International Journal of Academic Research and Development
ISSN: 2455-4197
Impact Factor: RJIF 5.22
www.academicsjournal.com
Volume 3; Issue 2; March 2018; Page No. 1282-1287

Challenges for smart environment: A review

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Abstract
Smart Environment provides a concept of the combination of Internet with sensors, smart objects, and radio frequency identification. The term Smart Environment is the interconnecting or internetworking of objects that contains sensors software's, and actuators. It enables devices to gather and transfer information over a network. Things in the Smart Environment have the ability to send and receive information to a network barring the intervention of humans and it contains physical objects that have a particular identifier with an embedded system. This new technology Internet of Things and various elements and technologies to implement Internet of Things are introduced. In this paper various applications and research challenges associated to Smart Environment are reviewed.

Keywords: wireless sensor networks (WSNs), smart home, future internet, internet of things (IOT)

Introduction

Now-a-days the wireless technologies are playing a vital role in our lives. These wireless technologies are the key technologies in smart environment. Things in the Smart Environment have the ability to send and receive information to a network barring the intervention of humans and it contains physical objects that have a particular identifier with an embedded system. Smart Environment provides a concept of the combination of Internet with sensors, smart objects, and radio frequency identification. It enables devices to gather and transfer information over a network. The term IOT provided new life to radio frequency identification (RFID) and was introduced to help radio frequency identification technology to particularly identify interoperable united objects.

Today, smart environment (IOT) is a "global infrastructures of networks that have self-configuring abilities and standard protocols for communication where virtual as well as physical and things have virtual personalities, identities, intelligent interfaces, physical attributes, which are combined into a network of information" [1].

The basic concept of IOT is the ubiquitous existence of different objects and things like sensors, RFID tags, network connectivity, mobile phones and actuators through which unique or particular schemes of addressing are capable to communicate with one another to complete targets [2]. One of the essential parts of Smart Environment is the future internet. Various research challenges and applications associated to Smart Environment are also reviewed in this paper.

Smart environment architecture

In SMART ENVIRONMENT architecture, there are four layers and these are: Perception layer, Network layer, Session layer and Application layer. Each layer is defining its functionality which is different from other layers. Participating devices, diverse technologies, and services it provides defines each layer. Threats to each layer architecture are directly affecting the functionality of that layer.

1. Network Layer: This layer is known as the network layer which is the brain of SMART ENVIRONMENT (IOT) and it is related to neural network. The prime task of this layer is to process and transfer data. It contains a center of information, a center of intelligent processing, a center of network management, a convergence network of communication and Internet network. The data aggregated by sensors used to be transferred through the Internet with the help of wireless/ wired network, computers and with many more components. Hence this layer is important for the communication of information with good quality delivery. The functionality of transport layer is also incorporated in this layer.

2. Application Layer: It is an aggregation of Internet of Things social division and industry demand. This layer analyzes the collected data. To get all the details of identification, connection and control between devices or objects, it does all the control decisions. Intelligence defines make usage of intelligent cloud computing technology and then transforms the data for better intelligent control. Process layer is another name of this layer

3. Perception Layer: Perception layer is also known as Sensors layer which receives data from the environment through sensors. Sensors and RFID readers are used in perception layer and these have limited memory, low power, and limited computational ability that make it less secure. Sensors attached to devices capture the information from these participating devices. GPS is also used in this layer for location tracing for spatial applications over a network. In local and short-range communication, node combination is done by the Perception layer. It observes, collects, processes and transmits data to the network layer. Threats in this layer majorly focus on data collection activities through sensors.

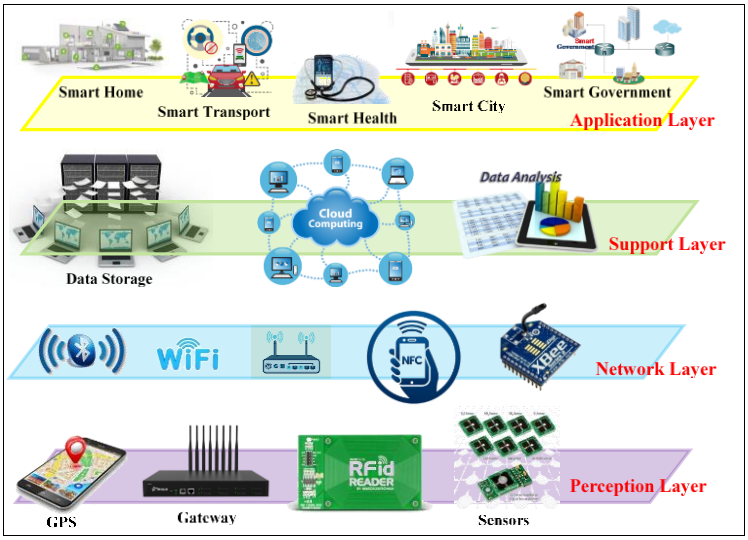

Fig 1: shows architecture of smart environment IOT

4. Support Layer: This layer is responsible for information collection, intelligent data processing and identifying the physical world. In mass data processing, handling malicious information smartly is very limited. According to the authors in [11], recognition of malicious information intelligently is not an easy task, it is a challenging job. Support layer is responsible for data storage activities, accessing cloud services for effective utilization of technologies over network and analysis of data to provide precise information.

Smart environment elements

To understand smart environment (IOT), study of IOT elements are necessary that are displayed in Fig. 4 [4]. In this section six main IOT elements are discussed which are mandatory to provide the functionality to IOT. These are identification, sensing, communication, computation, services and semantic. These are described as follows.

Sensing

This element of IOT means to receive information from various selected objects and then send the information to the data center, database, and data warehouse. The aggregated information is further evaluated and tested to execute particular actions of the mandatory services. The sensors of IOT include wearable sensing devices, humidity sensors, temperature sensors, actuators, and many others.

Services

The services of IOT are grouped into four categories [6, 7]. First category of IOT services is the identity related services. These are the main services which are needed for other type of services. Each application has to map real objects into virtual ones. Second category of IOT services is the information aggregations services. It aggregates and summarizes the raw data, process and informs it to the IOT application. Third category of IOT services is the collaborative aware services. It utilized the acquired data to make decision and react accordingly. Fourth category of IOT services is the ubiquitous services. It offers the above service to everyone.

Semantic

In IOT the meaning of semantic is the capability to grab information smartly to provide the mandatory services. It incorporates utilizing resources, discovering resources, modeling information, analyzing and recognizing data. Examples of some semantic technologies are web ontology language, resource description framework and efficient XML interchange.

Computation

The processing units of hardware such as System on Chips, microprocessors, microcontrollers and software applications show the computational capability of the IOT. A lot of hardware platforms were evolved to run IOT applications, some of which are Arduino, UDOO, Friendly ARM, Raspberry PI, Intel Galileo, Beagle Bone and WiSense. Software platforms were also utilized to provide IOT functionalities such as real time operating systems. To run the complete activation time of an object, real time operating systems are necessary.

Another main computational section of IOT is cloud computing. Cloud computing is useful for real time processing of data. It also extracts various amount of information from the collected data.

Communication

Communication technology in IOT connects different objects with one another to offer many smart services. Generally, the nodes of IOT are operating in less power when loosy and noisy communication links are present. Some communication technologies convenient for IOT are Bluetooth, Wi-Fi, Long Term Evolution-Advanced (LTE-A). These technologies are described in next section.

Identification

Identification plays an important part in matching services and naming. Some examples of this method that are used in IOT include ubiquitous codes and electronic product code (EPC) [5]. The addressing of objects of IOT is very important to

distinguish the identifier and the address of the object. Identifier of the object indicates name of an appropriate sensor and address of the object indicates address of a communication network. Objects that are present within a network need public Internet Protocol address not private Internet Protocol address. This method is needed to give a unique identity to every object of the network.

Challenges for smart environment

A. Radio Frequency Identification

It consolidates electromagnetic fields automatically and uniquely identifies and tracks the objects. RFID is a substitute to the barcode. A laser based optical scanner is used to read printed barcodes. It needs a straightforward line of sight to identify and obtain data. The benefit of RFID is that it does not need a line of sight scanning [9].

RFID is shaping up to be an important building block for IOT. The term IOT was first mint by the RFID community over a decade ago. RFID is one of the technologies used in the IOT to pinpoint objects and link them

to the Internet. Virtually all IOT applications connect the physical and digital world. RFID bridges these realms by providing data that identifies a specific object at an accurate place and time. There are issues of using RFID in IOT that how lower level data is transformed into higher level data. In paper [10], community oriented research infrastructure explored the issues. This infrastructure is known as the RFID infrastructure. This creates a little world for the IOT for investigation of applications, social issues and systems. They also designed a collection of web based user level applications and tools for IOT and arranged it into the system of RFID. There are various technologies for RFID and IOT [11]. There are numerous and far reaching application of RFID technology used in IOT which includes supply chain information transmission [12], monitoring and anti-counterfeiting for products [13], objects tracking management, agriculture management and many more.

A low cost and enhanced power method of RFID reader system framework for a smart home comprised Master Reader (MR), a number of slave readers and mobile radio frequency identification (MRFID) reader. This system explains the problem of power consumption for mobile RFID reader's technologies such as RFID/UHF (Ultra High Frequency) and provides a solution to increase the MRFID reader reading range and named it "RF Energy Generator" [14]. The reading distance and power optimization has been obtained via electromagnetic power which provides procedures such as transmission of information with a very less cost. This is called as "RFID Power Generator" [15].

B. Architecture

Architecture is a complex and carefully designed structure. It is the process and the product of planning, designing and constructing structures. TheSre are three types of architecture in IOT: - 3-layer, 4-layer and 5-layer architecture as discussed above. The three-layer architecture cannot express the whole features of the IOT. Hence new five-layer architecture of the IOT is established [3]. Much of work related to IOT architectures are from WSNs perspective. Architecture of IOT is a combined framework for connecting actuators and WSNs to standard networks [16].

Much of work has been done to build architecture based on the IOT. Various architectures based on IOT comprises mobility and security architecture in medical environments [17], multimedia traffic security architecture [18], mankind neural system on social organization architecture [19], an architecture for monitoring health of elderly people [20] and architecture for smart healthcare systems [21].

There are some others architecture also for the IOT which are energy efficient. Energy is considered as valuable resource for IOT network as the devices needed for the IOT applications are battery operated [22-24].

C. Energy efficiency

Over the last few years the IOT has become an omnipresent term, but up to this time neglected aspect of the IOT is the possible increase in power consumption. IOT objects are familiar to be reachable by other objects at all times. This shows that the device itself is consuming electrical energy. New IOT application comprising battery powered edge devices are a major driver for specific low power communication standards. The users would not adopt and by edge devices, if the battery has to be replaced every few months. The priority is to improve the energy efficiency of mains powered edge devices. A survey is done to conserve energy on issues and solutions of IOT objects from the aspects of wireless networking [26].

Most of the research work has already been done for powerful connectivity in wireless sensor networks for setup of a green IOT [27-29] and a solution to optimize devices for implementation of scalable and energy efficient IOT is also given [30]. An energy efficient real time information transmission for cooperative MAC structure [31], energy efficient data gathering in WSN and IOT with comprehensive sensing at sensor node [32] and energy efficient sensor nodes for fall detection system [33] are also proposed.

Some of the work in IOT is also done in energy efficient building such as design of energy saving and monitoring system of a building based on IOT [34], an architecture of location based energy control for a green building [35], energy consumption analysis of a building [36] and an IOT architecture for energy efficient buildings [37].

E. Smart home

Today, in houses there are plenty of appliances to entertain and support peoples living in them. Home automation aims for the group of all the appliances and devices that are used by users for comfort and security. Home automation systems generally cover lighting, heating, shading, door control and window control. Home automation is done in IOT for elderly people by using the combination of Keep In Touch technology and closed loop healthcare services [39]. Much of work has been done in home automation using Wi-Fi based system [40], low cost energy efficient smart home with task scheduling based on Arduino, [41] cloud network and mobile devices [42], ZigBee [43], android based smart phone [44], IOT with web services and cloud computing [45]. In addition, many other typical smart home architecture solutions are also proposed based on IOT [46-50].

Applications of Smart Environment (Iot)

IOT is now becoming component of every aspect of our lives. A number of applications are there in which the IOT play an important role. In this section of paper some important IOT applications are discussed.

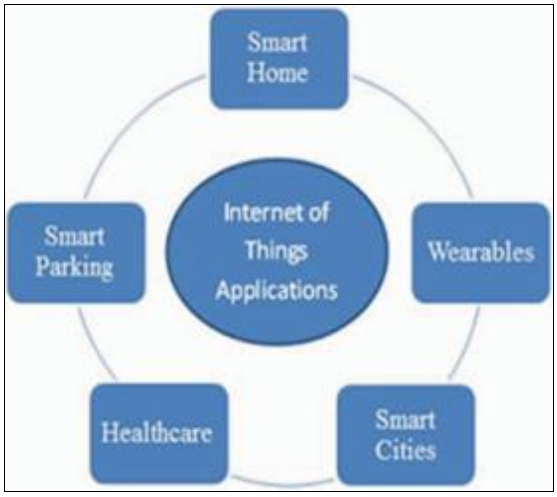

Fig 2: shows applications of IOT

Smart Home

The IOT helps in the design of smart homes (SH) [51]. In smart homes devices are connected and communicated with each other. It gives the owner the capability to control his or her home environment for efficient energy management and increased security. There are many IOT technologies available for monitoring and building smart homes such as Philips Hue-smart home lighting, Amazon Echo, nest learning thermostat and air quality egg. Smart homes are becoming more and more popular today because of two reasons. First, the sensor and actuation technologies along with wireless sensor networks have significantly matured. Second, people today trust technology to address their concerns about their quality of life and security of their homes. In smart homes, various sensors are deployed such as environment sensor, motion sensor, temperature sensor and luminance sensor, which provide intelligent and automated services to the user. They help in automating daily tasks and help in maintaining a routine for individuals who tend to be forgetful. They help in energy conservation by turning off lights and electronic gadgets automatically. Typically motion sensors are used for this purpose. Motion sensors can be additionally used for security also.

Wearables

This is another important application on IOT. Wearables consist of an array of devices. These devices contain sensors and software's which gather data about the users. Then this gathered data is pre-processed to extract important information about the user. Wearable devices mainly cover fitness, health and entertainment requirements. Some examples of IOT devices which are wearable are Motorola Moto 360 Sport, Jawbone UP2 and Fitbit ChargeHR. Wearable technology is a trademark of IOT and is the most pervasive implementation. The information processing efficiency is achieved by hearable, different smart wrist wear and smart glasses. It slowly removes inert skepticism within the public and gets nearer to wearable's which brings value to our lives. Some functions that wearable devices are already delivering are related to identification and security.

Smart Cities

Smart city is another application of IOT. It will solve many problems which people faces like pollution, traffic congestion, transportation and shortage of energy supply. Using sensors and web application, citizens can get free vacant parking slots across the city. Smart transport applications can manage daily traffic in cities using sensors and intelligent information processing systems. The main aim of intelligent transport systems is to minimize traffic congestion, ensure easy and hassle-free parking, and avoid accidents by properly routing traffic and spotting drunk drivers. The sensor technologies governing these types of applications are GPS sensors for location, accelerometers for speed, gyroscopes for direction, RFIDs for vehicle identification, infrared sensors for counting passengers and vehicles, and cameras for recording vehicle movement and traffic. Many other examples of IOT applications for smart cities include smart surveillance, urban security, automated transportation, energy management system, environmental monitoring and water distribution.

Healthcare

Healthcare is another application of IOT. Sensors are deployed to check patient's health. The collected information is then available on Internet for family members, doctors, and nurses. The devices of IOT can also be used to check a patient's medicines. Health applications make independent living possible for the elderly and patients with serious health conditions. Currently, IOT sensors are being used to continuously monitor and record their health conditions and transmit warnings in case any abnormal indicators are found. If there is a minor problem, the IOT application itself may suggest a prescription to the patient. IOT applications can be used in creating an Electronic Health Record (EHR), which is a record of all the medical details of a person. It is maintained by the health system. An EHR can be used to record allergies, surges in blood sugar and blood pressure. Stress recognition applications are also fairly popular. They can be realized using smartphone sensors.

F. Smart Parking

Today, a big issue in urban areas is car parking because day by day the amount of vehicles is increasing but there is lack of parking facilities. In urban areas vehicle drivers were roaming here and there in the city in peak hours in search of parking space. This creates traffic. To detect the arrival and departure of vehicles smart parking sensors can be placed in parking spaces. It can save fuel and time. It gives exact data about parking spaces which helps the traffic to flow better. The smart parking is designed for the parking system which increases flexibility, decreases human interaction and improves security. The smart parking system can be deployed in multiplexes parking and airports.

Conclusion

This paper presents an overview of new enabling technologies contributing to smart environment (IoT) for successful implementation. Further, some issues and challenges pertaining to the deployment of IoT architecture have been presented. In IoT architecture, functionality of each layer is explained with respect to the devices working on it and services it provides. There are security issues related to each layer and these issues should be dealt with by providing some proper security mechanism. Risk classification provides an opportunity to direct the research work in proper direction. Layers most vulnerable to threats can be provided more attention. A lot of work has been done in the area of Internet of Things architecture and energy efficiency. Internet of Things network architecture is quickly gaining attention in the scenario of next generation wireless communication. Energy efficiency is most important in object management because the devices like sensors and actuators which are used in Internet of Things are battery power sources. Hence energy efficiency and long lifetime of sensor nodes are very important. This paper provides insights into new challenges that a smart environment is facing with the deployment of IoT.

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