, the fog is required.

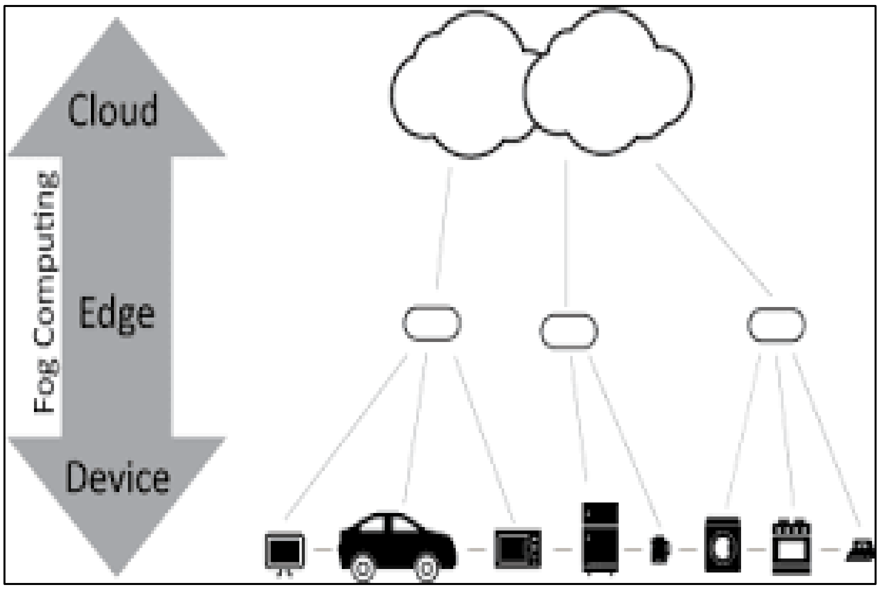

Figure 1.Cloud, Edge and Devices in fog Computing

The goal of fogging is to improve efficiency and reduce the amount of data transported to the cloud for processing, analysis and storage [6, 7].This is often done to improve efficiency, though it may also be used for security and compliance reasons. Popular fog computing applications include smart grid, smart city, smart buildings, vehicle networks and software-defined networks.

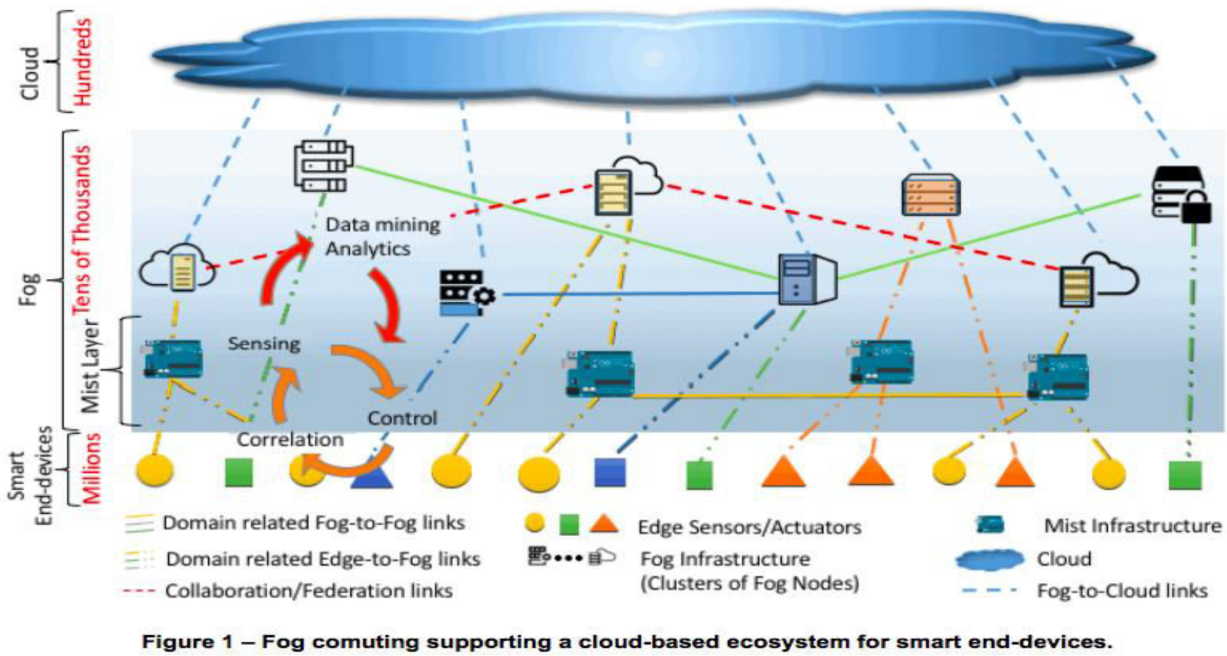

Figure 2.Layers in Fog, Edge and Cloud Computing

The difference between fog and cloud

The metaphor fog comes from a meteorological term for a cloud close to the ground, just as fog concentrates on the edge of the network. The term is often associated with Cisco; the company's product line manager, Ginny Nicholas, is believed to have coined term "Cisco Fog Computing" is a registered name; fog computing is open to the community at large [8, 9].

Both fog and cloud computing provide computation, storage, application, infrastructure, and data resources. However, they are still different from each other. The key difference is the fog's proximity to the underlying accessing nodes. The fog is localized, while the cloud is generalized. The fog extends the distant cloud to the edge of the network, closer to the accessing devices, IoTs, and WSNs. In other words, the fog is a descended cloud. Fog adds an extra layer of security to the sensitive data, including health care, location, metropolitan security, and other related services. The quality of cloud services, particularly multimedia, depends upon the quality of the core network. On the other hand, fog is much richer since it is available locally. Similarly when resource-constrained devices when resource-constrained devices are to be offloaded, fog is the most viable solution, rather than the cloud (or the cloud only), because it is more efficient and easy to access.

Table 1.1: Cloud Computing Vs Fog Computing

Parameter	Cloud Computing	Fog Computing
Latency	Cloud Computing has low latency but not compared to Fog Computing	Fog Computing has low latency in terms of network
Capacity	Cloud Computing does not provide any reduction in data while sending or transforming data	Fog Computing reduces the amount of data send to cloud computing.
Bandwidth	Cloud Computing conserves less compared with Fog Computing	Fog Computing conserves the amount of bandwidth
Responsiveness	In Cloud Computing, Response time of the system is low	In Fog Computing, Response time of the system is high
Security	High but less compared to fog computing	High Security
Speed	Access speed is high depending on the VM connectivity	High even more compared to Cloud Computing
Data Integration	Multiple data sources can be integrated	Multiple data sources and devices can be integrated

Keeping in view the basic tasks fog can provide, its overall layered architecture is presented in Fig. 3. In the physical and virtualization layer, physical nodes, WSNs, virtual nodes, and virtual sensor networks (VSNs) are managed and maintained according to the requirements. The monitoring layer watches the activities of the underlying nodes and networks. Which node is performing what task at what time and what is required from it next is monitored here. Other than this, the power-constrained devices or nodes are monitored on their energy consumption basis as well, so that effective measures can be taken in time. The preprocessing layer performs data-management-related tasks. It analyzes the collected data, performs data filtering and trimming, and in the end, more meaningful and necessary data is generated. Data is then temporarily stored in the fog resources. Once the data is uploaded in the cloud and it is no longer required to be stored locally, that data is then removed from the storage media. The IoT and WSNs may generate some private data as well. Ubiquitous health care and smart health-care services generate private data of the patients. Similarly, location aware data may also be sensitive in some cases, which should be made secure. This is where the security layer comes into play. In the end, at the transport layer, the ready-to- send data is uploaded to the cloud, burdening the core to the minimum and allowing the cloud to create more useful services.

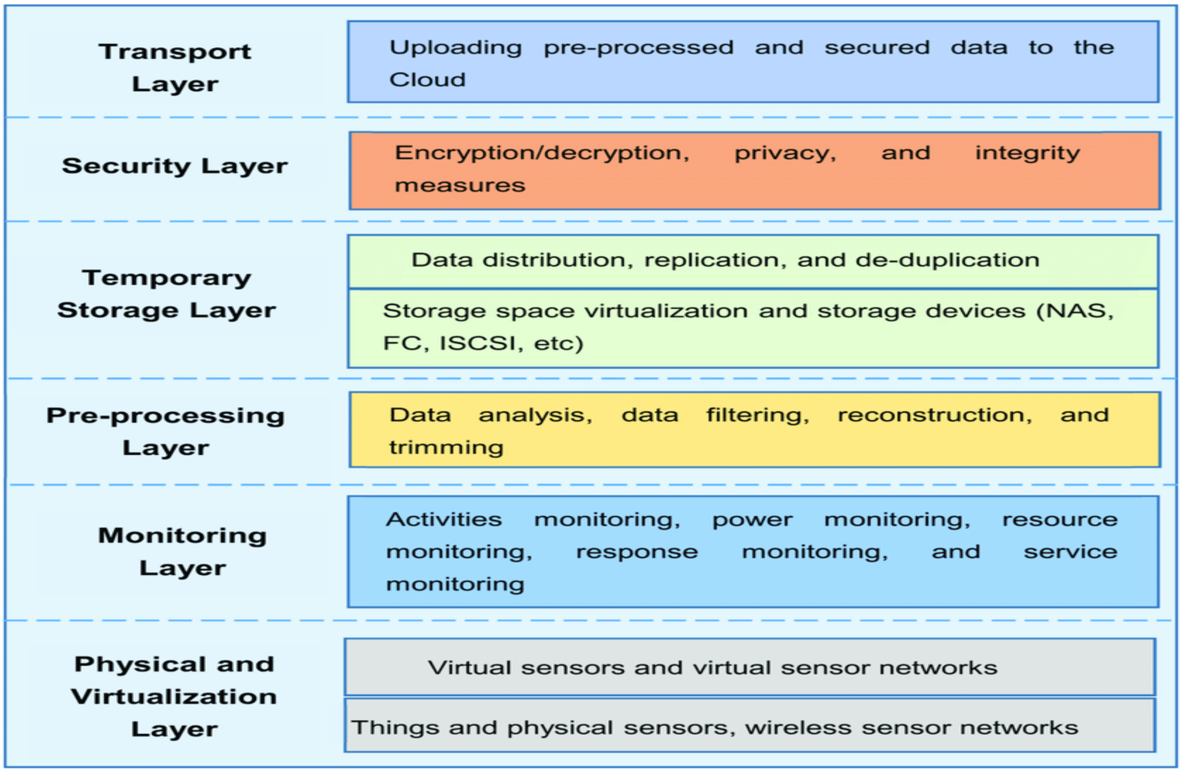

Figure 3.Layered Architecture of Fog

As per report by Open Fog Consortium, the global market of Fog Computing will exceed $18 Billion by year 2022.The Key findings from the report were presented during an opening keynote at the inaugural Fog World Congress conference. In addition to projecting an $18 billion fog market and identifying the top industry-specific market opportunities, the report also identified [10].

Conclusion

With rapidly increasing IOT services, service management, quality of service, efficiency, and users' satisfaction have become crucial. The future is the COT, in which IOTs are amalgamated with cloud computing for better resource management and service provisioning. In the case of multimedia content, many resources are required. Emergency, health care, and other latency-sensitive, as well as security-/privacy-sensitive services, require fog, as an MDC, to be present between the underlying nodes and the distant cloud. Efficient and in-time scheduling and management of resources allow data centers to perform according to the situation and help customer satisfaction. In this paper we have come up with fog computing and it gave advancement to the existing methodologies of securing data in cloud.

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