International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 10 | Oct -2016 www.irjet.net p-ISSN: 2395-0072

Fog Computing: Synergizing Cloud, Big Data and IoT- Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis

S.Balamurugan [#], L.Jeevitha [#] A.Anupriya[#] and Dr.R.Gokul Kruba Shanker[*3]

[#]Department of Computer Science and Engineering, KIT-Kalaignarkarunanidhi Institute of Technology, Coimbatore, Tamilnadu, India

**Consultant Surgical Gastroenterologist, Advanced Laparoscopic and Bariatric Surgeon, VGM Hospital-Institute of Gastroenterology, Coimbatore, Tamilnadu, India*

[1] sbnbala@gmail.com

Abstract— *This paper investigates the research challenges in Fog Computing. 'Fog computing' also known as edge computing'. The infrastructure which provides services at the edge of the network is fog nodes. IoT works by hosting application in a guest operating system (GOS)running in a hypervisor directly on Connected Grid Router(CGR). There are other similar concepts such as Mobile-Edge Computing (MEC).They overlap with fog computing. The processing delay should not exceed more than tens of milliseconds which may ruin the user experience. Fog servers are capable of providing dynamic customizable optimization based on client devices and conditions of local networks. Fog computing technique can tackle analytics on large data generated by IoT applications. When a new technologies arrive, its name should have proper definition and it should be accepted by the community. Fog has many features which are not present in cloud. Managing billions of varies devices connected to a Network for to implement NFV(Network Function Virtualization)as some network functions are done by software only. In the fog, services and networks returning on top can be deployed on demand in a edge device. Fog computing is a scenario where huge number of heterogeneous ubiquitous and decentralized devices communicates and potentially co-operate among them and processing tasks without the intervention of third parties. These tasks can be for supporting basic network functions or new services and applications that run in a sandboxed environment. This paper would promote a lot of research in the area of application of Fog Computing.*

Keywords-Fog Computing, Internet of Things, Cloud Computing, Data Science, Mobile-Edge Computing, Network Function Virtualization.

I. INTRODUCTION

Flauio Bonomi,Rodolfo Milito,Preethi Natarajan and Jiang zhu (2015) portrayed "pay-as-you-go"(postpaid)cloud computing model works efficiently in managing private data centres (DCS).IoT requires low latency, mobility support and location awareness which are available in fog computing. The fog vision gives convenient address to application and service than paradigm of the cloud. Smart Traffic Light System(STLS) developed using Fog Computing. Sensors which measures speed and distance of the approaching vehicle from every direction and detect the presence of pedestrians and cyclist crossing the streets are used to avoid accidents, maintain a steady flow of traffic and collection of relevant data to improve and evaluate the systems. The fog computing can also be used in wind form to collect wind data and control the speed of the turbine to similar to cloud, co-existence of application belonging to difficult tenants are supported by Fog. Fog network is heterogeneous in nature, which support wide range of applications through varies devices. Mohammed Aazam,Eui Nam Huh (2015) aimed to present an architecture of smart gateway with Fog Computing. Various tests have been done like upload delay, synchronization delay, Jitter, bulk-data upload delay and Bulk-data synchronization delay. IoT has become a major domain which has lot of applications. The objects themselves are used as nodes. Many heterogeneous devices interacts with each other and share information to make a network.IoT is based on Machine to Machine (M2M) interaction without human interference

IOT has 3 layers

i) Perception layer
ii)Network layer
iii)Application layer

In IOT ,the term things become node some consider here are two more layers.

Business layer and Middleware layer. Middleware layer takes decision based on the result and process the data. It also provides service management and storage of data.

Smart gateway means the gateway which decide the timing and type data to be sent. The timing refers the time which the device producing the data hold while uploading or sync data. Fog computing lies between underlying and cloud computing. For different file types, different processing algorithms are used. The communication through gateway and fog computing lessen the burden. The works that has to included depends on the variety of devices and circumstances surrounded the Things. Fog computing requires very large number of nodes, supports mobility, real-time interactions, gaming, access through wireless, heterogeneity. Fog computing and Internet of Things can be combined to form various useful applications in real-time. For example - A smart traffic light which interacts with various sensors which has collected information about the pedestrians. Bikes and speed and distance of the approaching vehicle gives a warning signal to the owner vehicle to prevent accidents. Fog provides localization and cloud provides global centralization.

The rest of the paper is organized as follows: Section 2 describes security issues in fog computing. Section 3 gives a broad overview of an mobile fog for large scale applications on the internet of things. Section 4 gives a detailed view on a integrating cloud and IoT. Section 5 portrays the research challenges in fog computing. resource provisioning in fog computing care is depicted in Section 6. Section 7 concludes the paper giving the future research direction.

II. SECURITY ISSUES IN FOG COMPUTING

M.T.Dlamini,H.S.Venter,J.H.T.Eloff and M.M.Eloff (2016) justified security concerns from hype, confusion and fear of unknown that currently prevails in FoG computing. It also aims to clear the 'foggy cloud' hovering over such a promising technology development .Security issues are the biggest challenges of cloud computing . Cloud computing is " a model for enabling convenient and on-demand access to a shared pool of configurable and on-demand access to be a shared pool of computing resources and service that can be rapidly provisioned and released with minimal management effort or service provides interaction" as defined by NIST. It is based on

1. Eight common characteristics: massive scale, homogeneity, virtualization, low-cost software, resilient computing, geographic distribution, service oriented and advanced security).
2. Five essential characteristics: on-demand self service, broad network access, resource pooling, rapid elasticity, measured service)
3. 3 service modes: software-as-a-service, platform-as-a-service, infrastructure-as-a-service)

Cloud computing lowers or removes intensive capital costs. It also helps them to convert into operational exposes to run core business operations. Most organizations consider as a biggest stumbling block to move their critical applications and sensitive data to the cloud. The reason for security concerns in cloud computing is its shared nature. Client quite often don't have idea of location of their data and who process it and for what purpose. Hence to reduce this kerberos authentication protocol and single sign-on mechanisms can be used. Service level agreements, transparency enhancing technologies and temper proof digital forensics audit logs can be integrated together to provide AAA in cloud (Authentication, Authorization, Accounting), by using Transparency Enhancing Technologies(TETs)user access and usage of their data.

Ivan stejmenovic,Sheng wen (2015) discussed about Fog-computing services and security issues by taking examples such as man-in-the middle attack. Authors also discussed the memory consumption of the devices. The difference between fog and cloud is fog's proximity to end users. The device geographical distribution and mobility support fog computing provides low latency ,quality of service(QOS) and location awareness for streaming and real time applications. It can be used in smart traffic light which calculate the presence of pedestrians ,bike and calculate the distance and speed of them using sensors and operate efficiently. It can be also used in strains as actuator to measure the heat levels in ball bearings and send an alert to the train operator. Also in mines, it will be used to control the change air-flow, if the conditions becomes dangerous to the miners CPS(Cyber Physical Systems) also co-ordinates the information from physical devices and integration of computer techniques IoT and CPS makes a revolutionary change to the world related to security issues. Intrusion can be avoided by signature -based method in which the regular pattern of behaviour is compared with the present one . Intrusion detection can be done by anomaly -based method using principal component analysis. It will distinguish regular and irregular subspaces from power flow variability. For example KFC or Star Bar customary when they connect to malicious access points which provide SSID can be hijacked by the attacker. For MITM attack, two things are necessary:

i)Compromise the gateway

ii)Insert malicious code to the compromised system.

To avoid this, refresh the ROM of a normal gateway or a fake active point in the environment can be placed. Hook techniques are used to do it. MITM attack is difficult to be addressed because of the negligible increase in both memory

consumption and CPU utilization. Encryption can be done but decryption cannot be done in Fog Computing. The original data can be obtained from operation centre.

III. MOBILE FOG FOR LARGE SCALE APPLICATIONS ON THE INTERNET OF THINGS

Kivak Hong,David LIlluthun,Umakishore Ramachandran (2016) pointed out the technology growth in mobile devices paved a way for sensitive applications. Platform as a service due to their scalability and high level programming models are used for developing large-scale applications through fog computing on the end devices. While developing applications, two main goals are,

i) To provide a high-level programming model that reduces the development complexities in varies devices over a wide-range.

ii) To allow applications to scale dynamically based on their workload using on-demand sources in fog and cloud.

For fog-computing infrastructure ,physical devices called fog computing nodes are placed in network infrastructure. Once the coding is written ,the programmer compiles it to produce a mobile fog process image that can be displayed with an unique identifier called appkey. Through this key ,the developer can manage the application through the management interface provided by Fog. The edge device connected to a fog network node should be capable of changing the node when the edge device location changes. On-demand computing instances in the fog and cloud is used by mobile fog to provide transparent scalability based on user-provided scaling polices. Metro area has hundreds of cameras. These cameras can be connect to a network for which the police officer can view the videos from his mobile. The mobility -drives distributed complex even processing (MCEP) systems can be used in this process. The mobile fog is highly skewed.(i.e) only a few process is overloaded. This results in motivating dynamic scaling to handle the highly skewed and dynamic workload of applications. Tom.H.Luan,Longxiang Gao,Zhili,Yang Xiang,Gusiviwe and Limin Sun (2016) say that cloud computing emerged as a key computing infrastructure for Internet Services. Nearly 90% global Internet Users rely on cloud. Cloud device can hardly manage the billions of requests from the mobile users. Fog computing is introduced to act as an interaction layer between cloud and mobile. Fog computing provides location awareness service which are desirable by mobile users. Fog servers are virtualized devices with build in data storage. Computing techniques and communication facilities. It can be implemented using the existing components. The servers may be static inside a shop or it can be placed on a moving vehicle(Greyhound Blue System). Fog server can directly communicate with the mobile with single hop wireless communications, to avoid the back and forth the traffic between cloud and mobile. Cross layer design and Predictable User feature and demand are the major factor through which fog communicates with virtualization (NTV) and Software -Defined Networking(SDN) are new technologies that can be incorporated with fog computing to enhance the service.

Enzo Baccarli,Nicola Cordesh,Alasandro Mei,Massimo Tanella,Mohammed Shojafan and Julina Stefa (2016) say Big data stream Mobile Computing has a goal to have a new generation of lossless integrated computing network-infrastructure, which has the ability to extract exact data from continuously increasing space-time correlated heterogeneous data streams. Five Vs of characterization for BDSMC are proposed .

i)Variety .

ii)Volume.

iii)Velocity(Data Generation Speed)

iv)Value(Huge Values but hidden in massive datasets at low density)

v)Volatility(Datastreams must be transported and processed in real time).

The performance of the BDSMC depends on physical location of the remote servers .The joint balance provisioning ,scaling and distributed management of the communication -plus-computer virtual resource are challenges for minimizing energy consumptions.

C-Droid module is a thing which is used for offload computation tasks.

1)Device-side

2)Cloud-side

C-Droid module involves in energy-size offloading are:-

i)Communication handling module

ii)Caching and perfecting module

iii)Traffic compressing module

iv)Synchronization module

By this, the fog centers cooperatively process the less intensive offloaded tasks, and it forwards the most expensive ones to remote data centers.

IV. INTEGRATING CLOUD AND IoT

Aussio Botta,Walter de Donato,Valario Persio,Antonio Pescape (2015) says that the integration of cloud and IoT is called as cloud IoT paradigm. IoT is generated a real world things when has low storage, processing speed and

performance with low security. But cloud has virtually unlimited storage, processing power and matured technology. In IoT, RFID(Radio-Frequency Identification Systems) are used which identifies the device connected and allow objects to be assigned unique digital identifiers. Sensing networks are also sensing the position, movement and temperature. The aim of the middleware layer used is to abstract the functionalities and communication capabilities of the device. The data collected from IoT devices are transmitted to powerful nodes where aggregation and processing is possible by cloud but scalability is challenging one. Vehicular cloud is another important one emerging in this area. Distributed system is exposed to several possible attacks for eg:- session riding ,SQL injection ,Cross Site Scripting and side-channel. Cryptography cannot be applied at layers is a major drawback of cloud. But the integration of IOT and cloud will make everyday life smarter. Mohamed Firdhous,Osman Ghazali,Suhaidi Hassan (YEAR) spoke that Cloud computing makes the hardware devices of varies heterogeneous systems to interact with each other. Fog networking is similar to cloud with lower latency, support mobility ,geographical support. Fog computing layer directly communicates to the devices such as phone, tablets, PC, etc.The fog layer lies between cloud layer and ground networks. As all the received tools are readily available the work can be done at minimal delay. SAAS (Software-As-A-Service) provides web based interfaces for customers. Some disadvantages of cloud computing are link outages, high latency and undefined security etc. IoTs, and many real time streaming applications have characteristics that cannot be satisfied by cloud computing. There are many differences between fog and cloud. The latency of fog is low. It has a defined security mechanism. Fog is location aware. Large no. of nodes are required. Fog support Real time interactions supports mobility, which when dealing with security issue fog is more preferred than cloud. Thus fog computing cannot totally replace cloud computing but have their own advantages and disadvantages.

V. CHALLENGES IN FOG COMPUTING

Mugen Peng,Shi Yan,Kechang Zhang,Chonggang Wang (2016) presented a paper which speak about the full advantages of local radio signal processing, co-operative radio resource management and distributed storing capabilities in edge devices. Issues like edge caching, software-defined networking and network function virtualization. The idea is to stop transmitting all the torrent data to the BBU Pool and process part of the signal at local PRHs. Fouermodes are used in this process.

a)D2D and RelayMode.
b)Local Distributed co-ordination Mode.
c)Global C-RAN Mode.
d)HPN Mode.

All the cache is need not necessary to store. Some cache can be stored in the device itself.

SDN (Software Defined Network) works on centralized manner while F-RAN depends on the distributed manner of edge services. The computing performance, security, VNF interconnection, portability, compatible operation and management with legacy RANS which are specified for F-RANS are the most challenge one. If there issues are exploited in future then, F-RAN would be a widely used enrapture across the globe.

Ahanhe Yi,Cheng Li,QuenLi (2015) terms important metric of fog server, QOS(Quality of Service). It provides four aspects: Connectivity, Reliability, Capacity and Delay, while considering with authentication in IoT biometric authentication such as fingerprint authentication ,face authentication ,touch-based or keystroke-based authentication etc. are feasible. For privacy protection homomorphic encryption at local gateways without decryption is preferable. Shi Yan, Mugen Peng, Wenbo Wang (2016) argues that Rather than using 4G, 5G wireless communication is proposed .Fog computing is similar to edge computing proposed by CISCO.

Various system model can be used ,

i) F-RAN (Fog-Radio Access Network) system model
ii)Cache model
iii)User access model:

- D2D mode .
- Nearest FAP mode .
- Local distributed coordinated mode.
- Original- to -interference ratio.

Using various algorithm these modes can be performed efficiently. Thus running of Fog computing using access modes can be done by various process.

VI. RESOUCE PROVISIONING IN FOG COMPUTING

Swati Agarwal,shashank Yadav,Arun Kumar Yadav (2015) says that Cloud computing is medium of sharing computing resources through any communication network. Fog computing is a intermediate layer between cloud and

client. The available resources are allocated to the required client through Infrastructure -as -a-service(IaaS). In the existing techniques, there is a problem of over provisioning and under provisioning.

To overcome the problems of resource allocation, a design model has been proposed :

1)Data centers are arranged in fog servers. Each fog server has its own fog server Manager, Fog server loads the request to the Fog Server Manager(FSM).

2)FSM process the request by

i)If all the requesting processors are available, the result will be sent to the client.

ii)If some requesting processors are available, the task is divided into many task.

iii)If the server is in allocated, then the client should wait for min term.

iv)If all process received at one fog server then failed one will be restored from (ii)

v)If no processor available on fog ,then the request is transferred to cloud.

If the sender did not receive the result within maximum time, then client will wait for processing. Thus these methods can be implemented for equal resource split up.

VII. CONCLUSIONS

This paper investigates the research challenges in Fog Computing. 'Fog computing' also known as 'edge computing'. The infrastructure which provides services at the edge of the network is fog nodes. IoT works by hosting application in a guest operating system (GOS) running in a hypervisor directly on Connected Grid Router(CGR). Fog servers are capable of providing dynamic customizable optimization based on client devices and conditions of local networks. Fog computing technique can tackle analytics on large data generated by IoT applications. When a new technologies arrive, its name should have proper definition and it should be accepted by the community. Fog has many features which are not present in cloud. Managing billions of varies devices connected to a Network for to implement NFV(Network Function Virtualization)as some network functions are done by software only. In the fog, services and networks returning on top can be deployed on demand in a edge device. Fog computing is a scenario where huge number of heterogeneous ubiquitous and decentralized devices communicates and potentially co-operate among them and processing tasks without the intervention of third parties. These tasks can be for supporting basic network functions or new services and applications that run in a sandboxed environment. This paper would promote a lot of research in the area of application of Fog Computing.

ACKNOWLEDGMENTS

S.Balamurugan and S.Jeevitha wishes to thank the Management, the Director, the Principal, of their institute, KIT-Kalaignarkarunanidhi Institute of Technology, for providing all the necessary facilities and never ending support for the work. Their special thanks go to, Prof.Dr.R.Nedunchezhian, Director-Research and Vice-Principal, for sowing the seeds of thinking big in research, his expert guidance and continuous motivation. They wish to thank their Department Head, Prof.Dr.P.Raviraj for the freedom to pursue research and excellent research ambience provided by him.

REFERENCES

[1] M.T. Dlamini, M.T. Dlamini, H.S. Venter, J.H.P. Eloff and M.M. Eloff,"Security of Cloud Computing: Seeing Through the Fog", NIST Draft Special Publication,2011.
[2] Flavio Bonomi, Rodolfo Milito, Jiang Zhu, and SateeshAddepalli," Fog Computing and Its Role in the Internet of Things" ,2012.
[3] Kirak Hong, David Lillethun, UmakishoreRamachandran, BeateOttenwälder, Boris Koldehofe," Mobile Fog: A Programming Model for Large–Scale Applications on the Internet of Things",2013.
[4] Ivan Stojmenovic, Sheng Wen," The Fog Computing Paradigm: Scenarios and Security Issues",2014.
[5] Flavio Bonomi, Rodolfo Milito, Preethi Natarajan and Jiang Zhu," Fog Computing: A Platform for Internetof Things and Analytics", Springer International Publishing Switzerland ,2014.
[6] Luis M Vaquero, Luis. Rodero-Merino," Finding your Way in the Fog: Towards a Comprehensive Definition of FogComputing",2014.
[7] Mohammad Aazam, Eui-Nam Huh," Fog Computing and Smart Gateway BasedCommunication for Cloud of Things",2014.
[8] Mohamed Firdhous, Osman Ghazali,Suhaidi Hassan," Fog Computing: Will it be the Future of Cloud Computing?",2014.
[9] Tom H. Luan,Longxiang Gao,Zhi Li, Yang Xiang, Guiyi We†, and Limin Sun," Fog Computing: Focusing on Mobile Users at theEdge",2015.
[10] Shanhe Yi, Cheng Li, Qun Li," A Survey of Fog Computing: Concepts, Applications andIssues",2015.
[11] Mugen Peng, Senior Member, IEEE, Shi Yan, Kecheng Zhang, Chonggang Wang," Fog Computing based Radio Access Networks:Issues and Challenges",2015.
[12] AlessioBotta , Walter de Donato, Valerio Persico, Antonio Pescapé," Integration of Cloud computing and Internet of Things: A survey", Future Generation Computer Systems,2016.
[13] Shi Yan, Mugen Peng, Wenbo Wang," User Access Mode Selection in Fog ComputingBased Radio Access Networks",2016.
[14] Swati Agarwal, Shashank Yadav, Arun Kumar Yadav," An Efficient Architecture and Algorithm forResource Provisioning in Fog Computing", I.J. Information Engineering and Electronic Business,2016.
[15] Enzo Baccarelli, Nicola Cordeschi, Alessandro Mei, Massimo Panella,MohammadShojafar, and JulindaStefa," Energy-Efficient Dynamic TrafficOffloading and Reconfiguration ofNetworked Data Centers forBig Data Stream Mobile Computing:Review, Challenges, and a Case Study ",2016.
[16] Mung Chiang," Fog Networking: An Overview on Research Opportunities",2016.
[17] SoumyaKantiDatta, Christian Bonnet, Jerome Haerri", Fog Computing Architecture to Enable Consumer Centric Internet of Things Services",2016.

[18] Chung-Sheng Li1, Frederica Darema2, and Victor Chang3," Distributed Behavior Model Orchestration inCognitive Internet of Things Solution",2016.
[19] Madiha H. Syed and Eduardo B. Fernandez," Cloud Ecosystems Support For Internet Of Things And Developments Using Patterns",2016.
[20] Kenji E. Kushida,DanBreznitz,JohnZysman," Cutting Through The Fog: Understanding Thecompetitive Dynamics In Cloud Computing",2016.