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A Survey on IoT: Architecture, Communication Technologies and Wireless Sensor

P. Kanaga Priya[1], R. Sivaranjani[2], M.Nataraj[3]

PG Student, Department of Computer Science and Engineering, KPR Institute of Engineering and Technology, Coimbatore, India

PG Student, Department of Computer Science and Engineering, KPR Institute of Engineering and Technology, Coimbatore, India

UG Student, Department of Computer Science and Engineering, Kongu Engineering College, Erode, India

ABSTRACT: The Internet of things (IoT) is an intelligent platforms for connecting smart devices. The data driven by the smart devices can be used for informative purpose. The survey on IoT describes about the architecture, communication technologies, and wireless sensor that are currently adapted under various circumstances. This survey greatly helps the researchers to study about the various technology. Future solution to the research challenges can also be found in this survey. The principle aim of this survey is to present a detailed description about IoT in various aspects.

KEYWORDS: Internet of Things (IoT), Sensor, Architecture, Communication Technology.

I. INTRODUCTION

The Internet of things in today's scenario gets more attention due to the advancements in sensors and communication technology as the number of physical objects that are going to get connected was increased. With the help of IoT it is possible to make the objects hear, and they can also talk with each other and they can share the information with other objects to make a decision hence IoT is called the future internet. The IoT transforms these traditional objects into smart by bringing the arrival of smart technology. This will create a dramatic change in the technology in business it provides more production at better quality. Some of the major applications of IoT include healthcare, industrial automation, transportation etc.

The IoT also has its significant growth in business and home application that increases the world economy. For example smart home using IoT is used to prepare coffee, switch on the TVs and other appliances. IoT having layered architecture is highly capable of connecting enormous object to the internet, hence there is a need of layered architecture for IoT that should be flexible in nature and they should provide security and privacy. Smart devices are now linked to the internet with the help of communication protocols such as WiFi, Zigbee and soon that helps in processing and collecting the data. Although the Iot has significant advantages, the major issue faced in IoT is security that is caused by internet hackers other problems include scalability which is a major problem [1]

II. ARCHITECTURE OF IOT

There are four major layers. It starts with the Sensors and Connectivity network which collects in sequence of information. The next upper most layers are Gateway and Network Layer. The consecutive layer of upper most layer Management Service layer and then at the end we have the application layer where the data collected together are processed according to the needs of various applications as shown in Fig .1.

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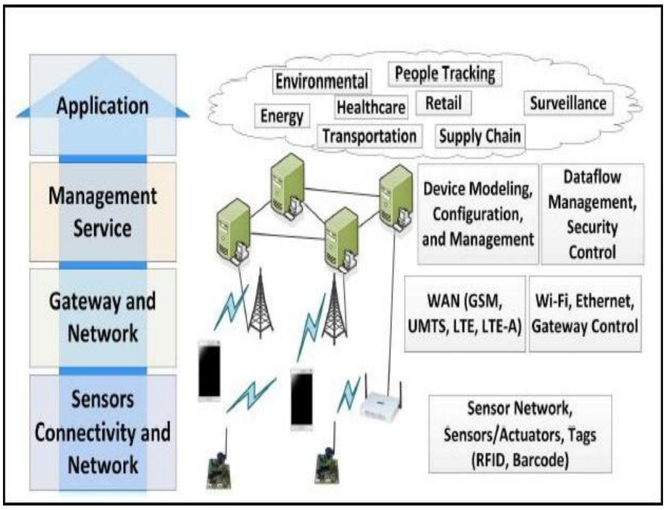

Fig.1. IoT architecture layers[19]

A. Sensor, Connectivity and Network Layer

Layer contains of RFID tags and sensors [which are necessary part of an IoT system and are dependable for collecting raw information]. Sensors and RFID tags are wireless devices and form the Wireless Sensor Networks (WSN). Sensors are active in nature which means that real time data is to be collected and executed. This layer also has the network connectivity (like WAN, PAN etc.) which is conscientious for communicating the raw information to the next upper layer which is the Gateway and Network Layer[19]. The devices which are comprised of Wireless Sensor Networks have finite storage facility, controlled communication bandwidth and have tiny processing speed. We have different sensors for different applications: temperature sensor for collecting temperature information, water quality for determine water quality, moisture sensor for measuring moisture content of the atmosphere and other. In below Fig .2. shows at the bottom of this layer we have the tags which are the RFID tags or barcode reader, next level of the layer we have the sensors/actuators and then the communication through networks.

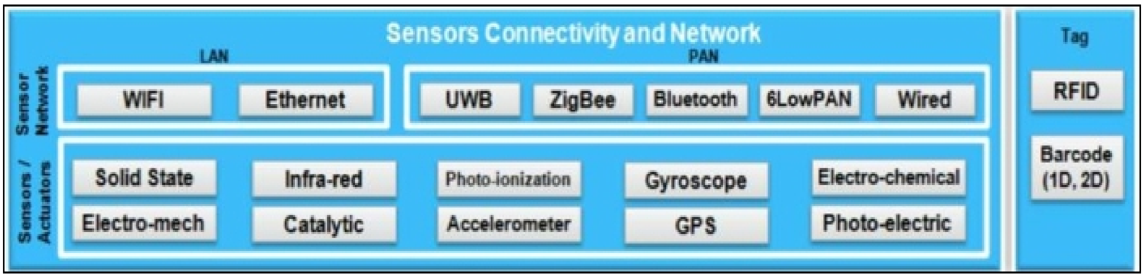

Fig .2. Sensor, Connectivity and Network Layer[19]

B. Gateway and Network Layer

Gateways routes the information getting from the Sensor, Connectivity and Network layer and pass that information to the upper layer that is Management Service Layer. Gateway and Network layer requires a huge storage facility for storing the massive amount of information getting from the sensors, RFID tags. It needs to have a regularly trusted performance in terms of public/private and hybrid networks. Different IoT model works on different kinds of network protocols[19]. All the protocols are required to be assimilated in a one layer and it is responsible for integrating a combination of network protocols.

In below Fig .3., at the low level we have the gateway which is comprised of embedded Operating Systems, Signal Processors and Modulators, Micro-Controllers and other. Next level, we have the Gateway Networks which are LAN, WAN and other area networks.

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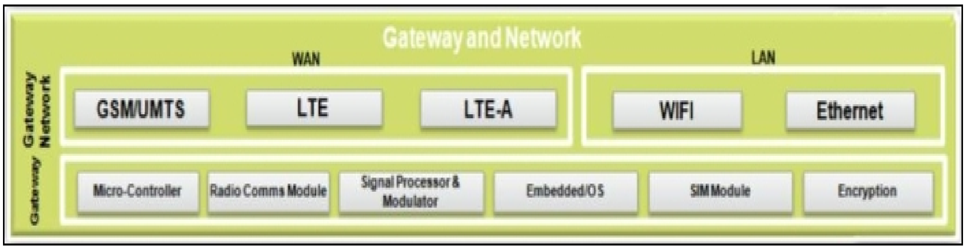

Fig .3.Gateway and Network Layer[19]

C. Management Service Layer :

MS layer is used for handling the IoT services. Management Service layer is responsible for Securing investigation of IoT devices and components, Analysis of data (Stream Analytics and Data Analytics), Device Management[19]. Data management is needed to extract the necessary data from the huge amount of raw data collected by the sensor components to yield a valuable result of all the data collected. Also, certain condition requires immediate response to the circumstances. MS layer helps in doing that by abstracting data, extracting information and handling the information flow. This layer is also responsible for data mining, text mining, service analytics and other. In Management Service, MS layer has Operational Support Service (OSS) which includes Device Modeling, Device Configuration and Management and Billing Support System (BSS) which supports billing and reporting[19]. we can see that there are IoT/M2M Application Services which contains Analytics Platform; Data – which is the most important part; Security which contains Access Controls, Encryption, Identity Access Management. ; and then we have the Business Rule Management (BRM) and Business Process Management (BPM). Fig .4. shown below represents the management layer.

Fig .5. Management Service Layer[19]

D. Application Layer

Application layer as shown in Fig .6. forms the topmost layer and last layer of IoT architecture model which are responsible for successful consumption of the information collected[19]. Various IoT applications include Home Automation, E-health, E-Government and so on.

In Applications Fig 4., we can see that there are two types of applications which are Horizontal Market and sector wise application. HM which includes Fleet Management, Supply Chain. Sector wise application of IoT we have energy, healthcare, transportation and other functionalities [11][19].

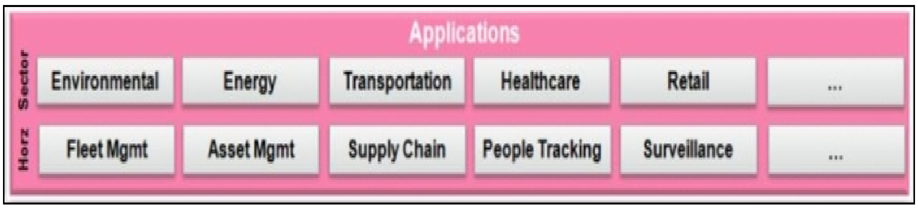

Fig .6.Application Layer[19]

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III. COMMUNICATION TECHNOLOGIES

The communication technologies provides a improved insight into the functionality and actual meaning of IoT[11]. Objects are connected together with the help of communication technologies like WiFi, bluetooth , Z-Wave, ZigBee, *LoRaWAN* to deliver smart services. These technologies play a major role in the IoT and they are described below. WiFi exchanges data using radio waves within the range of 100m. It allows devices to communicate and exchange data without the help of router. Bluetooth allows devices to exchange data over short distances. It uses short-wavelength radio inorder to minimize power consumption. The Bluetooth *special interest group* (SIG) produced Bluetooth 4.1. It provides high-speed, Bluetooth

Low Energy and IP connectivity to support IoT. Zigbee is a wireless communication technology, consumes low energy designed for short-term communication with low-energy consumption[13]. The advantages of Zigbee are low cost, low data rate, low energy consumption, low complexity, reliability and security. Zigbee network can support star, tree, and mesh topologies[13]. Z-wave is a short-term wireless communication technology. The main objective of Z-wave is to provide reliable transmission and supports the dynamic routing technology[13]. LoRaWAN is a protocol based on Long Range (LoRa) radio and maintained by LoRa Alliance [7]. The table 1 presents a feature comparison of communication technologies.

Table I Comparison table for communication technologies

TECHNOLOGIES	STANDARD	FREQUENCY	RANGE	DATA RATES
WiFi	Based on 802.11n	2.4 GHz and 5GHz bands	Approximately 50m	600 Mbps maximum
Bluetooth	Bluetooth 4.2 core specification	2.4GHz (ISM)	50-150m (Smart/BLE)	1Mbps (Smart/BLE)
ZigBee	ZigBee 3.0 based on IEEE802.15.4	2.4GHz	10-100m	250kbps
Z-Wave	Z-Wave Alliance ZAD12837 / ITU-T G.9959	900MHz (ISM)	30m	9.6/40/100kbit/s
LoRaWAN	LoRaWAN	Frequency Varies	2-5km (urban environment), 15km (suburban environment)	0.3-50 kbps.

The advancement in recent technological development with the use of Internet of Things and Deep Learning has made everything possible. The IoT is greatly helpful in collecting real time data using the sensors. The valuable data can be utilized in a way by which it can be fed to the trained deep learning algorithm such as Artificial Neural Network. The outcome greatly helps in finding out the suitable crop to be sown. This section describes about the dataset, features, preprocessing phase, IoT sensors and Deep Neural Network.

IV. WIRELESS SENSOR

A. Temperature and Humidity Sensor

The Temperature and humidity sensor is used as a thermistor and capacitive humidity sensor to measure the surrounding temperature and air, and splits the digital signal on the data pin. It is simple to use but sensor takes some time to collect data. The sensor can read the data only for 2 seconds. The connection of this sensor is the first pin is connected to 3-5V power, the second pin is connected to data input pin and the right most pin is connected to ground. It uses only a single-wire to send data. If we want to use multiple sensors, then each sensor must have its own data pin. Fig .7. shows the various temperature and humidity sensors.

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Fig .7.Temperature and Humidity sensor

B. Air Quality Sensor

Air quality sensor as shown in Fig.8. is an emerging technology and are commercially available in a wide variety of capabilities and designs. People can use these sensors – which is cost to easily collect real-time and highly localized data on air pollution. It is designed to detect gases associated with poor air quality: alcohols, ammonia, odorous gases, sulfides, and Carbon Monoxide.

Fig .8. Air Quality Sensor

C. PIR sensor

The Passive Infrared Sensor (PIR) is an electronic sensor for motion detection. It is also called as PIR, Pyroelectric, Passive Infrared and IR Motion sensor. It is used for sensing movement of people, animals, or other objects. It measures infrared (IR) light radiating from objects depending on the temperature and surface characteristics of the objects. They can be used in automatically-activated lighting systems and burglar alarms. PIR triggers the detection when conversion takes place from change in the incoming infrared radiation into change in the output voltage. The PIR sensor is shown below in Fig .8.

Fig .8. PIR sensor

D. Light Sensor module

The LDR Sensor Module as shown in Fig .9. is used for detecting the presence of light and measures the intensity of light. The modules output is high in presence of light and becomes low in absence of light. The signal detection's sensitivity can be adjusted with help of potentiometer.

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Fig .9. Light sensor module

E. IR Sensor

An infrared sensor as shown in Fig .10. identifies the surrounding objects that emits an infrared radiation. Infrared sensors measures the heat that is emitted by an object and detects motion. IR Sensor module have a pair of infrared transmitter and the receiver tube. It has great adaptive capability for the ambient light. The infrared emitting tube emits a certain frequency, and encounters an object then that ray is reflected back to the receiver tube. Then the green LED lights up. The effective distance range 2 to 10cm. The sensor's detection range can be adjusted by using potentiometer [4][15]. The Table II below shows the comparison table for various sensors.

Fig .10. IR Sensor module

Table II Comparison table for wireless sensor

Features	Temperature And Humidity Sensor	Air Quality Sensor	PIR Sensor	Light Sensor Module	IR Sensor
VOLTAGE	+5 V	2.5 to 12 v	4.5V- 20V	3.3V-5V	3-5V
SIZE	small size 14*18*5.5mm; big size 22*28*5mm	20x20x3 mm	3.2cm x 2.4cm x 1.8cm	3cm * 1.6cm	3.1cm * 1.5 cm
SENSING PERIOD	2s	<20 s	0.2 sec	20-30 sec	
DISTANCE RANGE	20m	10-300 ppm	7m		0.5cm – 5 cm
SUPPLY CURRENT	0.3 mA	0.5 mA	65mA	0.5-3mA	0.6 mA
APPLICATIONS	Smart room, Bearings, Engine oil	indoor air monitoring, air purifier controls, early fire detection, HVAC ventilation control.	Lift lobby, shopping malls, garden lights	Intruder alarm, smart buildings, industries.	Intruder detector, robot obstacle avoidance, black and white line tracking.

V. CONCLUSION

The IoT is going to provide the near future of the internet by allowing communication between things and people via. Internet, store and retrieve data, access data on the internet, intend to enhance the quality of life by combining these

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technologies and applications. It leads to the vision of “any media, anything anytime, anywhere,” communication. This paper surveys the evolution, the generic architecture, its enabling technologies, protocols, and sensors of the IoT.

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