ISSN No:-2456-2165

A Study on Review and Analysis of Cloud, Fog and Edge Computing Platforms

[1.] Ayesha Unnisa,
Assistant Professor, Department of ECM, Hyderabad,
JBIET, India

[2.] Kavuri Roshan,
Head of the Department
ECM, Hyderabad, JBEIT, India

Abstract:- Now a days the need for data is rapidly increasing globally at faster rate, it is necessary to deal with data safely In order to deal with data, we require some of the services like cloud and fog computing. These two computing platforms provide firms 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. Through this we can easily analyse the best computing platform for services. Cloud functions over internet it has many chances of collapsing while fog computing tend to be more secure when compared to cloud as it has different protocols and standards in it , fog computing have less chances of collapsing. Here fog computing security is higher when compared to cloud computing. This paper gives the study on the review and analysis on cloud, fog, edge computing. Edge computing is type of computer program that delivers low latency nearer to the requests. Edge computing is a distributed computing paradigm that brings computation and data storage closer to the location where it is needed, to improve response times and save bandwidth.

Keywords:- *Cloud Computing; Fog Computing, Cloud Security, Fog Security, Edge Computing.*

I. INTRODUCTION

As we know cloud computing technology is in trend since 1960s. In the Client-Server architecture before 1960s storing the data in CPU 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 began improving the 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 two people accessing it. Later in 1969 J. C. R. Licklider worked with ARPANET that is Advanced Research Projects Agency Network 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. Here Intergalactic Computer Network is also known as Internet which is must and important 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 the cloud. The availability of high-capacity networks, low-cost computers and storage devices as well as the widespread of hardware virtualization.

II. CLOUD COMPUTING

Cloud computing is the on-demand availability of computer system resources, especially data storage and computing power, without direct active management by the user. Large clouds, predominant today, often have functions distributed over multiple locations from central servers. Cloud computing relies on sharing of resources to achieve coherence and economies of scale. In the past few years to manoeuvre 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 ecommerce.

➢ *Advantages:*

- Lower cost.
- Unlimited storage.
- Backup & recovery.
- Software integration is automatic.
- Easy access of information
- 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. 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

ISSN No:-2456-2165

runtime. It is used by company like Google app engine, window Azure, computing wire, etc

➢ *IaaS:*

IaaS is Infrastructure as a Service which is used in Technical IT community. It is used for Servers, Networking, Storage, Data centre fabric, Load balancer, Firewalls. It is used by company like Amazon, Microsoft, hp, AT&T, Rockspace, etc.

➢ *Cloud Deployment Models:*

Cloud computing has four deployment models and they are as follows:

- *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.

- *Private cloud:*

They are similar inϖ 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 modelϖ 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.

- *Hybrid Cloud:*

Hybrid cloud allowsϖ 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.

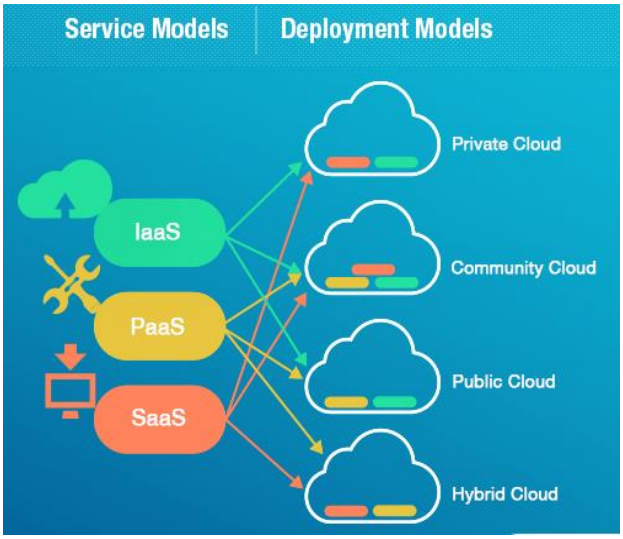

Fig 1.Cloud Computing Service and Deployment Models

III. FOG COMPUTING:

Fog computing or fog networking, also known as fogging, is an architecture that uses edge devices to carry out a substantial amount of computation, storage, and communication locally and routed over the internet backbone.

Fog computing is closer to end-users and has wider geographical distribution. Fog computing facilitates the operation of compute, storage, and networking services between end devices and cloud computing data centres. While edge computing is typically referred to the location where services are instantiated, fog computing implies distribution of the communication, computation, storage resources, and services on or close to devices and systems in the control of end-users.

Fog computing uses the concept of 'fog nodes' that reside either on the local LAN or a hop or two across the WAN of a private provider's network. These fog nodes have higher processing and storage capabilities than edge IoT devices and are located closer to the data source with a centralised cloud computing solution. Fog nodes can process the data from local edge IoT or user devices far quicker than sending the request to the cloud for centralised processing. This allows latency to be kept to a minimum for time-sensitive applications and services. Data can also be sent by the fog nodes to the cloud for further centralised processing and storage if required.

By handling these services that make up the Internet of Things (IoT) at the network edge, data can in many cases be processed more efficiently than if it needed to be sent to the cloud for processing. Fog computing is more energy-efficient than cloud computing. [2]

➢ *Advantages:*

- Privacy control
- Increased business productivity and agility
- Data security.
- Bandwidth
- Latency

➢ *Disadvantages:*

- Complexity
- Security
- Authentication
- Power Consumption

ISSN No:-2456-2165

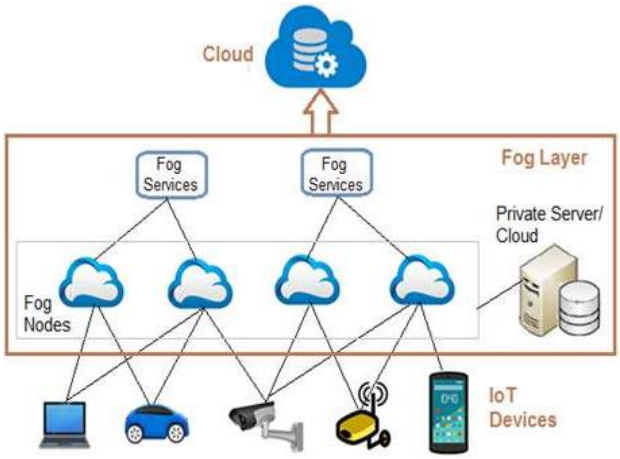

Fig 2:- Fog nodes as middle layer between cloud and end devices.

Fog computing acts as intermediate layer for cloud and end-devices, 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.

IV. EDGE COMPUTING

Edge computing can be defined as a distributed computing paradigm brings computation and data storage closer to the location where it is needed, to improve response times and save bandwidth. The increase of IoT devices at the edge of the network is producing a massive amount of data to be computed at data centres, pushing network bandwidth requirements to the limit. Despite the improvements of network technology, data centres cannot guarantee acceptable transfer rates and response times, which could be a critical requirement for many applications. Furthermore, devices at the edge constantly consume data coming from the cloud, forcing companies to build content delivery networks to decentralize data and service provisioning, leveraging physical proximity to the end user.

In a similar way, the aim of Edge Computing is to move the computation away from data centres towards the edge of the network, exploiting smart objects, mobile phones or network gateways to perform tasks and provide services on behalf of the cloud.[12] By moving services to the edge, it is possible to provide content caching, service delivery, storage and IoT management resulting in better response times and transfer rates. At the same time, distributing the logic in different network nodes introduces new issues and challenges.

Advantages:

- Privacy and Security
- Reliability
- Speed
- Efficiency.

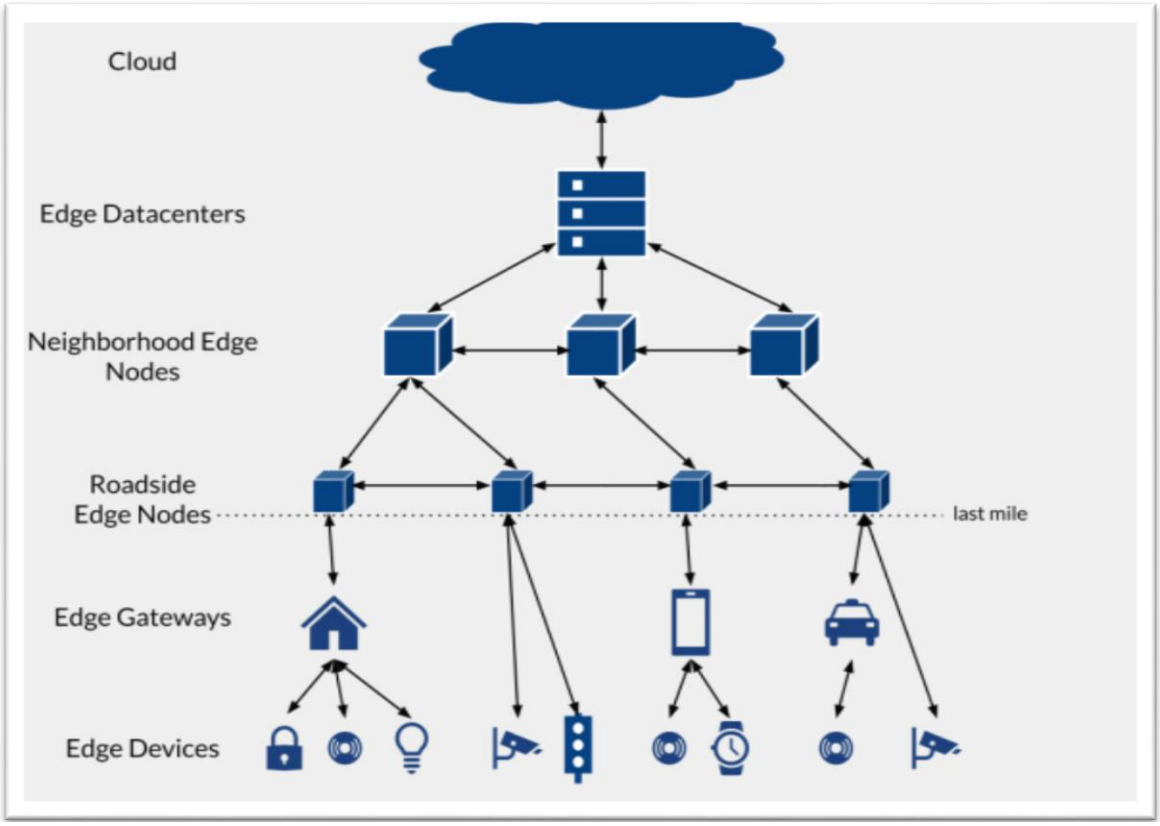

Fig 3: Edge Computing Architecture

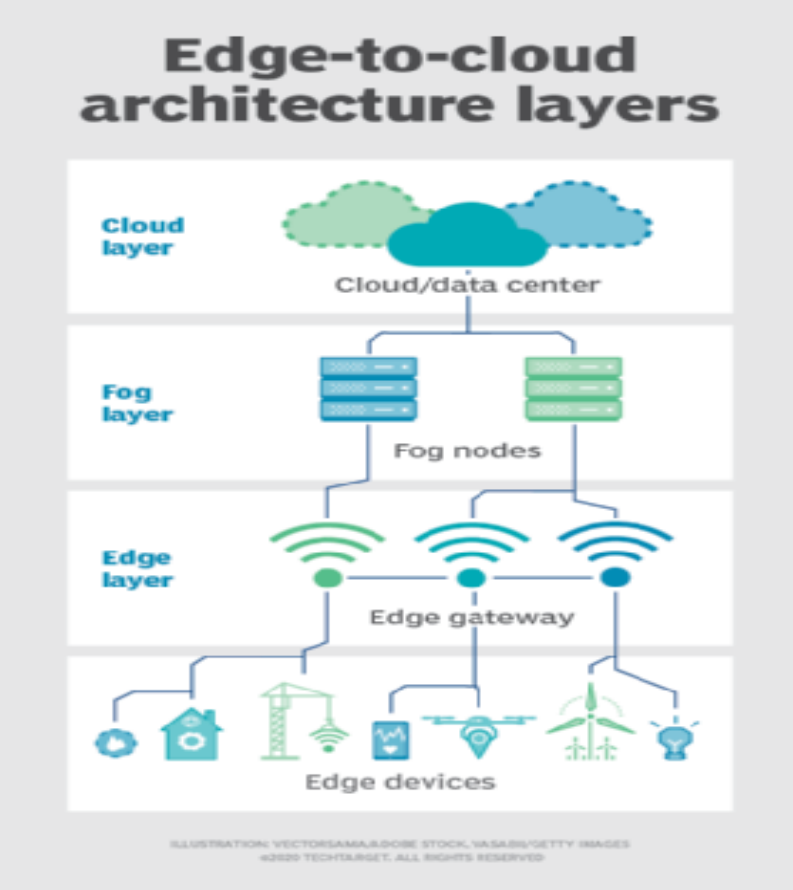

Fig 4:- Transmission of data from Edge Devices to cloud computing using edge, fog computing architecture layers in between

V. 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, LeandrosMaglaras, 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

Open Shift and cloud Foundry for Iaas Digital Ocean. 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].

Kalpit 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 Bandwidth83.723/101.918Mbps and for Cloud: RTT17.989ms and Up/Downlink Bandwidth1.785/1/746Mbps. 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].

VI. COMPARISON

Here in this section of the paper we do comparison between Cloud, Fog and Edge Computing platforms. This could help in understanding the benefits of computing platforms.

Attributes	Cloud Computing	Fog Computing	Edge Computing
Target Users	Internet Users	Mobile Users	Internet Users
Location Of Servers	Edge Nodes	Within Internet	Very near to the Edge Node
Geographical distribution of computing platforms	Centralized	Distributed	Distributed
Distance between customers and servers	Multiple Hops	Single Hop	Multiple Hops
Delay jitter	Higher	Less	Less
Latency	Higher	Less	Less
Connectivity type	Leased Line Connection	Wireless Connection	Wireless Connection
Awareness location	Not Provided	Provided	Provided
N/W bandwidth of computing	Large	Less	Less
Security	Less Secure	More Secure	Less Secure

ISSN No:-2456-2165

Goal	To provide scalable and easy access for IT services and computing resource.	To reduce the redundancies and work efficiently when data is transferred for processing and storing	To reduce network congestion and improve application performance by executing related task processing closer to the end user, improving the delivery of content and applications to those users.
Computational focuses of computing	Data is processed and stored	Network edge and provides hierarchical computing	On processing capabilities closer to the end user/device/source of data.
Scalability Degree of computing platforms	Higher	Higher	Higher
Supports Multitask	Totally	Totally	Totally
Transmission of data	System to Cloud	System-system	Device to Device
Level of Virtualization	Required	Required	Required
Accessible types	Internet Protocol	Internet Protocol	Internet Protocol
Scheduling	single authority or delegated to third person	single authority	Single Authority
Service pricing	Utility pricing and even discounts for larger customer	Utility pricing	Utility Pricing
Critical object	Web Service	Web Service	Web service
Number Of users	Any number	Any number	Any Number
Resource	unbounded	unbounded	unbounded
Future Of Computing Platform	Next Generation of Internet service	Fog Computing is the future of cloud computing	Edge will converge with the use of data through artificial intelligence and machine learning.
Architecture	Centralized architecture	Distributed architecture	Distributed Architecture
Communication with Device	From a distance	Directly from the edge	Device to device
Data Processing	Far from source of data or information	Close to the source of information	Closely with the devices
Computing Capabilities	High	Low	High
Number of Nodes	Few	Many	Many
Analysis	Long-term	Short-term	Short –Term
Latency in Computing platform	low latency but greater than fog	low latency in terms of network	Low latency in terms of network
Speed of Processes	speed depends on the VM connectivity	High	Faster Speed
Data Integration	data from any devices can be integrated.	data from any devices can be integrated	Data from any devices can be integrated

Table 1 Comparison between Cloud, Fog and Edge Computing

VII. CONCLUSION

In this paper we studied and analyse the cloud, fog and edge computing platforms and has done the literature survey on some research papers, which contains the information related to their comparisons. As Cloud computing innovation is currently to develop, numerous improvement devices that are accessible for plan to execute on cloud framework. The future goal of Fog computing is to makes all of the data to be quickly processed and analyzed in a possible way such that in order to run these systems even more effectively. In future the potential of edge computing is extremely high, since it has the strong ability to increase network performance by reducing latency.

REFERENCES

[1]. *Bar-Magen Numhauser, Jonathan (2012).* Fog Computing introduction to a New Cloud Evolution. Escrituras silenciadas: paisaje como historiografía. *Escrituras* .
[2]. Sarkar, S.; Chatterjee, S.; Misra, S. (2018). "Assessment of the Suitability of Fog Computing in the Context of Internet of Things". *IEEE Transactions on Cloud Computing*. **6**(1): 46–59.
[3]. Sukriti Yadav1*, Rakshith H.V.2, K. Badari Nath 3 "A Survey on Cloud Computing Providers and Applications" Vol.8 (5), May 2020, E-ISSN: 2347-2693
[4]. https://www.fingent.com/blog/cloud-service-models-saas-iaas-paas-choose-the-right-one-for-your-business/
[5]. https://www.vxchnge.com/blog/the-5-best-benefits-of-edge-computing#:~:text=By%20processing%20data%20closer%20to%20the%20source%20and%20prioritizing%20traffic,critical%20to%20performance%20as%20well.
[6]. Kalpit G. Soni1*, Hiren Bhatt2, Dhaval Patel3" Fog Computing: A Look on Present Scenario and Hopes for Future Research" Vol. 7(9), Sept 2019, E-ISSN: 2347-269
[7]. Moonmoon Chakra borty. "Fog Computing Vs. Cloud Computing" (2019). Fog Computing Vs. Cloud Computing. 10.6084/m9.figshare.7886126 Mithun
[8]. Mukherjee, Rakesh Matam, Lei Shu1, LeandrosMaglaras, Mohamed Amine Ferrag, Nikumani Choudhury, And Vikas Kumar, "Security and Privacy in Fog Computing: Challenges" VOLUME 5, 2017

➢ *Books*

[9]. Ray J Rafaels, "Cloud Computing from Beginning to End" in 2015
[10]. Zaigham Mahmood," Fog Computing: Concepts, Frameworks and Technologies"Kindle Edition