Survey on Fog Computing: Architecture, Issues, Applications and its Challenges

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Abstract: **Fog computing is one in every of the foremost essential paradigms utilized in modern international extension to cloud computing. Like Cloud computing, it provides info storage, manipulation and computation of data, but to the edge of the network, i.e. to the consumer give up. This paper offers with the risk to protection issues, particularly with location privateness and records confidentiality. The manner carrier companies as well as government will access customers facts is roofed. Furthermore the misconceptions approximately the rights of users are discussed. Finally the thought of decoy technique with some modification for location and data privateness is likewise blanketed. Virtualization is an important technology used in both fog and cloud computing that makes able virtual machines to coexist in a physical server to share resources. Indeed, the Fog, which does not replace the centralized Cloud but cooperates with it.**

Keyword- Cloud, Fog, network, confidentiality, Virtualization.

I. Introduction

The Internet of Things (IoT) is moving rapidly from experimental to active production status for companies. With many building custom circuits and expanding networks, it's time to plan for unmatched growth in data; which is all moving to the cloud. This is where fog computing comes in picture. A parable for a ground level cloud, fog computing moves the cloud closer to the devices that collecting the data. This is done to address a big problem internet facing now: lots of data. Consider this structure: a smart grid network is used to assess, to manage, and to report on data. The data is useful to the owner of a house, the manager for a city block, the leaders of a country and state.

The Internet of Things refers to an environment consisted of interrelated objects that are uniquely identified and can transfer data through the Internet with minimum human intervention. The goal of IoT is to take advantage of the information collected from those devices to perform synthesis, analysis, support decision making and finally make tasks richer and easier to carry out. The number of devices connected to the Internet was placed at 23.14 billion in 2018 as per the report from sources on internet [1], which already outnumbered human beings on the planet. It is estimated that the number will have been staggering by the year of 2020: 38.5 billion, or roughly 5 connected devices for every person in the world.

Fog computing essentially involves components of an application running both in the cloud as well as in edge devices between sensors and the cloud i.e. in smart gateways, routers or dedicated fog devices. Fog computing is distributed paradigm that provides cloud-like services to the network edge. It leverages cloud and edge resources along with its own infrastructure.

Cloud and fog computing are the 2 software program paradigm that can't completely overtake one another as each are equally vital. Hence, Fog computing is a now not complete solution. Even there are numerous issues which are unsolved as Internet of things (loT) applications require most vital data approximately the person along with geodistribution, mobility help, region focus as properly as low latency, More Importantly Fog (Edge) Computing is proposed to allow computing directly at the fringe of network in order that data may be transferred right away to billions of offerings and packages which can be related. A manner to study the layers of fog computing is to keep in mind it as a virtual platform this is located among the cloud centers and the devices as shown in Fig, 1, Typical example of fog computing devices is Wireless Sensors and Actuators

Networks (WSANs), Google glass, cell base stations etc, Fog Computing supports a spread of different services and alertness consisting of big information analysis, internet content transport, and augmented reality [2].

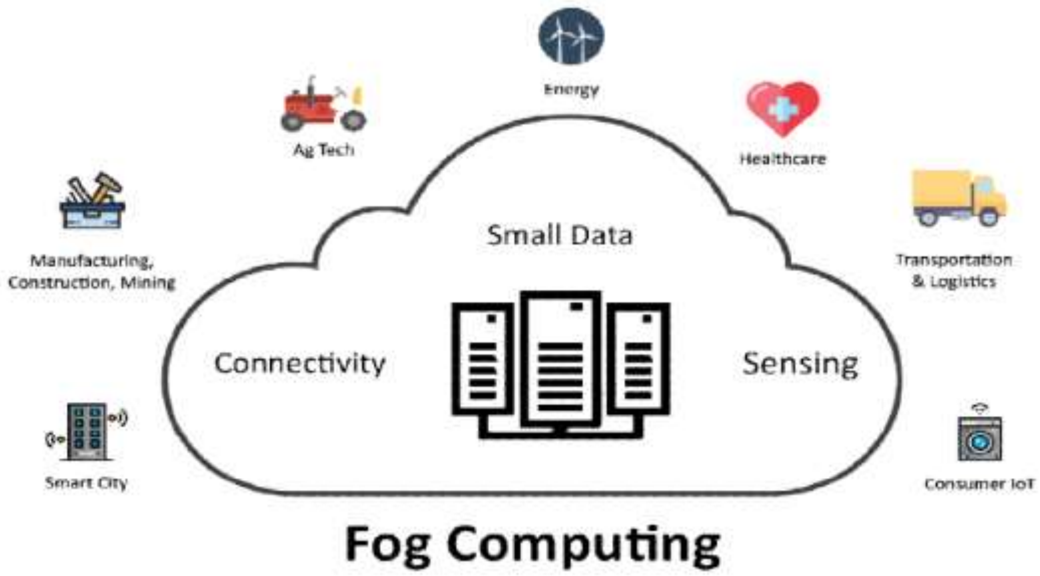

Fig. 1: Fog Computing Components

II. ISSUES IN CLOUD

IoT environments generate new amounts of knowledge that may be helpful in some ways, notably if analyzed for insights. However, the data volume can overwhelm today's storage systems and analytics applications. Cloud computing might facilitate by giving on-demand and ascendable storage, also as process services that may scale to IoT necessities. However, for health-monitoring, emergency-response, and other latency-sensitive applications, the delay caused by transferring data to the cloud and back to the application is unacceptable.

In addition, it isn't efficient to send so much data to the cloud for storage and processing, as it would saturate network bandwidth and not be scalable. Recent analysis of a healthcare-related IoT application with 30 million users showed data flows up to 25,000 tuples per second and real-time data flows in smart cities with many more data sources might simply reach countless tuples per second. To address these issues, edge computing was proposed to use computing resources near IoT sensors for local storage and preliminary data processing. This would decrease network congestion, also as accelerate analysis and also the ensuing deciding. However, edge devices can't handle multiple IoT applications competing for their limited resources, which results in resource contention and increases processing latency.

III. SO WHAT EXACTLY IS THE FOG COMPUTING?

Fog computing research is at a primary stage. Researchers have different perceptions and understanding about fog computing systems, which lead to various implementations and deployments of this technology. This issue makes the evaluation and comparison of these studies more difficult. Evidently, there is a need for a standard fog computing architecture that can be used as a reference for utilizing fog computing in different application domains. Moreover, in addition to latency aspects, essential parameters such as throughput, energy efficiency, scalability, and quality of service need more emphasis in future to answer the challenges posed by the growing demand of new IoT applications [9].

Fog computing is a natural and needed extension of cloud computing. Facing the possibility that there will be billions and billions of IoT devices, it is only through leveraging emerging models such as fog computing that the data collected from all these IoT solutions will deliver greater return on investment.

Fog computing is a distributed paradigm that provides cloud-like services to the network edge. It leverages cloud and edge resources along with its own infrastructure, as Figure 1 shows. In essence, the technology deals with IoT data locally by utilizing clients or edge devices near users to carry out a substantial amount of storage, communication, control, configuration, and management.

Fog computing involves the components of data-processing or analytics applications running in distributed cloud and edge devices. It also facilitates the management and programming of computing, networking, and storage services between datacenters and end devices. In addition, it supports user mobility, resource and interface heterogeneity, and distributed data analytics to address the requirements of widely distributed applications that need low latency.

Though fog is an essential extension of cloud computing, so there are some safety and privateness issues which can be unavoidable and feature a high-quality impact on it. Since those [3] issues if no longer well sorted will only effect the advertising of fog computing. We can see the assessment of laaS adoption in public, hybrid and personal cloud in Fig. 2. As Fog is in its growing section, and is proposed in context to Internet of factors, safety troubles are inherited with the aid of it from the cloud. While some problems are inherited even as there are new troubles that occurs because of distinct feature of fog computing together with area focus, low latency, mobility help required, massive no. Of geodisbursed nodes and unique sorts of fog node and community [4].

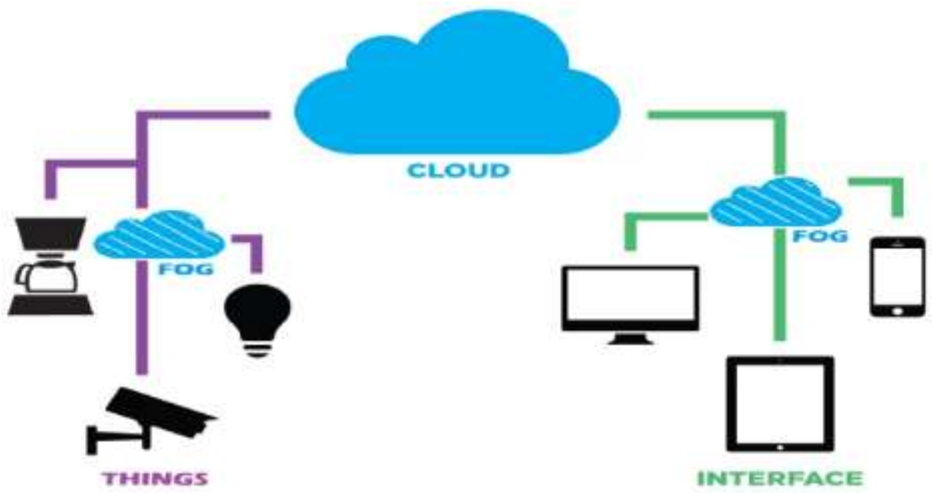

Fig. 2: Fog layer after Cloud

IV. WHO BENEFITS MOST FROM FOG COMPUTING?

Fundamentally, the event of fog computing frameworks provides organizations a lot of decisions for process knowledge where it's most acceptable to try and do therefore. For some applications, knowledge might have to be processed as quickly as doable – for instance, in an exceedingly producing use case wherever connected machines got to be ready to respond to an incident as soon as possible.

Fog computing will produce low-latency network connections between devices and analytics endpoints. This architecture in turn reduces the amount of bandwidth needed compared to if that data had to be sent all the way back to a data centre or cloud for processing. It also can be employed in situations wherever there's no information measure association to send knowledge, therefore it should be processed on the brink of wherever it's created. As a new profit, users will place security measures in an exceedingly fog network, from segmental network traffic to virtual firewalls to shield it.

Here are other use cases where a fog implementation can be of tremendous benefit:

- **Healthcare**: any device, such as a glucose monitor, can regularly send data. The data is beneficial for the patient, doctor, and potentially the insurance company. Both the patient and doctor will profit if a fog network is shut and immediate to knowledge, the information as the insurance underwriter usually needs trending data patterns.
- **Consumer packaged goods**: companies ship massive amounts of product all the time. Adding sensors to packaging provides period of time knowledge for once the merchandise is shipped, received, and sold. The whole method will cause higher money conversion cycles. Real-time cash conversion cycles help a store manager keep optimum volumes of the merchandise available.
- **Smart cities**: Sensors are now appearing throughout cities. Sensors for parking, water systems, sewage, energy, and street lighting each provide opportunities for efficiency improvements. Of course,

the amount of knowledge nonheritable is very large. Again, a fog network can keep knowledge about to those who ought to assess the information.

There's a common thread among varied fog computing scenarios: Not all individuals ought to have period knowledge. But for those that area unit most compact by knowledge results, the fog design can give them close to period access whereas permitting historical knowledge analytics to occur at no matter pace other teams require.

V. ISSUES AND CHALLENGES IN FOG COMPUTING

The concept of fog computing is very new. Cisco is the first company credited with the concept, having introduced it in 2014. As with many technologies, fog computing was created to address the specific problem of too many data reducing the efficiencies of cloud services [5].

Realizing fog computing full potential presents several challenges including balancing load distribution between edge and cloud resources, API and service management and sharing. There are several other important examples [6].

- **Privacy**: The fog will allow applications to process user's data in third party's hardware/software. This of course introduces strong concerns about data privacy and its visibility to those third parties.
- **Data Security Issue:** In fog Computing User's control to information is overtaken via fog node, subsequently the identical safety troubles rise up of cloud computing. Data Integrity cannot be maintain as facts can be lost or also can be modified. The information which is uploaded to the fog node can also be used by the 1/3 celebration. There are various strategies which can [7] be used to offer statistics Integrity, confidentiality and verifiability which includes aggregate of homomorphic encryption and searchable encryption. These strategies make certain that purchaser does now not keep statistics on untrusted server. Cao et al has made schemes the usage of the LT code which considers the storage a primitive factor, additionally the information can be retrieve in a miles quicker way and for this reason the communication cost will become low. There are always new demanding situations in fog computing associated with the designing of the [8] storage device which can cope with the dynamic operations in a much faster way and takes less area.
- **Quality of Service (QoS)**: This important metric for fog applications can be divided into four aspects, 1) connectivity, 2) reliability, 3) capacity, and 4) delay.
- **Enabling real-time analytics:** In fog environments, resource management systems should be able to dynamically determine which analytics tasks are being pushed to which cloud or edge-based resource to minimize latency and maximize throughput. These systems also must consider other criteria such as various countries‟ data privacy laws involving, for example, medical and financial information.
- **Security, reliability, and fault tolerance**: Enforcing security in fog environments which have multiple service providers and users, as well as distributed resources is a key challenge. Designing and implementing authentication and authorization techniques that can work with multiple fog nodes that have different computing capacities is difficult. Public-key infrastructures and trusted execution environments are potential solutions. Users of fog deployments also must plan for the failure of individual sensors, networks, service platforms, and applications. To help with this, they could apply standards, such as the Stream Control Transmission Protocol, that deal with packet and event reliability in wireless sensor networks.

VI. CONCLUSION

Fog computing may be a promising computing model and thought that has a stratified and distributed computing platform at the sting of the network for IoT applications. Because of its unique characteristics, a fog computing system provides better means of computing for delay-sensitive and geographically distributed IoT applications. A fog doesn't replace a cloud computing system; however it enhances cloud computing by a brand new breed of services. This paper reviewed key aspects of the fog computing technology for IoT applications. We analyzed and discussed the architectural models and the interplay of cloud and fog computing. We presented some application areas in which fog computing systems are used for enhancing services. Fog computing, however, faces many challenges in integrating fully with the current IoT domain. We categorized, analyzed and discussed these challenges in this paper. The aforementioned challenges together with design, specification, and development of a fog computing platform for IoT applications will be in front and center in our research.

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