ISSN:2231-0711

T.Venkat Narayana Rao et al | IJCSET(www.ijcset.net) | November 2015 | Vol 5, Issue 11,385-389

A Paradigm Shift from Cloud to Fog Computing

T.Venkat Narayana Rao[*1] , MD. Amer Khan[*2], M.Maschendra[*3] ,M.Kiran Kumar [*4]

Professor, CSE, Sreenidhi Institute of Science and Technology [*1]

Student, CSE, Sreenidhi Institute of Science and Technology [*2]

Student , CSE, Sreenidhi Institute of Science and Technology [*3]

Asst.Professor ,CSE, Sreenidhi Institute of Science and Technology [*4]

Hyderabad,T.S, India

Abstract: The computing scenario is shifting from cloud computing towards edge networking which is known as Fog computing. It is now becoming an important facilitator in upcoming internet of things applications. With the rapid increase in the number of internet connected devices, the increased demand of real-time, low-latency services is proving to be a challenge for the traditional cloud computing framework. Fog computing is observed to be an aerial compared to the traditional cloud. It is hierarchical distributed architecture. This computing ensures the low and predictable latency in the latency-sensitive of Internet of Things (IoT) applications such as the healthcare services which is primary objective of this computing. This paper focuses on architecture, policy manager involved in this novel computing technology and with its usage and applicabilty.

Keywords: Fog device ,software defined network, internet of things, actuator, foglet , orchestration .

I. INTRODUCTION

As internet of things is emerging, number of sensors have been employed in various devices which are rapidly leading to an increasing amount of data generation. Therefore, to explore the data, cloud is used to store ,process, retrieve data. Cloud computing is providing 'pay as you go model' which is an efficient way to have data centers rather than having private data centers for customers for having their Web applications, batch processing and other processes. Therefore, the cloud computing reduce the burden of specifications and details for an enterprise. Since devices which has computing capacity estimate the environment by interacting with networking devices and basic property of network connectivity. The network ensures that all devices can share information with each other over the single or multiple hops. The connected sensors distribute the generated data to central storing and computing devices called the Cloud. However, the collected task of cloud is rather difficult to execute. The reasons are as following:

A. Latency occurs when customer is far from cloud.

To reduce the operating costs of cloud computing, cloud server providers build data centers in places with the low-cost resources. Generally in the remote areas and this would increase the data transmission delay. For example, we found that it takes about one second to get the data generated by humidity and temperature sensors but stored in the cloud based on experiments, the delay is generally within milliseconds or even microseconds. For delay sensitive applications such as vehicle and body area network the latency is a big problem which need to be considered as well. Not only transmission delay ,calculation delays must be considered. IoT is evolving in our daily lives data calculations and requires some time to handle the massive data.

B. burden on cloud is increasing as increase of amount of data and data nodes due to IOT.

As a complex cyber-physical system, the IoT fuses all kinds of sensing, identification, communication, networking and information management devices into a system. In turn link people and things based on the cloud. IOT generates lot of data which is burden to a cloud and takes large network bandwidth so as to ensure that data can be sent and received without any delay. Data transmission and information distribution has become an issue. Small as well as large organizations are now utilizing services of cloud to protect and store their data. But, the problem arises for latency sensitive applications, which require nodes locally to meet their delay requirements. Cloud computing hardly supports mobility, low latency and geographical distribution in addition to location awareness. The Cloud cannot meet all the requirements of QoS (Quality of Service) in IoT, so an improved architecture is needed. The new architecture requires the quick response to the underlying device in order to reduce the burden on the cloud[2][1].

Fog Computing is proposed to address the above problem. It enables a new kind of applications and services, and there is fruitful interchange between the Cloud and the Fog, particularly when it comes to data management and analytics. It is also a good computing paradigm for real time big data analytics. This environment also supports densely distributed data collection points and provides advantages in personal computing, advertising and other applications. This technology is also proposed to secure the Cloud environment[3][1].

C. State of the art computing

Because of the improvements in communications and big data, to improve presentation, the rise in several new distributed computing has taken place.

Fog Computing

- ***Characterization of Fog Computing***

Fog Computing is highly virtualized platform but not a replacement of cloud computing. Which provides storage , computing and networking services between end to end nodes as well as traditional Cloud Computing Data Centers. Number of characteristics that make the Fog Computing a nontrivial extension of the Cloud Computing are listed as follows :

location awareness, low latency. edge location -Fog Computing stretch edge network which consists of many distributed endpoints also called as nodes. Fog nodes provide localization and support end devices with rich facilities at the edge of the network, resulting in low latency and context awareness. Internet of Things (IoT) has got lot of popularity from both academia and industry professionals as it interplay information and computing processes to control very large collections of different objects. The concept of IoT bound every smart connected device, which includes personal devices utilized by people in their daily lives . Such connectivity and shareability enable the growth of connected devices, which in turn create huge data which comes from billions of devices from around the world. However, if the nodes can work together to create meaningful services and data, all the information from devices may be meaningless. Therefore, the integration must be conducted intelligently and seamlessly. The usage of "pay-as-you-go" cloud computing model has reduced the overall burden of cost of users managing and owning private data centers. This has given rise to huge user demand for storage, computing, networking resource and the need for efficient management and access to highly virtualized resources. The technologies which are existing does not provide efficient solutions for huge data management, and therefore require an innovative approach with the capability in sharing information more closely with physical or end devices by extending cloud computing services. Therefore, fog computing is also termed as edge-of-network which has recently been introduced .The primary purpose of technology is to deliver seemingly infinite collection of resources for fulfilling customers' needs. Given the high volume of communication required between the fog devices, interacting end-user devices, and cloud computing data centers the security is also a prime concerned. In particular, as fog computing is distributed in nature, therefore more dynamic and robust policy management is required to accomplish different security requirements[5][4].

II. ARCHITECTURE

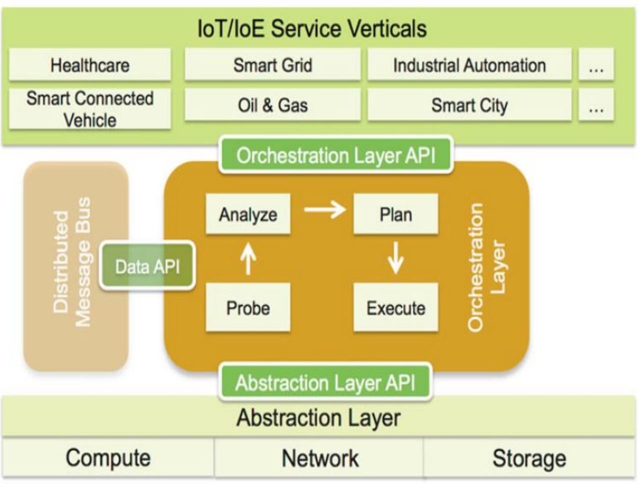

Figure 1: Fog Computing Architecture

Fog devices are heterogeneous in nature and deployed in variety of environments Such as core, edge, access networks and endpoints. The Fog architecture should ease seamless resource management across the diverse set of platforms. Fog nodes are deployed in variety of environments and heterogeneous in nature and Including core, edge, access networks and endpoints. The Fog architecture should facilitate seamless resource management across the diverse set of platforms[6][7].

- Fog architecture should expose generic APIs that can be used by the diverse set of applications to leverage Fog platform as shown in figure 1.The Fog platform hosts diverse set of applications belonging to various verticals such as smart connected vehicles to smart cities, oil and gas, smart grid etc.
- The Fog platform should provide necessary means for distributed policy-based orchestration, resulting in scalable management of individual subsystems and the overall service[8].
- The Fog platform hosts diverse set of applications belonging to various environments ,smart connected vehicles to smart cities, oil and gas and smart grid etc. Therefore, this architecture should expose generic APIs that can be utilized by the different set of applications to leverage Fog platform[10].

It should also facilitate means for distributed policy-based orchestration, which leads in scalable management of individual subsystems and overall services[9].

A .Heterogeneous Physical Resources

As discussed above Fog nodes are heterogeneous in nature. They range from high end servers, edge routers, access points, set-top boxes, and even end nodes such as vehicles, sensors, mobile phones etc. The different hardware platforms have varying levels of RAM, secondary storage and infrastructure to support new purposes. This platforms run various kinds of OS, software applications resulting in a wide range of hardware and software capabilities. The Fog network infrastructure is also heterogeneous in nature, ranging from high-speed links connecting enterprise data centers and core to multiple wireless access technologies (ex: 3G/4G, LTE, WiFi etc.) towards the edge [11][09][12].

B. Fog Abstraction Layer

The fog abstraction layer provides uniformity even in it's heterogenic infrastructure over various platform accessing, control and managing of resources through customizable APIs and UIs. With these APIs memory, network, energy and CPU such physical resources be provided and monitored on physical machines and it manages various hypervisors, services instances and containers[14] .

Effective Utilization of resources is done by number of OSs being run on physical machines with the virtualizing techniques and multi-tenancy support. This id done by Providing generic APIs concern the security, isolation and privacy to various tenants belonging to Oss on the same machine.

Supporting features over multi-tenancy:

- Multi-tenancy on the same physical infrastructure guaranteed by the isolation over resource and data.
- Insist no respected damage for the various parties on less concern.

- A single specified model consistently can provides isolation in all services.
- For administrators this abstraction layer exposes logical and physical network and the resource usage for each tenant in that network[13][15].

C. Orchestration service layer

The Policy based and dynamic Fog services life cycle management are exposed by Fog Orchestration service layer. The services and infrastructure of Fog is distributive in nature. Considering the Fog capabilities over services with huge volume of fog nodes with wide range be needed advanced technology and component usage such as:

- Foglet , software agents in possible small volume but with sustainability in functionality of this Orchestration layer as it follows this layer functionaly and provide needed requirements for their performances imbibed in edge devices.
- A consistent and distributed storing resource capability, performance that leads transaction rate to be high , updated and easy for retrieval.
- To carry and control messages for service orchestration and resource management it has a messaging bus.
- With local enforcement and a single global view there exist a distributed policy engine[16].

D. Foglet Software Agent

In the Fog platform of several Foglet software, the distributed Fog orchestration framework consists of foglet software agents running on each node APIs to monitor state and the health associated with the physical machine and services deployed on the machine . This information is rushed to distributed storage and analyzed locally for processing globally. Standing up to guest OSes, service containers, and provisioning and tearing down service instances etc. such life cycle management activities is performed which are Foglet responsibility. The Foglet agent uses abstraction layer. Foglet's interactions on a Fog node over a range of entities starting from the physical machine, hypervisor, guest OSes, service containers and service instances. For programmatic management and control these all entities implements all needed functions. Through the APIs of abstraction layer this Foglet calls those functions[17].

E. Distributed Database

for increasing Fog scalability and fault-tolerance is ideal to implement, this is complex while there distributed database enables storage and retrieval of data very quickly rather than centralized system for data. Both application data and necessary meta-data of the database is stored to aid in Fog service orchestration.

Sample meta-data:

- Hardware and software capabilities of Fog nodes enables the service instantiation with matching capabilities on a platform.
- Load balancing, and generating performance reports such as running service instances and Fog node's Health and other state information.
- Security and configuration such service's life cycles enforces and embedded with the Business policies.

F .Orchestration Service on Policy-Based

Framework of the orchestration exposes policy-based routing service, i.e., an incoming service request be routed to the specified needed service instance confirming the business policies relevantly. In this framework these are achieved with the help of policy Policy-Based Orchestration Service. The orchestration framework is interacted by administrators through an intuitive dashboard-style interface (UI). The business policies, manage and monitor the Fog platform administered through UI and policy templates and refine based on needs.

The policies include:

- Policies to specify thresholds for load balancing such as maximum number of users, connections, and CPU load etc.
- For specifying QoS requirements such as network, storage, compute with a service such as minimum delay and maximum rate etc.
- Configuring device, service instance in a specific setting.
- For associating capabilities of power management with a tenant/Fog platform.
- For specifying security, isolation and privacy in multi-tenancy.
- Policies that specify how and what services must be chained before delivery for ex: firewall before video service.

Business policies are pushed to a distributed policy database specifying he UI. An incoming service request triggers the policy manager. The policy manager gathers those pertaining to the service, subscriber and tenant etc. From the policy repository the policy manager tries to find an active service instance that satisfies the policy constraints, and forwards the service request to that instance. The capability engine hands over this ranked list to the life cycle manager that provides the service on a Fog device. Fog nodes whose capabilities match the policy constraints for instantiating the new service distributed control provides better resiliency, scalability, and faster orchestration. The policy manager also retrieves meta-data about currently active service instances from the services directory. If no such instance is available, then a new instance must be created. For that purpose, the policy manager invokes the capability engine whose job is to identify a ranked list of computing devices. The life cycle manager may reach out to the policy repository to identify device, service, and network configuration policies while provisioning the new instance and every Foglet has logic embedded in it[18].

III. APPLICATION AND USAGE

A. Traffic lights

In traffic when the vehicles pass through the streets then the smart lights should be on and off accordingly with the sensors these smart lights communicate with vehicles. Once the sensor identifies the movement of any vehicle it sends signals to make them react accordingly and thus neighboring smart lights work as FOG devices to create green traffic waves. They measure the distance and speed of reaching vehicles and in the way warn them and do serve in traffic in a better way that too well in advance.

B. Actuator and Wireless Sensor Networks

Even beyond the sensing and tracking applications, the wireless sensors need the actuators for great physical actions such as carrying them, closing and opening. There can be scenario where in WiFi,3G,smart traffic lights along road sides. The situation now demands more enriched automation involving sensors and communicating among vehicles to vehicles and vehicles to access points and access points to access points. Therefore, this scenario now requires actuators and these actuators served as Fog devices which would control the process of measuring.

C. Smart decentralized system control

In this case the sensors used to find the temperature, humidity and the system atmospheric conditions with various gas levels in it and from those sensors the information is exchanged among fog devices that are placed at different places. All those gathered information and reliable measurements taken and then the actuators react accordingly.

In trains which are self maintained the sensors senses the air levels in each compartment, gathers and monitors for system components to react , working together for providing fresh air and to open windows appropriately as needed.

Internet of things and cyber physical systems(CPSs):

For future scoped IoT and Cyber physical systems the new Fog technology provides support for fully computerizing through connecting the world. As IoT connects everything with an identifying address for each device. With Fog scenario the actuation can be achieved for smart buildings with the fabrications for energy conservation externally and internally. For the CPS systems these are associated with the embedded systems in which the software and the computers embed and work together for computing only. The main goal for involving these things are for integrating the software capability in correctness and doing networking with the mobilized things. There is a uncertainty in the environment of physical things to be connected such as machinery, cars and medical related devices or components. Thus, with CPS systems a new technical advancements has emerged to involve every things such as things highways, villages, buildings, industries connected through smart devices.

D. Software defined network(SDN):

As the Fog getting popularity in all the emerging technologies in networking and computing, another useful concept for networking i.e. software defined network (SDN) is also emerging in the domain of vehicular networking. The controlling is done at centralized server and communication among all the nodes is done accordingly through the server suggested paths. The communication and routing does not involve multihop concepts even in wireless sensors, WLAN and mesh networks. Thus, there raise communication gap among peer to peer, vehicle to vehicles. But with advent of the Fog computing the collaboration with the SDN bridges the gaps in vehicular network and reduces high packet loss rate.

IV. MOBILE FOG CONCEPT

It is latency specific and large scale high level programming model for the future internet applications. Low latency application of systems computing can be done on fog devices. But for higher latency, larger scale systems can only be done on remote resources knowingly on cloud. The mobile fog model never be served for generic applications rather for specific applications and consisting of event handlers and some operational code for serving those applications. But these functional code pulls out the challenges such as image processing but the fog concept reduces latency and traffic.

A method would emerge soon for migration of fog and cloud resources presenting the prominent uses over latency restrictions and a perfect panning in usage of network even in migration against time. When migration takes place then shall be knowledge of applications in computing with a decreased bandwidth for computing functions done on cloud and networking operators placed in Fog devices. The mobility work load cannot be reduced with fog as these also carry the computations.

Mobile users expect the user queries well in advance based on the locations and service accordingly in a efficient way from the service providers. To achieve this the authors propose pipeline processing through parallel resourcing with the several time steps ahead. From lot of predictions for a location the nearest related truth is processed. Applying existing methods at remote servers would result in more effectiveness in getting better performance. Serving the users by applying those methods at the Fog level systems, and combining them with their unique computation knowledge can achieve dynamic adaption with the user mobility[15].

In the case of mobile cloud the devices share resources that are heterogeneous in nature and in a local network all the nodes form a local cloud and one node selected as fog device is used as local resources coordinator. For heterogeneous resources the bandwidth, power and latency are the quantifying metrics. It is proposed that heterogeneous resources sharing on utility based services by mapping those quantifiers equating to time resources.

V. CONCLUSION

Fog computing has advantages for services on several domain such as smart grid, wireless sensor network, internet of things(IOT)and software defined networks(SDNs). We have focused on the state of art and disclosed some general distinctions of fog computing and concepts of mobile fog which are fast approaching towards technological developments. This paradigm shift to fog computing would extend beyond cloud computing boundaries and would be adopted by the computing world very rapidly.

REFERENCES:

[1] L. Piras. (2014March) A brief history of the internet of things [infographic].[Online]. Available: http://www.psfk.com/2014/03/internet-ofthings-infographic.html

[2] Internet of things market forecast:. Cisco. [Online]. Available:http://postscapes.com/internet-of-things-market-size

[3] (2014, Jan.) Cisco delivers vision of fog computing to acceleratevalue from billions of connected devices. Press release. Cisco.[Online]. Available: http://newsroom.cisco.com/release/1334100/Cisco-Delivers-Vision-of-Fog-Computing-to-Accelerate-Value-from-Billionsof-Connected-Devices-utm-medium-rss

[4] L. Zhang, C.Wu, Z. Li, C. Guo, M. Chen, and F. C. M. Lau, "Moving bigdata to the cloud: An online cost-minimizing approach," IEEE Journalon Selected Areas in Communications, vol. 31, pp. 2710–2721, Dec.2013.

[5] D. Lund, C. MacGillivray, V. Turner, and M. Morales, "Worldwide andregional internet of things (iot) 20142020 forecast: A virtuous circle of proven value and demand," International Data Corporation (IDC), Tech. Rep., 2014.

[6] D. Bouley, "Estimating a data center's electrical carbon footprint," April 2010. [Online]. Available:https://www.insight.com/content/dam/insight/en-US/pdfs/apc/apcestimating-data-centers-carbon-footprint.pdf

[7] "Report to congress on server and data center energy efficiency public law 109□431," U.S. Environmental Protection July 2007.

[8] M. P. Mills, "The cloud begins with coal," Digital Power Group, Tech.Rep., August 2013.Agency ENERGY STAR Program, Tech. Rep.,

[9] D. He and S. Zeadally, "An analysis of rfid authentication schemes for internet of things in healthcare environment using elliptic curve cryptography," IEEE Internet of Things Journal, vol. 2, no. 1, pp. 72–83,Feb 2015.

[10] I. F. Akyildiz, M. Pierobon, S. 2014Balasubramaniam, and Y. Koucheryavy, "The internet of bio-nano things," IEEE Communications Magazine, vol. 53, no. 3, pp. 32–40, March 2015.

[11] A. Aijaz and A. H. Aghvami, "Cognitive machine-to-machine communications for internet-of-things: A protocol stack perspective," IEEE Internet of Things Journal, vol. 2, no. 2, pp. 103–112, April 2015.

[12] A. M. Ortiz, D. Hussein, S. Park, S. N. Han, and N. Crespi, "The cluster between internet of things and social networks: Review and research challenges," IEEE Internet of Things Journal, vol. 1, no. 3, pp. 206–215, June 2014.

[13] J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, "Internet of things (iot): A vision, architectural elements, and future directions," Future Generation Computer Systems, vol. 29, no. 7, pp. 1645 – 1660, 2013.

[14] J. Jin, J. Gubbi, S. Marusic, and M. Palaniswami, "An information framework for creating a smart city through internet of things," IEEE Internet of Things Journal, vol. 1, no. 2, pp. 112–121, April 2014.

[15] C. Perera, C. H. Liu, S. Jayawardena, and M. Chen, "A survey on internet of things from industrial market perspective," IEEE Access, vol. 2, pp.1660–1679, 2014.

[16] J. Wei, "How wearables intersect with the cloud and the internet of things : Considerations for the developers of wearables." IEEE Consumer Electronics Magazine, vol. 3, no. 3, pp. 53–56, July 2014.

[17] L. Wang and R. Ranjan, "Processing distributed internet of things data in clouds," IEEE Cloud Computing, vol. 2, no. 1, pp. 76–80, Jan 2015.

[18] X. Zheng, P. Martin, K. Brohman, and L. D. Xu, "Cloudqual: A quality model for cloud services," IEEE Trans. on Industrial Informatics,vol. 10, no. 2, pp. 1527–1536, May.