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Review and Analysis of Cloud and Fog Computing Platforms

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Abstract

As the call for data is rapidly increasing all over the globe it is necessary to deal with data safely to deal with data, we need some services like cloud and fog computing. Cloud computing and fog computing are the computing platforms which provide firm to run the communication without any kind of disturbance. This paper gives overview of cloud computing and fog computing. The survey of this paper focuses on cloud and fog computing and comparison of those both computing platforms. As we can easily analysis the best computing platform. As fog computing is the extended part of cloud computing that is it is add-on for the cloud computing platform. Cloud functions over internet it has many chances of collapsing while fog is more secure when compared to cloud as it has different protocols and standards in it and this fog have less chances of collapsing. Here fog computing security is higher when compared to cloud computing. This paper gives the review and analysis on fog and could computing.

Keywords: Cloud computing, Fog computing, Cloud security, Fog security

1. Introduction

As we know cloud computing technology is in trend since 1960s. In the Client-Server architecture before 1960s storing the data in CUP was very expensive where the mainframe was used to connect sorts of resources and linked them to a small and low client-terminals. As the revolution begin vast amount of storage capacity was needed. In 1963 DARPA the Defence Advanced Research Projects Agency presents MIT with some \$ millions on the project of MAC. Here in this situation one of the archaic, gigantic computers used reels that is magnetic tape for storage and this was forerunner what has called as a "Cloud Computing". Here it was acting like a primitive cloud with more than 2 people accessing it.

Later in 1969 J. C. R. Licklider worked with ARPANET that is Advanced Research Projects Agency Network. Here licklider worked as both psychologist and a system scientist, and helped in bringing out the new version called *Intergalactic Computer Network*. In this version any person from any place on the planet can access the information as computers were interconnected [1]. Here *Intergalactic Computer Network* is also known as Internet which is must for access to the cloud.

As the cloud computing was implemented to make it still better, we had a new version called "Fog computing". Fog computing was implemented because when we upload a data in cloud first it goes to fog layer where it gets processed and then later it is sent to cloud.

2. Cloud Computing

Cloud computing is where we do storing of information or data or coding over the network instead of our computers hardware. Here cloud is metaphor for internet [2]. In the past few years to maneuver towards a world of technology that's dominated by the usage of cloud. one of the most reasons behind this is often the need to enhance the capabilities of device without investing in new infrastructure [3]. This does not only provide the extensibility but also it has the advantage to reduce the cost up to some extent. This shift is clearly visible as major players within the industry have invested in and unrolled their own cloud platforms. the present market is dominated by AWS, IBM Cloud, Google Cloud [3]. Cloud computing has become an integrated a part of everyday lives. a couple of samples of the daily usage of cloud are media streaming and e-commerce.

Advantages

- ❖ Lower cost.
- ❖ Unlimited storage.
- ❖ Backup & recovery.
- ❖ Software integration is automatic.
- ❖ We can access the information easily.
- ❖ Faster deployment.

A. Service Models of Cloud Computing

The service models in cloud computing are:

SaaS: SaaS is Software as a Service which is used in business or by consumer. It is used for Email, Business process, Industry application, CRM/EPR/HR [4].

It is used by company like Oracle, Apriom, salesforce, Sage CRM, etc.

PaaS: PaaS is Platform as a Service which is used in Technical IT community. It is used for Middleware, web 2.0, Application runtime, Development tools, Database, Java runtime. It is used by company like google app engine, window Azure, openshif, computing wire, etc [4].

IaaS: IaaS is Infrastructure as a Service which is used in Technical IT community. It is used for Servers, Networking, Storage, Data center fabric, Load balancer, Firewalls.

It is used by company like Amazon, Microsoft, hp, at&t, rockspace, etc [4].

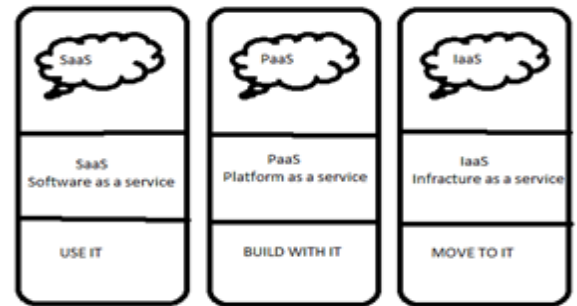


Fig.1. Cloud Computing Service Model.

B. Cloud Deployment Models

Cloud computing have 4 deployment models and those are:

- ❖ **Public cloud:** This deployment model is open and available for all the general public it is usually managed and designed by government organizations, business organizations, or educational organization or any of these combinations can use it and it depend on the service providers [5].
- ❖ **Private cloud:** They are similar in designs and structure to public cloud. The major difference is private clouds are owned by single company or single user and are protected by firewalls. Private clouds are used only in the organization that owns those clouds.
- ❖ **Community Cloud:** The cloud model that is similar to the private cloud but it has one difference. Instead of being owned by single company, multiple company which have similar usage of cloud and background they share those cloud which is called as the community cloud model [5].
- ❖ **Hybrid Cloud:** Hybrid cloud allows organization to incorporate with the best features of public, private, and hybrid clouds and allows the organization to select the features that suit their usage and requirements. [11]

3. Fog Computing

Fog computing is also known as fog networking, edge computing or fogging. Fog computing serve different operation of storage, networking service and computing between cloud and user devices or servers. Edge computing referred to those

situations where services are instantiated. Fog computing implies computation, storage resources, the distribution of the communication, services on or near devices and systems within the control of end-users [5]. Fog computing is being very popular by its advanced feature and by its better performance to process user request and stands better in the appearance compared to cloud computing. Fog computing can be explained as progressive and it also expands its variants of cloud computing to the edge time in process [6].

Advantages

- Privacy
- Productivity
- Security
- Bandwidth
- Latency

Disadvantages

- Complexity
- Security
- Authentication
- Maintenance
- Power Consumption

Fog computing acts as intermediate layer for cloud and end-devices [6]. here fog nodes communicate with other terminal nodes with one side and cloud on the other side in figure 2. The fog nodes are made in such way that the data is processed and it manages at the edge of this network, it helps in reducing network traffic and helps to reduce latency [12].

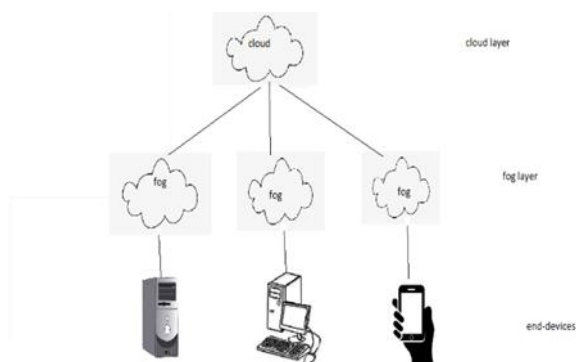


Fig.2. Fog being intermediate layer between cloud and end- devices

4. Literature Survey

Here this section presents the peer-reviewed work on the domain of cloud computing and fog

computing. As fog computing is extended part of cloud computing, it not only provides extensibility to the cloud computing but also decentralized architecture of cloud. Here the decentralized fog architecture has similar capabilities in the term of resource computing storing of data and details of services provided by it.

Moonmoon Chakraborty has given an overview about what is fog computing, it's uses, and has done the comparison between fog computing and cloud computing and author gives the layout of connection and attributes for both fog and cloud computing and where they vary by preparation, direction, outline, and strategies for company and clients. Moonmoon has explained how fog is connected to cloud and any other physical devices, and has discussed the advantages disadvantages of fog computing and comparison between cloud and fog computing. Moonmoon concludes that fog computing is more flexible as compared to cloud computing and it provides better service for processing data even at the risk of low network and less bandwidth instead of moving to some other computing platforms (cloud platform) [7].

Mithun Mukherjee, Rakesh Matam, Lei, Leandros Maglaras, Mohamed Amine Ferrag, Nikumani And Vikas Kumar. Authors in this paper they have provided the overview of privacy concerns and existing security especially for the fog computing and they have highlighted the ongoing research trends in privacy and security issues for fog computing. Mithun yet all, have discussed the features of fog computing and in detail they have explained cloud fog and edge computing and three-tier architecture of fog computing in this paper. Authors have concentrated towards security privacy issues in fog computing in that they have discussed on trust, authentication of network, secure communication in fog computing, end user privacy and malicious attack. Writers have extended the topic on existing research in fog computing and they have provided summary on state-of-the-art and research challenges in security and privacy issue for fog computing on fog network scalability, authentication and privacy-preserving schemes for fog and fog forensics. Authors conclude up that Security and protection issues are very much concentrated in cloud computing, in any case,

every one of them are not reasonable for fog processing because of a few particular qualities of mist registering just as a more extensive size of fog gadgets at the edge of the system [8].

Sukriti Yadav, Rakshith H.V, K. Badari Nath have written a survey paper on cloud computing providers and application. Author explains about cloud computing and its features by providing the outline of cloud computing and they discuss about some cloud deployment model in detail they explain these cloud models and explain public cloud marketing using graph along with that authors does comparison between all these four cloud models on different entities like maintenance cost, ownership, security etc. Secondly, author discuss about service models of cloud computing Software for all these models they explain about those model, characteristic and limitation along with that they provide popular examples for SaaS dropbox and lumen5 for PaaS OpenShift and cloudFoundry for IaaS DigitalOcean. Sukriti Yadav discuss about major service providers of cloud those are AWS by Amazon, GCP by Google, Microsoft Azure and does comparison between all these three service providers on strength, compute service, strong service key service. Sukriti Yadav have written on challenges and issue of cloud computing security, load balancing, communication in virtual network topologies and probability and then author discuss on application of cloud computing those are cloud computing in medical field, education field, entertainment field, banking field and finance. Sukriti Yadav conclude by writing cloud computing is raising in major companies where they have preferred cloud platform [3].

Kalp G. Soni, Hiren Bhatt, Dhaval Patel have written on fog computing and its current scenario and about its future research Kalpit G. Soni highlights open issue of fog computing related to IOT which determines future research works. Author gives review on basic concept of internet of things IOT, cloud computing and layers of cloud architecture. Then author in detail cloud of things that is cloud IOT integration where author explains how cloud can be integrated with IOT and then in detail author explains fog computing with diagram how fog is extension of cloud but closer to end user or servers. Author gives advantages and challenges faced by fog

computing. Advantages of fog are Low Latency, Scalability, Real-time, Interoperability, Distributed Approach and challenges faced by fog are Scalability, Resource Management, Energy Consumption, Latency, Heterogeneity, Dynamicity, Complexity, Security. Author discuss about some open issue of fog related to IOT that is Communications of the Fog and the Cloud, and Communications between Fog Servers, Fog Computing Deployment, Parallel Computation Algorithm, Security, End User Privacy and author does evaluation on fog and cloud's latency and bandwidth using RTT Round Trip Time as metric of latency and even they measure both downlink and uplink capacity of transmission. And they conclude but giving result as Fog: RTT- 1.416ms and Up/Downlink Bandwidth- 83.723/101.918Mbps and for Cloud: RTT- 17.989ms and Up/Downlink Bandwidth- 1.785/1/746Mbps. Author concludes by discussion of some serious issues of fog with IOT [6].

Jaishree Jain, Ajit Singh have written a survey paper on cloud computing and fog computing. where author analyses which computing platform requires more with its techniques and security purpose. Author gives introduction on fog and cloud computing and the impact on IOT. Further author in details explains Fog Computing its features characteristics and where and all we use this computing is explained next, author in detail discuss about cloud computing and its deployment models. Author gives the comparisons between fog computing and cloud computing on different parameters like scalability, transparency, allocation units, security, etc. author later discuss about some open research issues where author talks about application and tools of fog computing and cloud computing. Author Jaishree Jain and Ajit Singh states that fog computing should be more develop and it must include advanced features by its own for modern computing technology [5].

Vishal Kumar, Shahid Karim, Ali Anwar Brohi, Asif Ali Laghari, Muhammad Shakir have written a paper on comparison of fog computing and cloud computing. Here author gives brief introduction on computing technologies. Author in detail explain what is fog computing its characteristics and brief about fog

computing next author discuss about cloud computing in detail and explains its models Saas, Paas, and IaaS and about deployment models of cloud. Next author does comparison on fog and cloud computing on different parameters like Support of Multitask, Accessible type, Infrastructure, security and many more parameters. Then author discuss on open research issue on some application and tools related to fog and cloud computing. Authors conclude that fog computing

will be promising business model for any type of services providers [9].

5. Comparison between Fog Computing and Cloud Computing

Here in this section of the paper we do comparison between Fog and Cloud Computing platforms. This could assist to understand the benefits of computing platform.

Table1. Comparison between Fog Computing and Cloud Computing [8][9][10].

Attributes	Fog computing	Cloud computing
Target user	Mobile users	Internet users
Location of servers	Edge nodes	Within internet
Geographical distribution of computing platforms	Distributed	Centralized
Distance between customers and servers	Single hop	Multiple hops
Delay jitter	less	Higher
Latency	less	Higher
Connectivity type	Wireless connection	Leased line connection
Awareness location	provided	Not provided
N/W bandwidth of computing	Less	large
Security	More secure	Less secure
Goal	To reduce the redundancies and work efficiently when data is transferred for processing and storing.	To provide scalable and easy access for IT services and computing resource.
Computational focuses of computing	network edge and provides hierarchical computing	Data is processed and stored
Computing platforms Abstraction Level	Higher	Higher
Scalability Degree of computing platforms	Higher	Higher
Supports Multitask	Totally	Totally
Level of Transparency	Higher	Higher
Run time of platform	Real time service	Real time service
Allocation unit in computing platform	Wide& Narrow	Wide & Narrow
Level of Virtualization	Required	Required
Transmission of data	System-system	System to Cloud
Accessible types	Internet Protocol	Internet Protocol
Infrastructure of computing platform	decentralized	PaaS, SaaS,IaaS

Support of Operating System in platforms	hypervisor virtualization supported	hypervisor on which multiple OSs runs
Possession	many	Single ownership
Service negotiation provided	service-level agreement based	service-level agreement based
Support of User management in computing platform	single authority.	single authority or delegated to third person
Resource management	single authority	single authority or delegated to third person
Scheduling	single authority	single authority or delegated to third person
Interoperability of computing	heterogeneous resources	SOAP and REST
Defeat management	Arranging of tasks	Strong
Service pricing	Utility pricing	Utility pricing and even discounts for larger customer
Type of service provided	storage, network service, bandwidth, computing.	IaaS, PaaS, SaaS
Applications	Smart-grids, smart cities, connected cars	File storage, bigdata analytics
Response Time	less	More/higher
Critical object	Web Service	Web Service
Number of users	Any number	Any number
Resource	unbounded	unbounded
Future of computing platform	Next Generation of Internet service	Fog Computing is the future of cloud computing
Architecture	Distributed architecture	Centralized architecture
Communication with devices	Directly from the edge	From a distance
Data processing	Close to the source of information	Far from source of data or information
Computing capabilities	Low	High
No. of nodes	Many	Few
Analysis	Short-term	Long-term
Latency of computing platforms	low latency in terms of network	low latency but greater than fog
Speed of process	High	speed depends on the VM connectivity
Data Integration	data from any devices can be integrated.	data from any devices can be integrated.

6. Conclusion

In this paper explains Cloud Computing and Fog Computing. As it is survey paper, we have done literature survey on some papers what information do they contain and paper have comparison on Fog and Cloud Computing platform which helps to know the pros and cons of these platforms. Cloud computing innovation currently develop and numerous improvement devices are accessible for plan and execute cloud framework. Fog Computing is in beginning phase of exploration and still, model models and improvement instruments are under examination stage yet we accept that Fog computing is fate of current processing innovation and advance quick and used edge of device for computational assets.

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