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Exploring Internet of Things Applications, Technologies, Challenges in the Cloud and Use of Fog Computing in IoT Devices

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Abstract: The main purpose of this critique is to deal with the features of Internet of Things, applications, challenges involved with the storage in cloud with IoT and making IoT to utilize the fog computing. The promising model of this approach is the assimilation of technology with wireless sensor networks, communication protocols and smart objects. The objective of this consideration is focusing on Internet of Things vision and its emerging applications for different domains such as health care sector for continues health monitoring, industrial domain for analyzing water quality, home and office security door systems, city traffic controlling system, agriculture domain for soil monitoring application, and Challenges in the traditional network architecture. The major challenges are latency problem and slow response due to voluminous and variety of data handled while using cloud with IoT devices. The proposed solution is connecting the nearby IoT Devices using Fog nodes along with cloud will avoid the latency problem in the cloud.

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Keywords: Fog computing, IoT, Cloud computing

I. INTRODUCTION

Internet of Things (IoT) is the picture of connecting physical devices to the network for communication with a lesser amount of human interaction and involvement. Figure 1 shows the example of interconnected networks in IoT[1]. The interrelated system includes different domain like, vehicle, person, pet, agriculture automation, energy consumption, security, surveillance system, building management, health care, smart homes and cities, everyday things, machine-to-machine communication, wireless sensor network and embedded mobile.

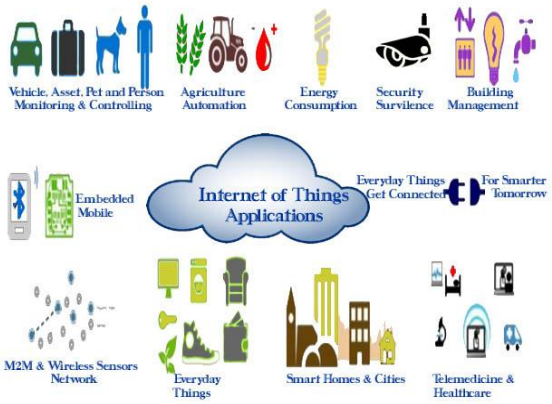

Figure 1: IoT applications for different domains

According to the Cisco's forecasting, the Machine-to-Machine connections will be increased from 24% to 43% in the year 2014 to 2019, respectively. So, data latency problem will occur while fetching large volume of Data from the cloud storage that is generated by IoT devices. To overcome data latency problem, this paper proposes the concept of using Fog computing to connect the IoT Devices along with cloud**.**

This paper is organized as follows. Section II describes the related study on IoT applications in various domains. Section III explicates the challenges in IoT with cloud architecture. Section IV provides the suggested solution known as fog computing with IoT devices along with cloud architecture. Section V concludes the paper with future research domains emerging with Internet of things in the nearby future.

II. RELATED WORK

This section describes about major IoT applications used in different domains that are summarized in Table 1 and the technologies involved with these domains are discussed below.

Table 1: IoT applications in different domains

DOMAIN	**PURPOSE**
Human	Health Monitoring
Home, Office	Security Door system
Agriculture, Surveillance system	Environmental monitoring
Industry	Water quality
City	Smart traffic control

[2]Partha Pratim Ray [2016] proposed an IoT and allied components. The components are wearables, communication technologies, hardware's, cloud platform etc. Then the comparisons between existing wearable's system, communication, hardware platforms to current system. By using the method pie – chart format the result will differentiated, which is more suitable platform for develop IoT application for e-health care sector.

[3] S. Nazeem Basha [2016] representing an intelligent door application using IoT. It notifies instruction by sending email or notification to the vendor. Each entry of the door data can be stored into Google spreadsheet of owners account. Materials used in this system are Raspberry Pi, ADXL345 accelerometer, and Amazon Web Service. Finally, the motion of the door can be detected and put entries on Google spreadsheet and send the notification to owners mobile as well as email. This application mainly developed for security purpose.

[4] Shailaja.M.Gunda Nikkam [2016] explained, analyzing the quality of water in the industry sector. The problem is today water can be polluted by industries. Through this system can solve that problem. First it needs the data like, PH level, turbidity, water rate etc. Manual process takes much time to find the quality. Through this system the water can be continuously monitored by using IOT, WSN, MCU communication standards, level sensors, turbidity sensors and temperature sensors.

[5] Ms.SupriyaChandrakantPadwal and Mr. Suraj Vishnu Kurde [2016] proposed the functional design and implementation of WSN platform, which is used for a long term environment monitoring in Iot applications for different domains. They explained totally four domain i.e. Agriculture domain, Surveillance system, Medical domain and Military domain. The important role of WSN in IoT is low cost, fast deployment and long unattended service time.

[6] S.Sivagami [2016] proposed the Smart Hospital System (SHS), which integrates IoT. The main aim of this application is to continuously monitoring the hospital patient's health. It includes the technologies, especially smart mobiles, WSN, RFID, CoAP, REST and Ipv6 etc. SHS provides number of key capabilities and piece of innovation. The result of the proposed system demonstrates appropriateness and remote patient monitoring and immediate handling of emergencies.

[7] Hon Fong Chong [2016] proposed the system Green light phase time (GLPT). This system is to control Traffic congestion in urban cities. GLPT system has two algorithms. Fixed cycle algorithm and dynamic algorithm. Fixed cycle traffic light system (TLS) is first introduced algorithm to solve traffic congestion. But, fixed cycle TLS is unable to cope with traffic. Dynamic algorithm overcomes these problems. An Intel Edison collects real-time traffic flow and Microsoft Azure IoT cloud server. Cloud server assign priorities to each road bounce based on present traffic volume. Green light phase time (GLPT) is utilizing a dynamic algorithm. The results showed that dynamic cycle TLS reduces queue length and waiting time on the road intersection. In addition, a monitoring application is designed for traffic officer to monitor real-time traffic flow.

[8] Yashashree Joshi [2016] proposed the system the use of infrared sensor in IOT. This system explained, placing infrared sensor on the road for alarming the traffic state. There is variety of applications available for controlling traffic using WSN. But, the problem is cost, maintenance and installation cost in WSN is very high. The solution for solving this problem is infrared sensor offers minimum cost and maintenance.

[9]Pooja Kanase[2016]explained the system for smart hospital using internet of things and combination of sensor technology. This paper proposed the concept of controlling saline bottle and electricity in the hospital using Ultrasonic sensor and temperature sensor. These sensors can be attached to the microcontroller (ATMEGA Atmel 328p). Because of excessive number of patients and relatives crowd, hospital staffs are unable to monitor the patient's saline bottle; it causes the heart attack patients to die. Next, monitoring electricity in the hospital lights, fans etc. Through this proposed system hospital staff can able to monitor the saline bottle and electricity power supply in the hospital.

[10] Kai Ding [2016] proposed the RFID technology for manufacturing environment. The RFID technology is generally used in production (manufacturing) environment. The main purpose of RFID in manufacturing environment is to find the hidden information, knowledge, and rules, which are invaluable for real-time production control and decision-makings. Thus, a well-organized analysis method is required to use with the very useful data. This work introduced an RFID invention data analysis method for manufacture control in IoT based smart job-shops. An RFID-based manufacture data model is built to make official and compare the variety of manufacture data.

[11] Imtar Chaudary [2016] proposed the system called smart home automation based on IoT. This system uses PCs, mobile phones and remote devices to control vital operations in home automatically from anyplace in the world, using internet. This system differs from existing system, because it allows the user to control the system from anywhere in the world by using internet. This system is implemented a home automation system using sensor nodes that are directly connected to Arduino microcontrollers.

From all the above discussed related works, the major technologies involved with IoT devices are listed below.

- Different types of Sensors and actuators
- RFID (Radio Frequency Identification)
- WSN (Wireless Sensor Network)
- Cloud platform (such as Microsoft Azure server)
- Microcontroller (Rasperry Pi, ATMEGA Atmel 328p and Arduino)
- Accelerometer (ADXL345)
- Web Services (like Amazon web Service)

III. CHALLENGES IN IOT APPLICATION WITH CLOUD

IoT devices raise many challenges for the conventional network architecture. At present IoT devices (application) constantly generates more data for each and every second. These data can be stored into the cloud, analyzing the cloud data sometimes cause data latency problem in the network. To deal with these problems, this paper proposes a latest model of IoT architecture. This architecture combines benefits of two emerging technologies, cloud and fog computing.

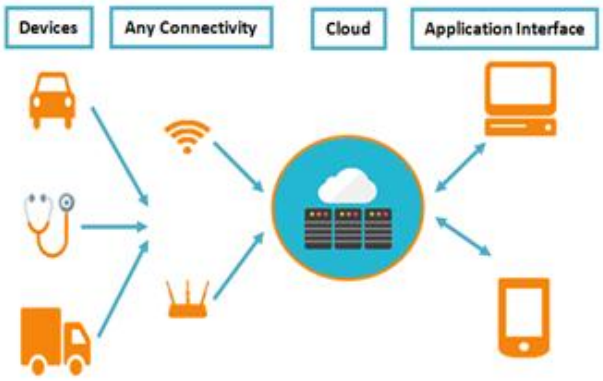

Figure 2: Conventional IoT Architecture

Organizing 3V's (volume, variety and velocity) in IoT applications data need an innovative computing model. The intelligence of approaching the smart IoT objects are realized and improved by the "value" of Big Data[12].
The main requirements are:

- Reduce latency
- Preserve network bandwidth
- Tackle security concerns
- Run reliably
- Place data into to best place for processing

Conventional cloud computing architectures do not fulfill all of these requirements. So Cisco introduced a new emerging technology called fog computing.

IV. FOG COMPUTING BETWEEN CLOUD AND IOT DEVICES

"Fog computing refers to extending cloud computing to the edge of an enterprise's network. It is also known as Edge Computing or fogging. Fog computing facilitates the operation of compute, storage and networking services between end devices and cloud computing data centers."

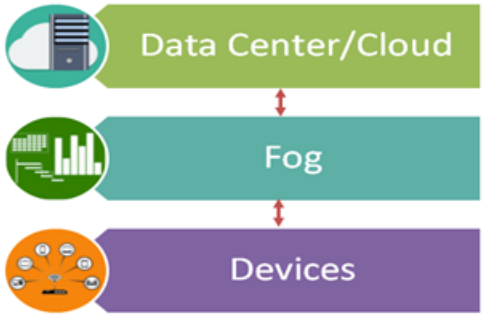

Figure 3: The Fog Extends the Cloud Closer to the Devices Producing Data

By using the fog network, it is possible to avoid network latency problem. The main advantage of fog computing is quick response comparing to cloud. Table 2. Shows Fog vs. Cloud.

Table 2: Fog vs Cloud

Comparison factors	Fog nodes closet to Iot Devices	Cloud
Response Time	Milliseconds	Minutes, Days or Week
How long IoT data is stored	Transient	Months or Years

V. CONCLUSION

Today, Internet of Things is the most popular model in connecting physical objects together. Hence making the communication between several media and physical thing at anywhere at any time is possible. In addition, this paper highlights on the applications of Internet of Things and focused on the future research domains of Internet of Things. For the most part, the major problems in the field of Internet of Things discover privacy, security, interoperability, legal rights and emerging development. Definitely, in the upcoming years, the problems will be overcome by the research groups from the academia and industries.

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Authors Profile

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