A REVIEW OF CLOUD COMPUTING AS A COMPLIMENTING AID TO INTERNET OF THINGS

Abin T Abraham[1], Dr. E.J. Thomson Fredrik[2]

ABSTRACT

Cloud computing is an established technology which offers on-demand access to services such as storage, processing etc. Internet of Things (IoT) is a specialized domain which leads to scenarios where each object (Things) can communicate with other objects to perform some tasks. Cloud architecture can be used as aid to leverage the full potential of Internet of Things (IoT) in terms of performance, storage, collaboration, reliability, etc. This paper provides an overview of combining IoT with cloud computing architecture and some challenges and issues faced on integration. The main purpose of this survey is to provide all the possibilities of Integrating Internet of Things with cloud computing for providing on-demand access to computational resources in a flexible and scalable manner. It will be helpful for further research.

Key words — Cloud computing, Internet of Things, Integrating Cloud computing with IoT,

I. INTRODUCTION

Nowadays most of the devices are getting smarter as the result of a huge amount of data generated. The huge chunks of data thus generated from the distributed devices are further transferred to a secure cloud for further processing. Enterprises are moving to a cloud-based solution which offers scalability, reliability and security.

II. INTERNET OF THINGS

Modern societies are seeing an unmatched surge in the number and range of devices deployed and used in day-to-day applications, including mobile phones, tablets, wearable devices and other connected sensing and actuation devices, collectively referred to as the Internet of Things (IoT) [1]. As per the latest surveys more than 50 million devices will be deployed by the year 2020.

The devices might be capable of storing data in the device or the data can be transferred to cloud through internet. The following are the major advantages of using cloud computing techniques in IoT devices.

1. Scalability
2. Security
3. Collaboration of data
4. High Availability of data
5. Integration with Mobile, web or desktop applications

A. Scalability

Cloud platform is well known for its pay-as-you-go policy. We can expand the storage as the data generated from the device get expanded. For research and analysis purpose more historic data are required and can be availed of by integrating a cloud architecture to the IoT devices.

B. Security

Security is the most important factor while thinking about storing data. Most of the cloud platforms like Azure, AWS, Google cloud etc. offer both physical security as well as data access security. Physical security deals with the protection of data centres while data access security deals with the prevention for various attacks.

C. Collaboration of data

Collaboration is yet another aspect of cloud. We can collaborate data from different devices

[1]*Research Scholar, Department of CS,CA & IT, Karpagam Academy of Higher Education, Coimbatore, India*

[2] *Professor, Department of CS, CA & IT, Karpagam Academy of Higher Education Coimbatore, India*

D. *High Availability of Data*

The data stored in cloud are available 24*7 so that we can access the data from anywhere any time. Also, data stored in cloud systems have replicas in different locations, so there are less chances of failure.

E. *Integration with Mobile, web or desktop applications*

Since data stored in cloud have cross platform accessibility, developers can easily create applications using any platform such as IOS, Android, Windows or Linux.

III. APPLICATIONS OF CLOUD-BASED I

A. *Smart homes and appliances*

IoT based devices have their own existence in digital homes. Houses are becoming smarter day by day. Most of the devices available in the market are smarter in a way that it can be controlled by a local Wi-Fi network. Recent reports suggest that even door security (access control) is taken care of by IoT based solutions. Cloud-based IoT smart homes can be even controlled from across the globe or we can induce Artificial Intelligence to the IoT devices based on historic cloud data to make the device smarter. Several issues in Energy management such as managing air-conditioning, heating, lighting can be easily resolved using Cloud-based IoT solutions [2].

B. *Logistics and freight forwarding*

A major pain in logistics industry is tracking of the goods. To an extent IoT devices can support the tracking of goods. According to Jeff Bezo, Amazon CEO small drones can deliver cargo worth up to five pounds.

C. *Automobile industry*

In modern era automobile industry is renamed as smart mobility. Many of the automobile manufacturers are embedding smart devices in their vehicles which have the capability of monitoring the vehicle conditions and location. GPS devices have made a great revolution in this area, which have the capability of tracking the vehicles in unfavorable conditions.

D. *Retail shopping*

In retail shopping IoT based systems are equipped with low cost RIFD tags. Smart shelving can be added into this system, equipped with RFID readers, and can monitor stock, perhaps also updating a central server. Inventory management can be made easier using IoT enabled devices instead of manual scanning of stock items [3].

E. *Video Surveillance*

Intelligent video surveillance is an inevitable tool in security related applications. Storing videos may require huge disk space which can easily be managed by a cloud vendor. Cloud solutions offer to store and manage the content generated from IP-based and analog cameras [4].

IV. ARCHITECTURE OF CLOUD-BASED IOT ENVIRONMENT

Cloud-based IoT environment may consist of 3 major layers

1. Sensor Layer
2. Network Layer
3. Application Layer

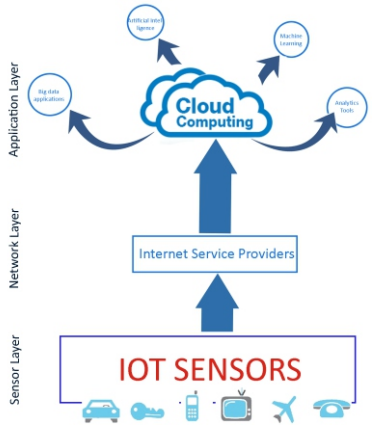


Figure 1 Architecture of a Cloud based IoT Environment

A. *Sensor Layer*

Sensor layer is the base layer in the IoT-based systems. This layer may consist of different types of sensors equipped in different devices such as smart phones, smart homes, vehicles, etc. These sensors will generate different values they are intended for and transfer them to the next layer. Sensor-based systems may have limited memory. So it is advisable to store the data in a cloud-based system.

B. *Network Layer*

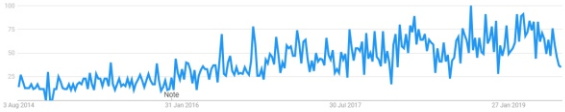
Responsibility of Network layer in IoT is to transfer the data to cloud. The connectivity to cloud is established with the help of Internet Service Providers (ISPs). Connectivity is possible through a Local Area Network (LAN), Wi-Fi, GSM networks, etc., which can access internet. IoT systems which require higher level of portability use mobile networks such as GSM network.

C. *Application Layer*

Application Layer is the layer in which the data obtained from the cloud are processed. Different modern techniques such as Artificial Intelligence, Machine Learning or Analytics method is applied to the raw data to make them presentable and useful. Many of the cloud providers like Azure and Amazon Web Services (AWS) are giving analytics and Machine Learning features as standard tools.

V. INTEGRATION OF CLOUD COMPUTING AND INTERNET OF THINGS REVIEW

Cloud computing combined with IoT has gained more popularity in the past few years. As a result more papers are published in this area. Figure 2 Shows the research and interest regarding cloud and IoT for the past five years.



Usually IoT sensors are tiny devices which have less capabilities for processing power, storage, memory etc. The capabilities of cloud can be used to compliment the limitations of tiny IoT devices to produce better results. IoT sensors produce a huge amount of structured, semi-structured or non-structured data [5]

IoT devices are generally small devices which can generate data, but they have limited capability of processing the data. Data collected are transferred to more powerful nodes which are capable of processing the data. In such cases scalability is a challenging task. Capabilities of cloud enable users to process and analyse the data generated from IoT-enabled devices in on-demand model [6].

Issues in Cloud integration with IoT

1. *Diversity:* Internet of Things (IoT) is the combination of diverse devices, platforms, operating systems and services. There are no defined standards for the generated data form these heterogeneous devices [7].
2. *Performance:* There may be performance lags while integrating cloud with IoT. In order to overcome the same QoS (for storage, communication, computation) are implemented at several levels [8]
3. *Storage*: By 2020, it is estimated that around 50 billion devices will be networked. Special attention is required for the storage, transportation and processing of the data that will be produced by the devices. Popularity of mobile devices will prompt the industry for scalable storage in cloud computing architecture [9].
4. *Monitoring:* Monitoring is a crucial activity in the cloud environment for planning the capacity and resource management [10].

Cloud computing is expected to play a significant role in IoT paradigm. Cloud storage and processing capabilities are essential to make the IoT vision a reality [5].

I. CONCLUSION

In reality cloud computing offers endless possibilities while integrating with Internet of Things (IoT). Cloud architecture refers to an infrastructure where data are processed and stored. The possibility of integrating cloud with Internet of Things (IoT) extends from storage to processing of data. The challenges surveyed in this paper could be helpful in further research.

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