A Review on Fog Computing and its Applications

Gollaprolu Harish, S.Nagaraju, Basavoju Harish, Mazeeda Shaik

Abstract—Internet of things is an associate degree spotlight innovation to connect on the far side ancient devices to a various vary of devices through extended net property that has the potential to provide endless advantages to the society. IoT services collaboration become essential to bring explosive proliferation of end points. Industries become progressively sensible and economical as it targets for enhance the producing technologies productivity and analyze the real-data from the big quantity of data generated endlessly by totally different sources. The increasing necessity of information and therefore the explosion of sensing devices are extremely compel with the requirements related to divulgence, accumulator, and power utilization at finish devices like sensible meters, data transmission and will not afford serious storage hundreds from multiple numbers of IoT devices in plant through IoT-cloud architectures. The IoT development through cloud computing cannot profit because of problems with cloud services like high latency, lack of quality giant scale non-uniformity and location awareness, wherever information intensive analysis become a major challenge in sensible cities. To beat these problems with real time latency applications of for the most part distributed IoT devices and sensors, information analytics and management, a federate reckon prototype, Fog Computing is instigated. Fog Computing extends facilities to the network extremity as compared to cloud computing and impart information, calculate repository, and supplication amenity to finish operators. During this article, IoT design victimization Fog Computing is proposed that works as service entrance to multiple IoT services to build an efficient IoT application to hooked up the responses through the nodes, sensors and devices used to investigate Fog Computing unit. And also discuss similar ideas of fog computing as goals, challenges, supported observations, future directions for analysis.

Index Terms—IoT, Cloud Computing, Fog Computing, Fog devices, Sensors, Big Data.

1. INTRODUCTION

Multiple numbers of devices can be easily accessible using IoT technology through immense connectivity of internet. Cloud computing empower people to use services and hardware at faraway distances which is managed by a arbitrators. Examples should be internet stockpile, social media trademarks, web-mail, and online trade requests. This paradigm permits to ingress the information from anywhere, anyplace that having a grid generation continuously. From the application viewpoint, divergent devices data congregate and dump at desperate locations uniquely and articulation to use the expedient should be non-identical.

IoT services become necessarily colonize to transfer the emerging data fundamentally. Cloud paradigm networks having a limitations of high-latency, poor Quality of service. Hence, this software comes to naught to handle the billions of details from geo-circulation IoT devices/sensors. CISCO innovates Fog Computing phenemenon as it works on already connected devices in IoT to scuttle at fringe networks. By manoeuvre the fog computing concept,many more implementations deals so close to recognize triable and tremendous statistics. When compare both fog and cloud, fog provides many supportive features related to storage, communication between client and server and geo-graphical compilation along the system to support the system quality.The fourth Industrial revolution called as Industry4.0, is todays industrialproduction from a disreptive paradigm capitulate from the Information and Communication Technologies.To implement the fog computing concept in Industries4.0, the integration should be performed between cyber-physical systems and IoT apparatus. Industries develop huge amount of data, compiles with cloud computing, becomes a crirical phenemenon.Cloud software authorize vertical and horizontal paradigms in conjunction to provide efficiency, scalability, flexibility. However, the IoT based deployments have numerous requirements,cloud not proficient to join each and every of it.Fog computing(FC) deals out enumerate exemplar as halfway of cloud data center and IoT appliances. Its comes very nearer to IoT contraption to propound better networking and storage facilities whereas cloud has limitations across the properties as latency, power and location awareness.

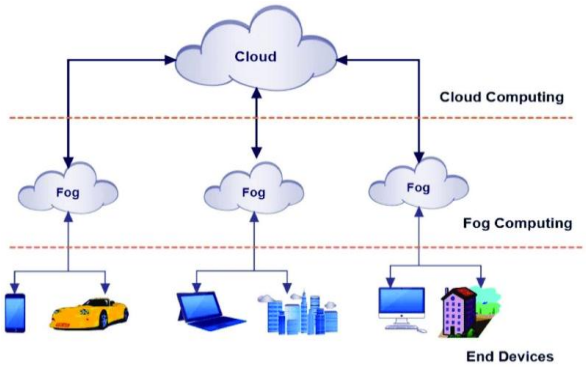

Fig1: Architecture of Fog

In this paper, a novel plan of IoT application architecture is observed to ingress many elements of IoT at application level. Thereby, the communication between IoT devices and

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IoT resources should be improved. By placing a fog server in between edge devices and cloud layer, it can blaze IoT services systematically. Also a process to reduce the vitality at Industry4.0 by using fog-based architecture. According to the application requirement, it can scrutinize pliable networks, calculated huge load, developed by divination progress.

A Fog consists of ancient networking elements examples as routers, switches, gateways, prime boxes etc.., which placed betwixt of IoT appliances to implement an application and cloud software. The relevant fog node representation is as shown in Fig.2.

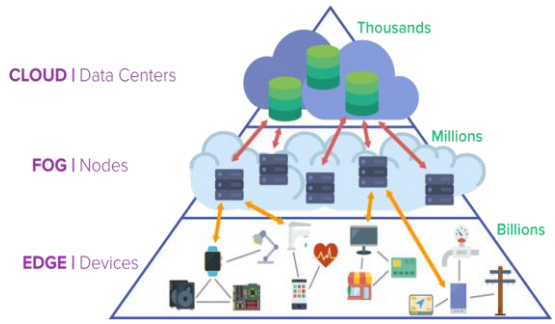

Fig2: Fog nodes of FC architecture

These elements area unit supplied with various computing, storage, networking, etc.., to cloud services using Fog computing establish enormous geo-graphical distribution. However, fog supports mobility and access time-sensitive information and having location awareness along with scalability. Thereby, fog will differ from cloud with greater efficiency, low power usage, low delay and jitter. Hence, fog correlates the requirements with relevance to cloud contrast.

2. RELATED WORK

A. OVERVIEW OF FOG

Fog computing is defined in words to meet the objectives of equal notions. Fog computing is a software platform considered as non-trivial supplement of menace access where summons and interventions will relocate the fog having some illustrious possessions.

Generally fog concept orally represented as *"Fog computing is a geographically distributed computing architecture with a resource pool consists of one or more ubiquitously connected heterogeneous (variegated)devices (including edge devices) at the sting of network and not solely seamlessly backed by cloud services, to collaboratively provide elastic computation, storage and communication (and many other new services and tasks) in isolated environments to an outsized scale of purchasers in proximity".*

B.NEED FOR FOG

IoT dispenses with big data investigative, Mobile and cloud computing where IoT is trending automation. Internet of things guarantees to implement high-range functions related to homes, automation of vehicles as smart works. To increase the possibilities and requirements evaluation, IoT needs a maturing creativity to make an application reliable at gateway functionalities.

IoT collaborates with cloud to store the data gathered from appliances whereas it requires backup and more time to perform an action regarding implementing application of IoT. Hence, it's become a drawback; IoT needs a progress in smart way and need quick action.

CISCO coined to invent fog computing. Fog computing emeses with IoT applications whereas the fog nodes can analyze the time-period data at edge of networks and sends the data which is selected by fog to cloud for historical and future employment.

C. FOG NODE

Fog nodes are the hardware appliances or physical elements as gateways, switches, cloudlets9, routers etc.., to provide the essential resources for IoT applications through these apparatus.

The fog nodes can be in between the cloud layer and IoT application layer in suburbanized manner to organize the mechanism at geo-locations dispense over the scalability to federate along to form cluster of nodes/servers.

D. COMPARISION OF FOG WITH CLOUD

Here orally shows the comparison between computing paradigms:

1. **Latency**- Low in fog as compared to cloud.
2. **Location of service-** In fog, the services can be provided at the edge of the network whereas in cloud, it performs within the internet.
3. **Security-** Security can't be defined in cloud compared to fog, it's definable.
4. **Location awareness-** There is no availability of location awareness in cloud.
5. **Geo-distribution-** Fog is a distributive paradigm whereas cloud is a centralized.
6. **Real-time interactions-** In cloud, real-time interactions are not supported.
7. **Mobility-** Cloud not supports mobilization.
8. **No of server nodes-** Fog has a multiple number of nodes compared to cloud.

3. FOG COMPUTING-DESIGN

A. FOG COMPUTING WITH IoT

The overall mode of FC is shown in Fig. 3. The procedure of FC service is represented as follows:

1) The information is collected from multiple number of devices/things.
2) Fog nodes can be allotted to collect the variety of data related to IoT application.
3) Fog nodes; retrieve the data which are sent by IoT appliances.
4) After the retrieving of data, the valuable data which can be useful for future references directly pass on to the Cloud.
5) Whereas fog supports distributive process, the devices can change the location according to the fog topological structures.
6) The data directly stored in cloud according to the rules and patterns of fog data services.

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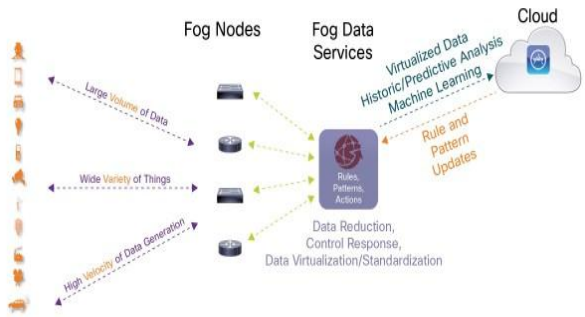

Fig3: Architecture of Fog with IoT

1) Hardware Platform:

To perform an IoT application, hardware can be easily designed to leverage the Fog architecture, whereas FC transpires to place the character concerning to the hardware devices. It's should have two premises according to appliances.

Firstly, the equipment has to manage with ease along with contribution and compatible interfaces for programming. To convince the premise request, a primary alternative towards the embedded system can be an ARM board. However, ARM has many applications with IoT.

Secondly, a main purpose is to improve the speed of computing. Although, ARM has wonderful process energy to concern the implementation towards the complicated platforms/designs.

Field Programmable Gate Arrays documented as hardware to work in complex designs.ARM and FPGA collaborates the functioning between cloud and IoT application. To implement an adequate IoT application, ARM works to manage the design and FPGA on algorithms. It will be advantageous to fix nodes between the application and software layer.

2) Software Platform

Hadoop, Spark and Open Stack software's are taken into consideration to perform action on ARM datacenters. From PC server to embedded hardware, the data computing platform become a possible and acrobatic proceeding.

The abstraction layer designs on Open stack. To probe, analyze, set up the employment during huge information, the orchestration layer is deployed. By considering an example, ARM core employed with open stack along with Hadoop, Spark and a lot of facilities to figure the genus apes.

3) Cloud Assist

Fog requires an issue for agreeable controlling the cloud and maintenance are clearly difficult to handle manually on an area device. As an example, the programs for processing are at the start put in within the RAM to perform storage. Modifications can be performed on patch and configurations towards the downloaded stuff related to programming.

B. PRIVACY CONCERN

Privacy becomes an major obligation to recover as soon as possible. Besides some ancient techniques as reputation based dimensions may be thanks to cut back danger information outflow that relates to world data. However an outsized node, the data can be reduced to minimum the effect of latency.

4. APPLICATIONS OF FOG COMPUTING

There square measure several significant areas as shown in figure4 wherever fog computing will play an important role in several IoT applications. Here the IoT applications are related to fog to shown the benefits between them.

4.1. Connected automotive

According to Cisco, automation may be a challenging cars task. These square measure several positive options, that rely upon the fog and net property, which will be adscititious to cars like driverless car and "hands-free" operation or park can be done by self individually. The cars can be able to communicate with other cars within a few years by using fog computing concept.

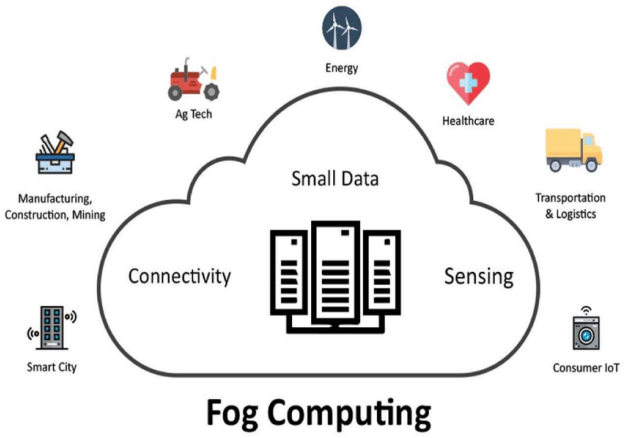

Fig4: Fog with IoT applications

4.2. Smart Traffic

Sensing the presence of pedestrians and cyclists by traffic sensing flashing lights can be performed with fog computing concept. Whereas using fog computing, to measure the space and speed of the vehicles that is closer to the traffic lights. These lights are also thought-about to be fog nodes that square measure synchronic with one another to send acknowledgements to close vehicles.

4.3. Smart Home

Integration of different platforms empowers an good home application. Fog computing benefits home security application. It unified interface to integrate all totally different freelance devices. It provides springy resources to change the properties of geo-distribution.

4.4. Wireless device and mechanism Networks

The main options of wireless mechanism networks are that to extend lifetime of networking platform by working at principally low capability. It extends the usage through the less information measure, less energy.

4.5. Health care and Activity chase

Fog computing is an important concept in health care. It provides data evaluation and responses that square measure essential in health care. Additionally, the interaction of an outsized variety of health care devices for storage, process

and case history enhancement from the cloud needs a supportive network affiliation that isn't on the market. It additionally addresses problems relating to network property and traffic.

4.6. IoT and Cyber–Physical Systems

The combination of IoT and Cyber-Physical systems (CPs) can convert the globe into a computer-based physical reality as connected vehicles, smart way buildings, robotic and agricultural innovations.

4.7. Increased Reality

Virtual reality (VR) adds virtual data to the platforms $64000 world. VR becomes a crucial application because of having the small devices, storage compatibility. Fog computing has flexible to become a key player between the fog and cloud.

5. BENEFITS –FOG COMPUTING

Fog computing has many benefits when compared to cloud. The benefits are listed as follow:

1) **Greater business agility**: Fog computing applications quickly deployed and developed. These applications can progress the work by using machines as per consumer wish.

2) **Low latency:** Fog concept supports time-sensitive services whereas it works on data retrieval mainly.

3) **Geographical and giant-scale distribution:** Fog distributive computing can store resources to large and cosmopolitan applications.

4) **Low operative expense:** Saving network information measure by process elect information regionally rather than causing to analyze the cloud.

5) **Flexibility and heterogeneity:** Fog computing permits different infrastructures among multiple services relates to different environments.

6. CHALLENGES-FOG COMPUTING

The fog computing offers different advantages for various applications deployed through IoT. Whereas it has several challenges to overcome and provide better outlook in Fog computing as shown in Figure5.

(1) Scalability: Iot devices/sensors can generate huge amounts of data as billions of Iot devices manageable through fog nature. Hence, it requires adequate resources for fog servers such as to process power and storage.

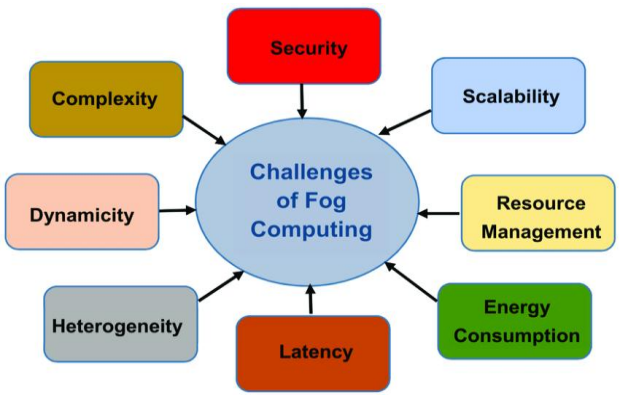

Fig5: Challenges of Fog Computing

(2) Complexity: Many IoT devices are designed by different manufacturers as if choosing the optimal components are very complicated. It needs septic hardware and protocols to operate, which will increase the difficulty of the operation.

(3) Dynamicity: Fog nodes can adopt their structure as fog supports mobility. It's become complicated to perform an operation because of this dynamical workflow.

(4) Heterogeneity: Management and co-ordination of networks become a key challenge as per the application resources.

(5) Latency: Fog has capacity to overcome latency issue. There are a several unit factors presenting a high latency of application towards the application performance.

(6) Security: Security providence is directly not applicable to fog because of mobility, heterogeneity. The cryptography format is to enhance the network to safeguard the devices of fog environment.

(7) Resource management: Smart management of fog resources can be needed for efficient operation analysis through fog servers.

(8) Energy consumption: Multiple fog devices can distributed regards energy efficiency becomes less. Therefore, reduction of energy can be a vital challenge.

7. CONCLUSION

Fog computing combines cloud and on-the-spot computing. With the management authority, overall automation management and analytics primarily based within the cloud, associate on-premise entry answers the challenges identified as being crucial for any IoT preparation.

By relegating some responsibility to the native entry the production facility isn't most in danger from a web failure. This autonomy implies that production will continue whereas with a exclusively cloud-based approach it might stop.

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