Applications, Challenges and Research Directions of IoT

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Abstract— The Internet of Things is considered as the fast emerging technology which will revolutionize many industries, homes, health centers, etc. IoT is compared to an ecosystem which consists of devices for computation, hardware, software, various physical entities, living beings interacting over network. IoT's pervasive and ubiquitous nature arises many challenges in its existence. This article represents current challenges that mostly exist in IoT. Here, applications of IoT are also discussed which proves the relevance of IoT in vast number of areas. This article also describes few research directions of IoT.
Keywords: IoT, RFID, WSNs

I. INTRODUCTION

In next 10 years, it is predicted that plethora things will be connected to internet which will produce huge amount of data. IoT is compared to an ecosystem which consists of devices for computation, hardware, software, various physical entities, living beings interacting over network. IoT provides a platform that works seamlessly to connect various things and people for making our lives easier. This will offer distributed environment for various applications like smart cities, smart home, smart grid, smart wearable's, etc.

A. IoT Multi-Layer Architecture:

1) Interaction: This layer provides interaction with the user by providing them useful output which is provided to them in very interactive manner.
2) Application: This layer provides satisfaction to users by providing them proper service like security, data flow management etc.
3) Networks: This layer will provide support to the data being transferred through wired or wireless connection.
4) Sensor / Actuator: At this layer, sensor will sense the data from hardware devices and all the processed data will be passed to actuator.

II. IMPORTANT ASPECTS OF IOT

A. Radio Frequency Identification (RFID):

Through this technology, various physical entities that are part of the system are assigned unique identification number. Things that are attached to the system are known in the network by RFID tags only.

B. Wireless Sensor Networks:

WSN's interact with the system's components using RFID. RFID tags are actually used in the WSN to better track the things. WSN's also consist of sensors, computing elements, communication channel, actuators and some powered devices. There are various challenges in WSN like fault performance, scalability, production cost, operation environment, quality of service, latency, data compression, data aggregation etc.

C. Addressing:

RFID tags and wireless technology makes it easy for the system to identify the things. But this addressing will be done by IPv4 addressing system. As more and more devices will be connected to the system and need of addressing will increase then IPv6 addressing system will come into play.

D. Middleware:

As different things are to be connected over the network, Middleware provides set of programs through which various things will be connected to each other and they will be able to communicate via message exchange also. There are various companies like WSO2, Mulesoft, RedHat and Oracle that provide service of IoT middleware.

III. MAIN CHALLENGES OF IOT

A. Technology:

Huge amount of data is generated by the things connected to the smart devices. Underlying networks play very important role in this. To manage this data various models like edge computing model, fog computing model etc. will provide assistance to the networks by reducing the flow of data.

B. Artificial Intelligence:

Incorporating human behavior in the system is very challenging. It is very difficult to predict the nature of the human. What type of input to use, output variables should be there, equations should be used, selecting testing statements is very problematic.

C. Security and Privacy:

Security, trust, authentication, message integrity and confidentiality are the few aspects that are very important when communication is done between the devices that are part of the system. Proper policies should be there to provide access to guarantee services as these devices are working wirelessly.

D. Energy Efficiency:

Different types of devices are used in the system that is using IoT as technology; it is very difficult to compute energy generated by different devices. Solving problem of robustness and fault tolerance is very important in this technology.

IV. COMMON STANDARD OF IOT DEVICES

Different IoT devices that are part of the system are manufactured by different number of manufacturers. So, it is very important that common standards should exist for easy exchange of communication between the countless devices that are part of the system.

A. Data Collection and Protection:

Data being collected by the system is very helpful for us in taking smart decisions. Collection of correct information makes security and privacy concerns very crucial. Secure transfer of data, unauthorized interference and misuse of data across the networks is very important for extracting right data and then making right decisions from the data.

B. Big Data:

As we are connecting more of our devices to the system, chances of data intrusion are also most likely to increase. It is believed that 50 billion of devices will be connected with in next 10 years so data privacy is very challenging as chances of data theft or leaking are more.

C. IoT Applications:

1) Sensing and Sharing of Location:

The IoT system can collect information using GPS of the IoT terminals. Its basic applications includes tracking of mobile assets, management of smart fleets, managing information that is collected from traffic system.

2) Sensing of Environment:

IoT devices can sense various physical and chemical aspects of environment. Data sensed by these systems can be used in monitoring forests, volcanoes, factory. This information can also be used for sensing patient's body also.

3) Remote Control:

Application control and disaster recovery are the applications of IoT which facilitates people a lot. This information can save many lives.

4) Ad Hoc Networking:

In the vehicular networks, the data collected from this can be very beneficial for managing vehicles. This can make roads very self-organized.

5) Smart City:

Environment monitoring, safety, food traceability, smart agriculture are the few areas that are being used as most active applications of IoT. These devices can be monitored and controlled through a computer, tablet or Smartphone.

6) Big Data and Business Analytics:

IoT can be merged with already existing business analytics tool which can provide good source of information for enhancing business revenues, providing customer satisfaction.

7) E-Health Care:

Data analytics provided by sensing human body is very helpful in monitoring one's health sitting at a distance. Various things are sensed using body sensor networks which is reducing visits to emergency rooms and frequent hospital visits.

8) Smart Grid:

IoT can provide facilitates like smart power monitoring, smart scheduling, dispatching automatic power, reading remote meters. This can help in energy saving and power management a lot.

V. RESEARCH DIRECTIONS

A. Protocol's Security in IoT layers:

Creating secure protocols in the IoT's network layer and transport layer is very crucial. Security in IPsec can provide authentication, protection, confidentiality and message and data integrity. These protocols must be implemented in encapsulated security protocol and authentication header.

B. Privacy preservation in IoT:

Secure, trust and privacy are the main aspects of privacy preservation in IoT. Some protocols are required for uniquely and securely identifying all the devices of the system. Privacy preservation becomes very important when data is passed from one system to another system.

C. Wireless Sensor Networks (WSNs):

Wireless Sensor Networks play very important role in IoT. Its research directions include choosing correct node, analyzing traffic, message exchange, various types of attacks, malfunctioning of nodes. Lot of work is done on this area as WSNs are the backbone of IoT.

VI. CONCLUSION

The implementation of IoT in various spheres of life will improve our quality of life. As IoT system has the ability of extensions and can be enhanced very easily that is why they can provide services in many fields like security, education, logistics, healthcare etc. There also exists need to work upon various challenges of IoT to improve its applications. Its ubiquitous nature will increase its applicability in various fields. Its research directions can also provide us various areas where its work can be extended and make it deployable worldwide.

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