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Survey on Cloud Based Internet of Things Environment

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Abstract: ***Internet of Things concept has evolved rapidly in recent years. It can be seen as an umbrella term for interconnected technologies, devices, objects and services. The IoT is the most important concept of Future Internet for providing a common global IT Platform to provide backend solution for processing huge data streams and computations on a seamless network. Cloud computing is an emerging model of network resource delivery and usage. This is how the both technologies integrate. This paper discusses the Internet of Things (IoT) within the cloud computing concepts and architectures. We review different frameworks of combined IoT architecture with cloud being in the center.We propose a novel framework that incorporates and supports adaptive interaction of the user with the IoT cloud architecture.***

Keywords: Internet of Things (IoT), Cloud Computing, Cloud paradigms (Iaas, Saas, Paas, Daas), WSN, CoT, Smart warehousing, Security layers, Application.

I. INTRODUCTION

The internet of things is a term that has been around for several years. In the future people will be connected anytime, anyplace with anything and anyone and appropriately utilizing any network and any service. In other words IoT addresses the convergence, content, collections, computing, communication and connectivity between people and 'things'. [3]

On the other hand cloud computing is regarded as backend solution for processing huge data stream and computations while facing the challenges of everything will be connected with seamless network. Cloud technologies can provide virtual, efficient and flexible data center for context-aware computing and online services to enable IoT.

Both of them are trends of future internet. However the developments of IoT technology are not interoperable. That results the service provider and operator have no definite specification to follow. On the other hand cloud computing are dependent on service providers [4] .These days many of the devices we use and encounter daily are smart devices starting from mobile phone and TV to our car and even kitchen appliances. This leads us to the internet of things concept which is semantically defined as "A worldwide network of inter connected objects uniquely addressable, based on standard communication protocol." Hence, cloud acts as a front end to access Internet of Things. Applications that interact with devices like sensors have special requirements of massive storage to storage big data, huge computation power to enable the real time processing of the data, and high speed network to stream audio or video. In this paper, we describe how Internet of Things and Cloud computing can work together can address the Big Data issues[2] .We also illustrate about Sensing as a service on cloud using few applications like Augmented Reality, Agriculture and Environment monitoring[1].

II. BACKGROUND

1) Internet of Things

The Internet of Things is an emerging global Internet-based information architecture facilitating the exchange of goods and services. The IoT has the purpose of providing an IT-infrastructure facilitating the exchange of "things" in a secure and reliable manner, i.e. its function is to overcome the gap between objects in the physical world and their representation in information systems. The IoT will serve to increase transparency and enhance the efficiency of global supply chain networks.[5]

The IoT is a very complex platform for the connection of things based on objects being tagged for their identification, but also sensor, actuating elements and other technologies. In the paper, the focus is put on the identification of things, which is the most important aspect of the IoT.[9] Extending the initial application scope, the IoT might also serve as backbone for ubiquitous computing, enabling smart environment to recognize and identify objects, and retrieve information from the Internet to facilitate their adaptive functionality.[6]

Through the IoT, everyday objects(such as car, refrigerator, TV, Phone etc as well as more advanced, computer and information service) will be able to interact and communicate. "Things" do not have to be products of higher technology – any one of the around 50,000 billion objects existing on earth can be introduced in the IoT.[5]

Many good examples have been provided. They include cars warning other cars of traffic jam, a cell phone reminding a person when it was last left next to keys, a wastebin inquiring its contents about their recyclability, or a medicine cabinet checking the storage life of medications in it. For these reason IoT described as new terms such as 'ubiquitous computing', 'pervasive computing', 'things that think', 'ambient intelligence', and 'silent commerce'. [9]Each of the term describes a significant research avenue; they are all characterized by theadvent of everyday physical objects equipped with digital logic, sensor, and network capabilities, which together forms the internet of things. Haller defined IoT as "a world where physical objects are seamlessly integrated into the information network and where the physical objects can become the active participant in business process."

2) Cloud Computing

The Cloud computing emerges as a new computing paradigm which aims to provide reliable, customized and dynamic computing environments for end-users. Cloud computing is one contemporary technology in which the research community has recently embarked. Cloud Computing provides us a means by which we can access the applications as utilities, over the internet. It allows us to create, configure, and customize the business applications online.[8]

With rapid development of processing and storage technologies and the success of internet, computing resource have become cheaper, more powerful and more ubiquitously available than ever before. The technological trend has enabled the realization of a new computing model in which resources (e.g. CPU and storage) are provided as general utilities that can be leased and released by user through the internet in an on demand fashion. Here traditional role of service provider divided into two: the infrastructure provider and the service provider.[8]

The Cloud Computing architecture comprises of many cloud components, each of them are loosely coupled. We can broadly divide the cloud architecture into two parts:

- Front End
- Back End

Each of the ends are connected through a network, usually via Internet.

Front End refers to the client part of cloud computing system. It consists of interfaces and applications that are required to access the cloud computing platforms, e.g., Web Browser.

Back End refers to the cloud itself. It consists of all the resources required to provide cloud computing services. It comprises of huge data storage, virtual machines, security mechanism, services, deployment models, servers, etc. [8]

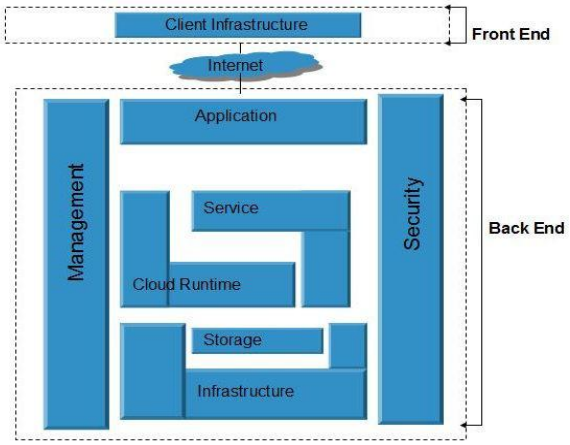

Fig 1.The Cloud Computing Architecture

There are several types of cloud computing infrastructures which consist of servers, storage, network, management software, and deployment software and platform virtualization, such as public cloud, private cloud, community cloud and hybrid cloud. [8]

- The **Public Cloud** allows systems and services to be easily accessible to general public, e.g., Google, Amazon, Microsoft offers cloud services via Internet.
- The **Private Cloud** allows systems and services to be accessible within an organization. The Private Cloud is operated only within a single organization. However, it may be managed internally or by third-party
- The **Hybrid Cloud** is a mixture of public and private cloud. Non-critical activities are performed using public cloud while the critical activities are performed using private cloud
- The **Community Cloud** allows system and services to be accessible by group of organizations. It shares the infrastructure between several organizations from a specific community. It may be managed internally or by the third-party.

[8]To accomplish this complex infrastructure the cloud needs to be agile, flexible, scalable, multi-tenancy, and secure.

- **Infrastructure as a service (IaaS)** provides access to fundamental resources such as physical machines, virtual machines, virtual storage, etc. IaaS allows the cloud provider to freely locate the infrastructure over the Internet in a cost-effective manner
- **Platform as a service (PaaS)** offers the runtime environment for applications. It also offers development & deployment tools, required to develop applications. It allows the developer to create database and edit the application code either via Application Programming Interface or point-and-click tools.
- **Software as a Service (SaaS)** model allows to provide software application as a service to the end users. Using SaaS has proved to be beneficial in terms of scalability, efficiency, performance and much more.
- **Development as a Service (DaaS)** is web based, community shared development tools. This is the equivalent to locally installed development tools in the traditional (non-cloud computing) delivery of development tools.[8]

So Cloud computing is attractive to business owners as it eliminates the requirement for users to plan ahead for provisioning, and allows enterprises to start from the small and increase resources only when there is a rise in service demand. That's how cloud computing offers huge opportunities to the IT industry development.

III. Importance of Merging Cloud Computing with IoT

Cloud and IoT are two complementary technologies merged together are expected to disrupt both current and future Internet. The integration of Cloud and IoT is a really promising topic for both research and industry. With rapidly increasing Wireless Sensor Networks (WSNs) and Internet of Things (IoT) based services; a lot of data is being generated. It is becoming very difficult to manage power constrained small sensors and other data generating devices. With IoT, anything can become part of the Internet and generate data. Moreover, data generated needs to be managed according to its requirements, in order to create more valuable services. For this purpose, integration of IoT with cloud computing is becoming very important. This new paradigm is termed as Cloud of Things (CoT). CoT provides means to handle increasing data and other resources of underlying IoT and WSNs. It also helps in creating an extended portfolio of services that can be provided with this amalgamation. In future, CoT are going to play a very vital role. Cloud computing can enhance the IoT objects with high performance computing capabilities and huge storage resources.

The key challenges in cloud computing to enable future internet of things are

IoT requirements	Cloud challenges
Highly **dynamic** resource demands.	Support for application **elasticity**
Real-time needs	**Quality of service** assurance.
Exponential growth of **demand**	Infrastructure **scalability**
Availability of application	Cloud **reliability**
Data **protection** and user privacy	Cloud **privacy** and security
Efficient **power consumption**	Efficient **energy resource**
Access to an open **interoperable** cloud ecosystem.	Cloud **interoperability** and portability

Table 1. Key Challenges

For example IoT applications often require a large number of devices which are very difficult to implement because of restriction of time, memory processing and energy constraints. Calculation of a daily temperature variation around all over the country may require millions of devices and result in unmanageable amount of data. And the deployed hardware in IoT often have different hardware characteristics such as sampling rate, error distribution. To manage all the heterogeneous data stream cloud computing is the only solution of a successful implementation of IoT.

IV. Related Work

The digital space has witnessed major transformations in the last couple of years and as per industry experts would continue to evolve itself.[10] . The latest entrant to the digital space is the Internet of Things (IoT). IoT can also be defined as interplay for software, telecom and electronic hardware industry and promises to offer tremendous opportunities for many industries.

Department of Electronics and Information Technology,(DeiTY) has come out with a draft IOT Policy document which focuses on following objectives:

i. To create an IoT industry in India of USD 15 billion by 2020. It has been assumed that India would have a share of 5-6% of global IoT industry.

ii. To undertake capacity development (Human & Technology) for IoT specific skill-sets for domestic and international markets.

iii. To undertake Research & development for all the assisting technologies.

iv. To develop IoT products specific to Indian needs in all possible domains.

V. Storage Management

With the development of enterprises and the constant demands of the product diversity, traditional warehouse management model cannot meet that, due to its heavy workload and low efficiency. [3] This needs a new type of intelligent warehouse management system - Smart Warehouse Management System which based on the IOT, and expounded the principles and structure of it. This system has great advantages compared with the traditional mode. [2] Suppose a system in which status information is processed with the existing sensor nodes. But in the sensor node system, the nodes are put on specific locations, and the sensor sends sensing information on a large space [2]. Thus, the system is inappropriate for that environment that a temperature-sensitive product has to be checked thoroughly down to a tiny section. To solve this problem, as a part of the smart logistics system, the smart storage modeling technology with sensor tags is introduced with help of cloud storage and IoT.[4]IoT Cloud systems provide scalable capacity and dynamic behavior control of virtual infrastructures for running applications, services and processes. Key aspects in this type of complex systems are the resource optimization and the performance of dynamic management based on distributed user data metrics. Enabling management systems to use shared infrastructures and resources to enable efficient deployment of IoT services and applications.[2] Distribution and management of IoT services across different Cloud vendors and use the results from the analysis as mechanism to control applications and services deployment in Cloud systems. For IoT Cloud data management solution we utilize performance metrics expressed with linked data in order to integrate monitored performance data and end user profile information (via linked data relations).

VI. Security Issues

Due to the development of mobile network, proliferation of smart phones and increasing of interest for personal safety [7] .So protection of data and privacy of things is one of the key challenges in the IoT[5] .Lack of security measures will result in decreased adoption among users and therefore is one of the driving factors in the success of the IoT [11] . IoT contains three layers: perception layer, transportation layer and application layer[8] **.** The security problems of the terminal access mechanism and the routing attacks of wireless sensor networks for the sensor layer; the address space shortage and the denial of service due to network congestion for the network layer; personal privacy and unsound security standard for the application layer.WSN sensor perceive for the end of information technology, which protect the integrity and confidentiality if information by the password encryption technology. Identity authentication and access control can determine the communication between both sides and confirm each other's true identity, prevent disgusted attack and prevent authenticity, validity of information and so on. [7] One risk for IoT security is from itself and other comes from related technology[8] .IoT itself integration of multiple heterogeneous network and deals with compatibility issues which solved by key management and routing protocols. Security issues such as DOS/DDOS attacks, forgery/middle attack, and application risk of ipv6 also affect the transport security of IoT[5] .In core network due to the large amount of data during the transmission it is easy to cause network congestion. As the application of IoT directly connects with people's everyday life. To ensure the technical security and to strengthen human identity awareness the proper security criteria must be preserved.

VII. Application

Below are some of the IOT applications that can be developed in the various industry sectors:

i) Supply Chains

Traditionally, the order picking management in the warehouse picks up mul0tiple types of commodities to satisfy independent customer demands. The order picker (done manually) tries to minimize the travelling distance for time and energy savings via route optimization and order consolidation. The application will plan the delivery routes centrally before activating order pickers for the delivery. [1] Using executable algorithms in active tags, the tags can choose the best paths for the order pickers to

take, as well as paths that are within their responsible areas. This results in a more optimized order processing, time savings and lower cost of delivery [8] .

ii) Crowd Control during Emergencies and Events

The crowd control application will allow relevant government authorities to estimate the number of people gathering at event sites and determine if necessary actions need to be taken during an emergency. [9]The application would be installed on mobile devices and users would need to agree to share their location data for the application to be effective. Using location-based technologies such as cellular, Wi-Fi and GPS, the application will generate virtual "heat maps" of crowds[8] .Emergency vehicles can also be informed of the best possible routes to take, using information from real-time traffic sensor data, to avoid being stuck among the crowds.

iii) Shopping Assistants

In the retail sector, shopping assistant applications can be used to locate appropriate items for shoppers and provide recommendations of products based on consumer preferences. The application can reside in the shopper's personal mobile devices such as tablets and phones, and provide shopping recommendations based on the profile and current mood of the shopper [2] .

iv) Continuous Patient Monitoring

Continuous patient monitoring requires the use of medical body sensors to monitor vital body conditions such as heartbeat, temperature and sugar levels. The application examines the current state of the patient's health for any abnormalities and can predict if the patient is going to encounter any health problems [14] .

VIII. Challenges of IoT due to Integration with Cloud Computing

i) Cost versus Usability: IOT uses technology to connect physical objects to the Internet. For IOT adoption to grow, the cost of components that are needed to support capabilities such as sensing, tracking and control mechanisms need to be relatively inexpensive in the coming years.

ii) Privacy and Security: As the adoption of IOT becomes pervasive, data that is captured and stored becomes huge[7].

One of the main concerns that the IOT has to address is privacy. The most important challenge in convincing users to adopt emerging technologies is the protection of data and privacy [11] .

iii)Interoperability: Different industries today use different standards to support their applications. With numerous sources of data and heterogeneous devices, the use of standard interfaces between these diverse entities becomes important. [11] This is especially so for applications that supports cross organizational and various system boundaries.

iv)Complex Data mining: Data Mining is a process of extracting potentially useful information from raw data.The Microsoft suite of cloud-based services includes a new technical preview of Data Mining in the Cloud "DMCloud" but which comes with a burden of needing costly technology and technology professionals [15] .

v) Network Capacity Constraints: With convergences brought about by connected machines and smart mobile devices, there is an increasing demand for network infrastructure to support these data "hungry" [9] .

IX. Conclusion

According to an earlier analysis in January,2015 claimed there are 8.7 billion devices are connected with IoT in 2012 and feels that number can actually be as high as 75 billion by 2020 [2] .There's no reason to doubt that devices connected to the Internet of Things will soon be flooding the mass market. Researchers have been functioning for fairly some time in design ubiquitous Cloud support for smart applications of Internet of things. Tomorrow everything is going to be connected to the

Internet and its data will be used for various progressive purposes, creating not only information from it, but also knowledge and even wisdom. Internet of Things becoming so pervasive that it is becoming important to integrate it with cloud computing because of the amount of data IoT's could generate and their requirement to have the privilege of virtual resources utilization and storage capacity, but also to make it possible to create more usefulness from the data generated by IoT's and develop smart applications for the users [9]. It is not easy to integrate two very large components in heterogeneous domain. Though the both topic is solely related to each other but being a very vast area a few researcher publish about this topic.

In this paper we tried to highlight some important aspects of Internet of things and the future of computer with help of cloud computing, After explaining two subjects in brief we discussed about the paradigm of Cloud computing and How it can be integrated with IoT[4].Even though there are Countless application fields on IoT;

In this paper we tried to keep up with an general overview on the applications and also about their benefits in mankind hoping that it would interest people more about exploring this topic.

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