Internet of Things (IoT): In a Way of Smart World

Malay Bhayani, Mehul Patel and Chintan Bhatt

Abstract Internet of things-"IoT" is an interconnection of exclusively identifiable embedded computing devices where all devices are made equipped with communication and data capture capabilities so that they can use the ubiquitous internet to transmit or exchange data and other controlling purposes. IoT is expected to bring a huge leap in the field of global interconnectivity of networks. Here we are going to draw an attention on the topics which have attracted the researchers and industrialists such as remote excavation, remote mining, etc.

Keywords Internet of things · Radio frequency identification (RFID) · Long-range wireless IoT protocol (LoRa) · Lezi · Zigbee · WINEPI

1 Introduction

The popularity of IoT has been increasing greatly in the recent years due to much higher affordability and simplicity through smart devices [1]. IoT, a platform where variant networks and mass of sensors that function together and interoperate with common set of protocols. It has espoused the world through various applications like home automation, ZigBee, Big-data, and auto-id such as RFID.

Many technical communities are vigorously pursuing research topics that contribute to IoT. One of the upcoming applications is Smart ATM that can perform all the operation on user account by authenticating the user by its retina and voice. Some other embryo staged IoT applications are smart air conditioners, 3D traffic, smart building, and smart health support service. Internet of things is connecting

Malay Bhayani (✉) · Mehul Patel · Chintan Bhatt
Computer Engineering, CHARUSAT, Anand, Gujarat, India
e-mail: d14ce170@charusat.edu.in

Mehul Patel
e-mail: d14ce179@charusat.edu.in

Chintan Bhatt
e-mail: chintanbhatt.ce@charusat.ac.in

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S.C. Satapathy et al. (eds.), *Proceedings of the International Congress on Information and Communication Technology*, Advances in Intelligent Systems and Computing 438, DOI 10.1007/978-981-10-0767-5_37

heterogeneous network/devices so that they can bring qualitative change in how we work and live. It is making our life more and more simple and increasing openness, privacy, security, analytics, and management.

2 History of IoT

Internet of things is evolved with convergence of more than one technologies [3]. The idea of smart device communication comes in 1980s but it became popular in 1990s. IoT made a revolution in technology of smart devices, wireless sensors, and networks. In the 1980s system was in existence but it did not have a name till the 1990s.

First initiative of the smart coke vendor machine was by Carnegie Mellon University which used Internet appliance to connect programmers to check cold drink in machine. After that actual rootlet of IoT track down at MIT in 1990s by the work of auto-center in networked RFID and sensing technologies. By that time, competitive congeal started for innovations in a path of IoT that we understand by some important evidence.

1999—Auto-id labs at MIT
2000—MEME (internet refrigerator) by LG
2002—Ambient orb by David rose (idea of the year by NY times)
2005—First report by ITU (UN)
2005—Nabaztag by Rafi haladzian and Olivier mevel
2008—IPSO alliance by 50 member companies including Cisco, Intel, Sap, Sun, Google
2008—Growth report of smart devices by Cisco-IBSG
2010—China plans to make major investment on IoT stat by Wen Jiabao
2011—IPv6 public launch for addressing things approximately 340 undecillion.

See Fig. 1.

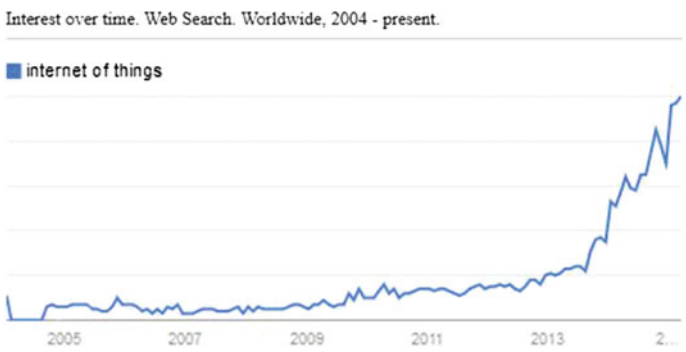

Fig. 1 IoT interest over time

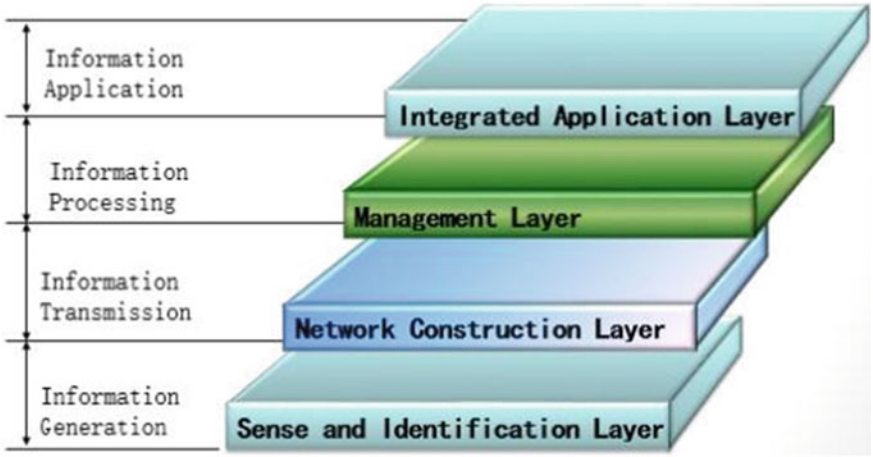

Fig. 2 IOT architecture

3 Architecture of IoT

Architecture of internet of things is designed in such a way that it can handle a large mass of data at any instance [2]. It is one of the highly reliable structure that can patch up with any element of smart device. This architecture will make us understand the abstraction of what is inherent to the actual systems. Its architecture is designed in such a way that it can be extrapolated in the reference architecture and current systems.

At its ground level, it will have sensing and identification layer. All the devices which have the ability to sense and uniquely identify that sensed data come under this layer. Generally, it is a sensor but it can also be RFID, GPS, smart devices, etc. This layer is responsible for collecting the raw data from the target, generating information, and sending it to the network construction layer (Fig. 2).

Now the layer above sensing and identification layer is network construction layer. It handles all the logistical task of the IoT. It is basically responsible for routing the information. It can be anything like WLAN, WMAN, WWAN, WPAN, Internet, etc. At the modular level WLAN is used. It is obliged to accumulate all the data from the sensing level and sending it to the management layer.

Management layer is above the network construction layer. It is designated to process all the information provided by the layer below it. All the final decisions regarding the information processing will be taken this layer. This layer may consist of the combinations of either of the given options: Data mining, information security, data center, search engine smart decision, etc. Currently, these information processing is done through cloud computing.

Application layer is the top most layer which is responsible for interpreting the data processed by the Management layer. And according to its interpretation it will

react. Suppose, if a smart home sense that temperature of your room is rising, then it will immediately turn on the air conditioner. Examples of smart applications are smart logistics, smart grid, green building, smart transport, and smart environment Monitor.

4 Algorithms of IoT

See Table 1.

5 Applications of IoT

5.1 Current Applications

As per demand and needs, existed IoT application can make seamless changes in existence of things which are related to human lives such as healthcare, transport, agriculture, energy, etc [1, 7]. When different technologies work with smart devices, sensors, networking devices at that time we recognize the value of IoT.

Smart Parking: This application is currently implemented in the city of Barcelona. Here a weight sensor is placed on each parking slot. So when the car comes and stands on it, it will get activated. When the car driver opens the mobile application, he will get to know about the number of free car parking slots on the basis of the data sent by the sensors to the cloud computer, which will in turn process the data provided by the sensor.

ZigBee: It is a description of high-level communication protocol which is used for developing PAN (personal area network). It is a wide range LAN generally termed as Smart MAN. It consumes low power and limits the transmission distance of 10–100 m line-of-sight, as per their power output and their environmental characteristic. It will be very useful to us in certain applications such as wireless light switches, traffic management, etc. Its specifications are it is inexpensive, simple to install, and initializes than other PAN like Bluetooth and Wi-Fi.

Remote Monitoring: United States is currently using this application to monitor the habitat at the Great Duck Island. They have also invested millions in installing many types of sensors in certain vegetation to track each and every movement.

LoRa (Long-range Wireless IoT Protocol): All the connected devices so far run on the same network and protocols such as Wi-Fi, Bluetooth, cellular, etc [5]. But the case of IoT device is different, they have special network requirements than smart phones, tablet, and PCs. They only need to send small data packets at a logical interval, and connect to the areas far from the traditional infrastructure of Wi-Fi and cellular. LoRa chips transmit the data in sub-gigahertz spectrum (generally it is 109, 433, 866, 915 MHz), it is unlicensed band that has less interface

Table 1 IoT algorithms

Algorithm	Description	Advantage	Disadvantage	Application
LZ78	This is a loss less data compression algorithm For each input of string it will search in its dictionary, if it is found then it work on it else it will update the dictionary	Faster decompression can be done The number of string comparisons reduces with each encoding step It attempts to work on the future data	Lz78 suffers from this problem of slow convergence There are plenty of chances that important patterns may overpass boundaries Long-term storage for the calculation of probability is not possible	Smart home Smart city Smart car and etc.
Active LeZi	This prediction algorithm helps in providing solution to the problem of information theoretic standpoint, by forecasting the upcoming symbol in sequence	It can store data for longer term for better probability It has reached the highest hit rate It has large data for predicting and its ability to pile data is high	At the time of input string parsing, all the information crossing boundaries are lost	Smart home Smart grid Smart home Appliances and etc.
Episode Discovery (WINEPI)	This algorithm manages a serial of events and also monitors its behavior and action, and helps to act on an event It identifies the frequently occurring episodes in a sequence	It helps to identify which patterns can be automated easily with least occurrence of fault	The size of episodes discovered is limited, as the window length is predefined by the user.	Smart irrigation system Smart telecommuter and etc.
Apriori	This algorithm uses breadth-first search strategy for counting item sets and generating a candidate	Easily immobilized Straightforward implementation	Difficult to find rarely appearing events Require several iterations of data Utilized fixed least support threshold	Data mining of large databases such as Banking, E-commerce
EClat	This algorithm uses vertical database layout Each item is stored together with its tidiest	Address the problem of load balancing Exploit the power of clusters or distributed systems with many nodes	In the case when it uses the existing parallel approach, it suffers from load unbalancing problem	Data mining

than others (like Wi-Fi, Bluetooth, etc.). At these frequencies, signals pierce the barriers and travel long distance.

Smart Street Light: This is the most mass energy savvy application used to control Street lights. It has sensors to detect weather and daylight. It will send the data to the data processor for analysis, in turn the street light will receive the signal of on/off lights or dim/bright light.

5.2 Upcoming Applications

Some applications are attracting the market and upcoming interesting applications have potential to lead in future with different sectors like smart ATM, remote excavation, remote mining, land slide and avalanche prevention, and chemical leakage detection in river.

6 Advantages and Disadvantages of IoT

See Table 2.

Table 2 IoT Advantages–Disadvantages

Advantages	Disadvantages
Information: To make better decision, we need to have more information. So as we all know that knowledge will help us take better and faster decisions. Suppose vegetables in the vegetable basket are going to get empty soon, so out smart basket will send us an SMS to informing us to get vegetables from the stores **Tracking**: Another disadvantage of IoT is tracking. It provides advance level information that could not have been possible before this so easily. Let us take an example of medical store, the application will inform the store keeper about the upcoming expiration dates of the medicines, so that they can get replaced or whatever **Time**: IoT saves more time which we generally used to get it wasted on gathering and processing information so that they can be accurately analyzed, in order to get better decision **Money**: If the cost of tagging and monitoring equipment goes down than the market for IoT will cross-skies in a very short period	**Compatibility**: In current time, there is no universal standard of compatibility and facility for the tagging and monitoring devices or equipment. So the disadvantages of is that as the number and nature of devices available in market, soon it will be getting tough to connect them using IPv4 **Complexity**: With the help of all complex systems, there are more and more chances of failure, suppose in the vegetable market app, if the application send message about vegetable basket getting empty to two or more people with whom it is associated with them. Then both the people will go to the shop to get the vegetable as asked by app. In such a case, it may be possible that the unnecessarily double purchase of the item may be done by the people **Safety**: It is necessary to provide safety, else if it expired product id medicated to the patient then the ill reaction will responded by the body and damaging health **Bandwidth**: It can be a problem for IoT applications, as it is limited

7 Challenges and Solutions for IoT

7.1 Challenges for IoT

According to the CISCO, there will be around 50 billion smart devices connected to the internet [2]. This figure shows that at that period of time each person the earth will be having five smart devices on an average as the prices of the processor will fall; hence it will be feasible to use processor on almost everything to make it smarter. So when these smart devices start creating data, organizations will have no organized plan to manage large data. Therefore, we need to think about where all the data generated by the processor going to be stored?

And this becomes a very serious problem. IoT promises the organizations which are going to get the insight of the customer activity. The organizations also have to maintain the data till analyzing. According to the paper published from the Gartner the Impact of the Internet of Things on Data Centers, there are several issues which have to be solved before the organization begins to earn from IoT.

The issues to be solved by organization before setting up business of IoT are:

IoT while using will generate large-scale amount of data to be processed and examined in real time, and processing large amount of IoT data will increase the workload on the data centers, thereby directing the providers to the new security, analytics, and challenges [6].

The problem is within the characteristics of IoT itself. It will connect two devices and systems and provide a data stream between the devices and the dispersed management systems. Enterprise's IT Department have to deal with IoT data as an exclusively dataset in its own. For instance, the initial set of what will build IoT data are arriving in the storage layer, same way as other unstructured data does. So, ultimately, the traditional storage architecture and management software will treat the IoT data in the same way as unstructured data.

As the number of smart devices is increasing, it will force the enterprises to bring the solution to make their system more scalable and cost-effective. Now the enterprises will have to tackle some more issues after handling the above given issues: Big number of devices, joined with sheer velocity, creates challenge, especially in the areas of security, data storage management, security, data center network, as data processing at stack.

7.2 Solutions for IoT

As far as we are concerned with the traditional storage of the data, it can be done using Hadoop. Now as we are dealing with the decreasing inefficiency of cloud computing, there is increase of burden on the cloud servers due to IoT data being processed over there. So the solution to the big data problem is to replace cloud computing with fog computing, in which all the processing and analytics works are

done on its respective routers instead of cloud severs, as a result all the data in the cloud become structured data. And the duty of the cloud server will get limited to making the data reachable the application device. For the challenge of security and privacy, we will have to increase the number of bytes being encrypted.

8 Conclusion

IoT have enormous impact on all sectors all over the world. It has helped us to improve our personal and professional life. From waking up in the morning with the help of hot coffee till switching off lights before going to sleep, we will be accompanied by the Iot. Technocrats and researcher realize revenue potential of IoT which make influence on affordable solution of problems and leads us to bright future.

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