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# The Fog Computing: Extension of Cloud Computing and Roles in Internet of Things

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***Abstract*-Fog computing is not a replacement of cloud it is just extends the cloud computing by providing security in the cloud environment. Similar to Cloud, Fog provides data, compute, storage, and application services to end-users. Cloud computing promises to significantly change the way of use computers and store our personal and business information .With these new computing and communication paradigms arise new data security challenges . Existing data protection mechanisms such as Encryption have failed to protect the data in the cloud from unauthorized access. Cloud computing has become the buzz word during the recent years. But it largely depends on servers which are available in a remote location, resulting in slow response time and also scalability issues.**

***In this research work, I have explained a different approach for securing data in the cloud using offensive decoy technology. Monitor data access in the cloud and detect abnormal data access patterns. When unauthorized access is suspected and then verified using challenge questions, we launch a disinformation attack by returning large amounts of decoy information to the attacker. This protects against the misuse of the user's real data. Experiments conducted in a local file setting provide evidence that this approach may provide unprecedented levels of user data security in a Cloud environment. Also I'm going to elaborate the motivation and advantages of Fog computing, and analyze its applications in a series of real scenarios, such as smart traffic lights in vehicular networks and software defined networks.***

***Index Terms*- Fog Computing, Cloud Computing, Internet of Things.**

## I. INTRODUCTION

Fog Computing is that which can be adaptable to any environmental changes, it extends cloud clouding and also servers to the edge of network. Fog is quite similar to the cloud. Like cloud fog also provides data, compute, storage and application given to end user. The term Fog Computing has been incorporated by CISCO system. The Fog Computing has three primary goals:

• To improve efficiency and trim the amount of data that requires to be transmitted for processing, analysis and storage.

• Place the data close to the end user.

• Provide security and compliance to the data transmission over cloud.

Fog Networking consists of a control plane and a data plane, where most of the processing takes place in the data plane of a smart mobile or on the edge of the network in a gateway device.

There is an effective alternative to owning and managing private data centers for customers all those also facing problems. This model is known as "pay-as-you-go" Cloud Computing model. There are some scales of mega DCs: higher predictability of massive aggregation, which allows higher utilization without degrading performance; convenient location that takes advantage of inexpensive power; and lower OPEX achieved through the deployment of homogeneous compute, storage, and networking components.

Cloud Computing specificies many details like enterprise and end users. This bliss becomes a problem for latency-sensitive applications, which require nodes in the vicinity to meet their delay requirements. Fog Computing are rapidly used for IoT's. In this data is fetched and services from network centre to the network edge. Internet of Things (IoTs), requires mobility support and geo-distribution in addition to location awareness and low latency. in fog computing, much of the processing takes place in a local device. This type of computing creates a virtual platform that provides networking, compute and storage services and functions in the middle of cloud data centers and end devices. These services are central to both fog and cloud computing.

Cloud computing comprises and uses more powerful servers harnessed together. On the other hand, fog uses weaker and dispersed computers that are already around us, connected together.

Cloud computing is a centralized computing with applications, private/public cloud hosting and core networks. These functions are subdivided into three parts i.e Fog computing (Distributed computing) which is access point and wifi/LAN, which is further divided into end devices(smart devices) such as vehicles, setupbox, IP Tv, machines, gaming,etc.[7]

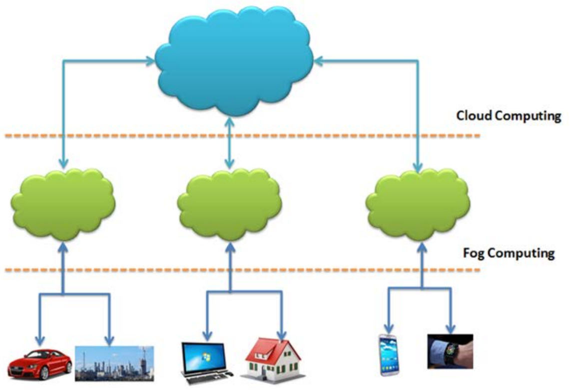


Figure 1- An Intermediate Level between Cloud and IoTs.

Fog computing 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. Cloud computing is a delivery platform which promises a new way of accessing and storing personal as well as business information. Cloud computing refers to the practice of transitioning computer services such as computation or data storage to multiple redundant offsite locations available on the Internet, which allows application software to be operated using internet-enabled devices. In existing data protection mechanisms such as encryption was failed in securing the data from the attacker. It does not verify whether the user was authorized or not. Cloud computing security does not focus on ways of secure the data from unauthorized access.

## II. LITERATURE SURVEY

Salvatore J. Stoflio et al.[1] proposed a technique and named it as Fog computing. Security is implemented by method called decoy information technology. Here we are using two methods. They are: User behaviour profiling and Decoy. In User behaviour profiling we can see that how much amount of information does an user can access. User's activity is observed for checking of any abnormality in data acces behavior of the user. The second technology is decoy in which information which is bogus or we can say fake such as honey files, honey pots, etc. are used so that the attacker get confused and them to feel that they attacking to real one but actually it is fake.

Madsen.Hand Albeanu. G[2] presented the challenges faced by current computing paradigms and discussed how Fog computing platforms are feasible with cloud and are reliable for real life projects. The main purpose of Fog computing is done for the need of geographical distribution of resources instead of having a centralized one. Fog computing platforms is followed by multitier architecture. Machine to machine communication is done in first tier and in higher tiers visualization and reporting is done. The higher tier is represented by the Cloud. Its very challenging to build Fog computing projects but their algorithms and methodologies available that deal with reliability and ensure fault tolerance. With their help such real life projects are possible.

Z. Jiang et al. [3] Discussed Fog computing architecture and further used it for improving Web site's performance with the help of edge servers. The emerging architecture of Fog Computing is highly virtualized. They presented that their idea that the Fog servers monitor the requests made by the users and keep a record of each request by using the user's IP address or MAC address. when a user requests for same website increases than a given number (N is tuneable parameter) then the user's browser can cache the common CSS and JS files and then onwards send them externally. They also mentioned that it is possible to measure page rendering speed with the help of snippets.

Disadvantages of existing system:

•Existing data protection mechanisms such as encryption was failed in securing the data from the attackers.

• It does not verify whether the user was authorized or not.

• It does not focus on ways of secure the data from unauthorized access.

• Bandwidth issue is there.

• Latency.

• Delay jitter is high.

• There is no support for mobility.

Unlike traditional data centers, Fog devices are geographically distributed over heterogeneous platforms, spanning multiple management domains. Cisco is interested in innovative proposals that facilitate service mobility across platforms, and technologies that preserve end-user and content security and privacy across domains.

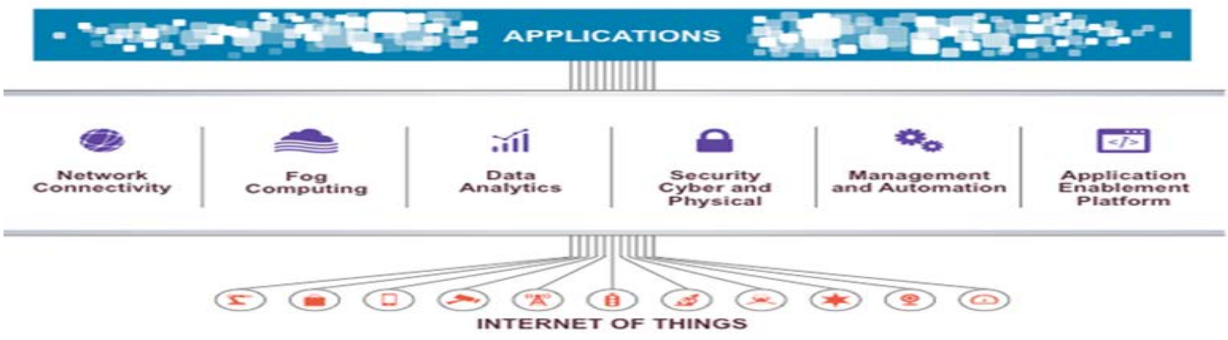


Figure 2: Fog in Local Services.

Cloud computing has provided many opportunities for enterprises by offering their customers a range of computing services. Current "pay-as-you-go" Cloud computing model becomes an efficient alternative to owning and managing private data centers for customers facing Web applications as shown in Figure 2.

Advantages of existing system:

• Fog can be distinguished from Cloud by its proximity to end-users.

• The dense geographical distribution and its support for mobility.

• It provides low latency, location awareness, and improves quality-of-services (QoS) and real time applications.

• Scalability.

• Low bandwidth use.

• Heterogeneity.

• Support for mobility.

• Support for on-line analytic and interplay with the Cloud.

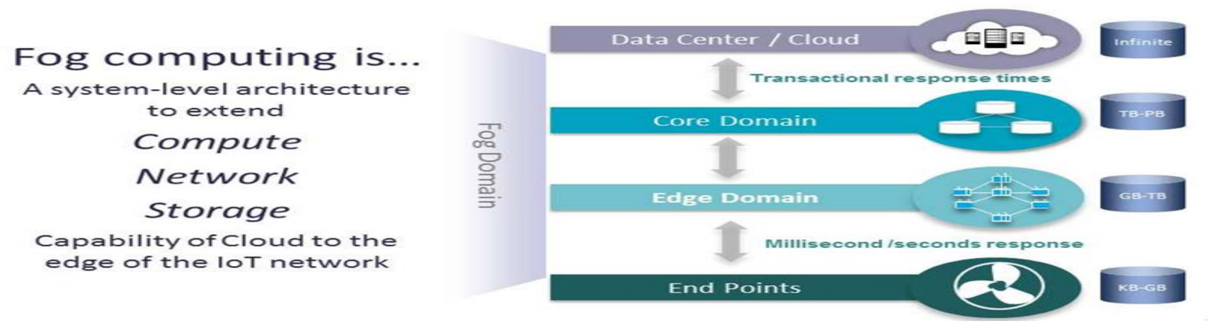


Figure 3: Fog

Computing

Here we can see that there are many smart devices that are in their particular locations and each of these smart devices are connected to fog and then again these fog are further connected to cloud as shown in Figure 3.[6]

## III. SYSTEM DESIGN

There are basically two types of algorithm:

• Vm scheduler algorithm

• Resource scheduler algorithm.

3.1 VM Scheduler Algorithm [3]:

```
Algorithm1  : Vm scheduler algorithm
Purpose     : To minimize power consumption within the data center.
Input       : Loading each node with as many VMs as possible.
Output      : Capacity value of new VM.

FOR i = 1 TO i _jpoolj DO
    pei = num cores in pooli
END FOR
WHILE (true)
    FOR i = 1 TO i _jqueuej DO
        vm = queuei
      FOR j = 1 TO j _jpoolj DO
        if pej _ 1 THEN
          if check capacity vm on pej THEN
              schedule vm on pej
              pej 1
          END IF
        END IF
      END FOR
    END FOR
        wait for interval t
END WHILE
```

VM scheduling algorithm that minimizes power consumption within the data center. This task is accomplished by continually loading each node with as many VMs as possible. The pool acts as a collection of nodes remain static after initialization. While not in the algorithm, the pool can be initialized by a priority based evaluations system to either maximize performance or further minimize power consumption. At a specified interval t the Algorithm 1 runs through each VM in the queue waiting to be scheduled. The first node in the priority pool is selected and evaluated to see if it has enough virtual cores and capacity available for the new VM. If it does scheduled, the pei is decremented by one, and this processes is continued until the VM queue is empty.

3.2 Resource scheduler algorithm[4]:

First, since the iterations are carried out at the beginning of each slot, the iteration index n must run faster than the slot time TS. Hence, the actual time duration: TI (s) of each n-indexed iteration must be so small to allow the iterations to converge within a limited fraction of the slot time. At this regard, the formal results of assures the asymptotic convergence of the iterations. Second, since each VM updates the size of the task to be processed and the corresponding processing rate, the total number of variables to be updated at each slot scales up linearly with the number M of the available VMs. Therefore, the total per-slot implementation complexity of the scheduler of Algorithm 2 is of the order of O (M). Furthermore, since the pursued primal-dual approach allows the distributed implementation of the solutions of the afforded reconfiguration and consolidation], each VM may locally update its task size and processing rate through local measurements. As a consequence, the per-VM implementation complexity of the proposed scheduler does not depend on the number M of the available VMs, that is, it is of the order of O (1).

```
Algorithm 2: Resource scheduler algorithm
Purpose: Each slot, the iteration index must run faster than the slot time.
Input: size of the task at processing rate.
Output: Scheduler is adaptive or distributed and execution time is limited upto
about 15 iterations.

FOR t _ 1 DO
    Apply the `-out-m decision rule and flag t as reconfiguration
    or consolidation slot;
    IF t is a consolidation slot, THEN
        Perform resource consolidation by running the iterations
        Update the sets S(t) and S(t);
    END IF
    IF t is a reconfiguration slot, THEN
        Evaluate;
        Compute;
        Evaluate;
    END IF
    Update s(t + 1) and q(t + 1) ;
    Compute, with _ replaced by t;
END FOR
```

In smart grids, privacy issues deal with hiding details, such as what appliance was used at what time, while allowing correct summary information for accurate charging. R. Lu et al. described an efficient and privacy-preserving aggregation scheme for smart grid communications. It uses a super increasing sequence to structure multi-dimensional data and encrypt the structured data by the homomorphic cryptogram technique. A homomorphic function takes as input the encrypted data from the smart meters and produces an encryption of the aggregated result. The Fog device cannot decrypt the readings from the smart meter and tamper with them. This ensures the privacy of the data collected by smart meters, but does not guarantee that the Fog device transmits the correct report to the other gateways. For data communications from user to smart grid operation center, data aggregation is performed directly on cipher-text at local gateways without decryption, and the aggregation result of the original data can be obtained at the operation center Authentication cost is reduced by a batch verification technique.

Regarding the first task, we note that QoS mapping of the demands for processing and communication rates may be actually performed by equipping the Virtualization layer with a per-VM queue system that implements (in software) the so-called mClock and SecondNet scheduler ,the mClock scheduler is capable to guarantee hard (e.g., absolute) reservation of CPU cycles on a per-VM basis by adaptively managing the computing power of the underlying DVFS-enabled physical cores (see Algorithm 1 of for the code of the mClock scheduler). Likewise, the SecondNet network scheduler in provides bandwidth guaranteed virtualized Ethernet-type contention-free links atop any set of TCP-based (possibly, multi-hop) end-to end connections. For this purpose, SecondNet implements a suitable Port-Switching based Source Routing algorithm, that may directly work at the Middleware layer.

## IV. CONCLUSION

The vision and defined key characteristics of Fog Computing, a platform to deliver a rich portfolio of new services and applications at the edge of the network. Fog is an unifying platform, which is rich enough to deliver all the new breed of emerging services and can enable the development of new applications. The state- of-the-art and disclose some general issues in Fog computing including security, privacy, trust, and service migration among Fog devices and between Fog and Cloud.

There are some collaborations on the substantial body of work ahead: 1) Architecture of massive infrastructure of compute, storage, and networking devices; 2) Orchestration and resource management of the Fog nodes; 3) Fog should support Innovative services and applications. There are two methods such as user behavior profiling and decoy system for securing data from attackers and algorithms such as VM and resource scheduler are involved here which provides strong evidence of illegal access and helps to improve accuracy of detection. Only use of one technique cannot produce accurate results. By combing two techniques the rate of detecting illegal access can be increased.

Future work will expand on the Fog computing paradigm in Smart Grid. Two models for Fog devices can be developed. Independent Fog devices consult directly with the Cloud for periodic updates on price and demands, while interconnected Fog devices may consult each other, and create coalitions for further enhancements. “Fog could take a burden off the network. As 50 billion objects become connected worldwide by 2020, it will not make sense to handle everything in the cloud. Distributed apps and edge-computing devices need distributed resources. Fog brings computation to the data. Low-power devices, close to the edge of the network, can deliver real-time response “says Technical Leader Rodolfo Milito, one of Cisco’s thought leaders in fog computing.

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