International Journal of Emerging Trends & Technology in Computer Science (IJETTCS)
Web Site: www.ijettcs.org Email: editor@ijettcs.org
Volume 5, Issue 3, May-June 2016 ISSN 2278-6856

Smart Vehicle Management through IoT

B. Sobhan Babu[1], T.Ramanjaneyulu[2], I. Lakshmi Narayana[3], K. Srikanth[4], D.Hema Sindhu[5]

[1]Gudlavalleru Engineering College, Gudlavalleru. Krishna District, Andhra Pradesh, India.

[2]Gudlavalleru Engineering College, Gudlavalleru. Krishna District, Andhra Pradesh, India.

[3]Gudlavalleru Engineering College, Gudlavalleru. Krishna District, Andhra Pradesh, India.

[4]Gudlavalleru Engineering College, Gudlavalleru. Krishna District, Andhra Pradesh, India.

[5]Gudlavalleru Engineering College, Gudlavalleru. Krishna District, Andhra Pradesh, India.

Abstract

Internet of Things (IoT) is the network of physical objects or things embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data. The Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure. The IoT is enabled by the latest developments in RFID, smart sensors, communication technologies, and Internet protocols. IoT is most useful in every sector. This paper contains how Internet of Things is helpful to manage different types of vehicles. Now a day's transportation is most important in every aspect. At the same time to prevent accidents and find out problems those which are occurred at the time of driving the vehicles. To do this every vehicle is built with different type of sensors for getting information during its travel. For example a truck made with some sensors, those sensors will measure daily conditions of the truck, about with how much speed vehicle is going, and what is the present condition of truck, Air condition in Tyres, how much weight is carrying by the truck, engine status, fuel status all these information is stored in database. By using this information the vehicle manufactures will develop better useful vehicles in future, and produce better products. And this information is also helpful for the vehicle driver to predict what type of problem may arise in his driving in near future. After collecting the vehicle information the sensors posts that data to server via its nearest Wi-Fi. All objects are maintain IPV6 (Internet Protocol version 6) address to send information to server. The important protocol is 6LoWPAN (IPV6 Low Power Personal Area Network) is used with devices. If Any trouble occurred at the time of vehicle movement, check the database which is posted by the sensors and get the details, what type of reasons are caused to make vehicle in trouble, and perform relevant actions to ensure good condition of vehicle. IoT uses different types of protocols to work with different objects. CoAP, XMPP, AMQP and MQTT protocols are also used with IoT.

Keywords: IOT, RFID, CoAP, 6LowPAN, MQTT, AMQP, XMPP.

1. INTRODUCTION

Internet of Things (IoT) is an ideal emerging technology to influence the internet and communication technologies. Simply "Internet of Things" connects living and nonliving things through "internet". Traditionally in the object oriented paradigm everything in the world is considered as an object, but in the IoT paradigm everything in the world is considered as a smart object, and allows them to communicate each other through the internet technologies by physically or virtually. IoT allows people and things to be connected Anytime, Anyplace, with anything and anyone by using any path/network and any service. Every day the modern people expect new device and new technology to simplify their day to day needs of life. The innovators and researchers are always trying to find new things to satisfy the people, but the process is still infinite. In the 1990s, Internet connectivity began to proliferate in enterprise and consumer markets, but was still limited in its use because of the low performance of the network interconnects. In the 2000s Internet connectivity became the norm for many applications and today it is expected as part of many enterprise, industrial and consumer products to provide access to information. However, these devices are still primarily things on the Internet that require more human interaction and monitoring through apps and interfaces. One research reveals, the Internet of Things (IoT), which excludes PCs, tablets and smart phones, will grow to 26 billion units installed in 2020 representing an almost 30-fold increase from 0.9 billion in 2009[1]. This paper contains eight modules introduction of IOT, RFID, and CoAP in IOT, 6LowPAN, other protocols related to IoT and how IOT is useful to manage vehicles, Devices used with IoT and then conclusion. The large-scale implementation of IoT devices promises to transform many aspects of the way we live. For consumers, new IoT products like Internet-enabled appliances, home automation components, and energy management devices are moving us toward a vision of the "smart home'', offering more security and energy efficiency. Other personal IoT devices like wearable fitness and health monitoring devices and network enabled medical devices[2] are transforming the way healthcare services are delivered. This technology promises to be beneficial for people with disabilities [5] and the elderly, enabling improved levels of independence and quality of life at a reasonable cost. IoT systems like networked vehicles[6], intelligent traffic systems, and sensors embedded in roads and bridges move us closer to the idea of "smart cities'', which helps to minimize congestion and energy consumption. IoT technology offers the possibility to transform agriculture, industry, and energy production and distribution by increasing the availability of information along the value chain of production using networked sensors. However, IoT raises many issues and challenges that need to be considered and addressed in order for potential benefits to be realized. A number of companies and research organizations have offered a wide range of projections about the potential impact of IoT on the Internet and the economy during the next five to ten years.

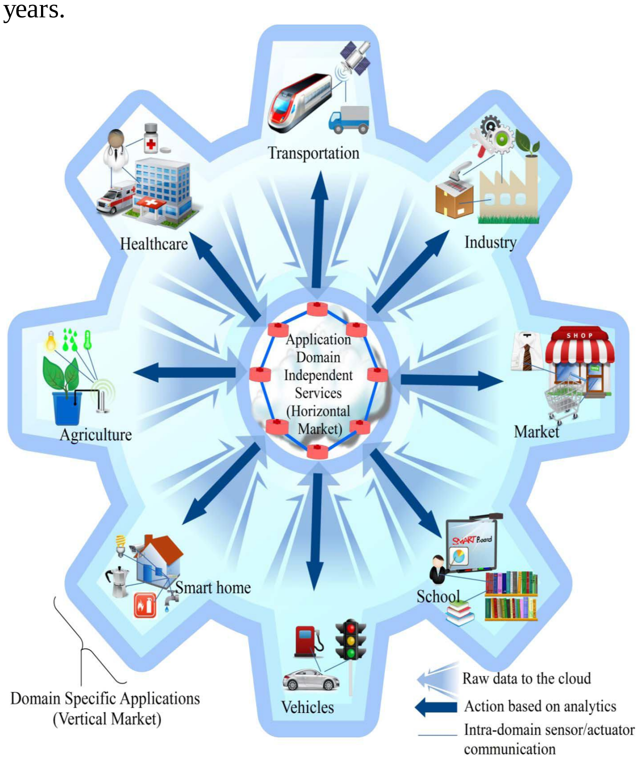

Figure 1: Objectives of IoT

2. RADIO-FREQUENCY IDENTIFICATION (RFID)

It was seen as a prerequisite for the Internet of Things in the early days. If all objects and people in daily life were equipped with identifiers, they could be managed and inventoried by computers. Besides using RFID, the tagging of things may be achieved through such technologies as near field communication, barcodes, QR codes, Mobile Computing, Ambient Intelligence. The RFID tag represents a simple chip or label attached to provide object's identity. The RFID reader[4][12] transmits a query signal to the tag and receives reflected signal from the tag, which in turn is passed to the database. The database connects to a processing center to identify objects based on the reflected signals within a (10 cm to 200 m) range. RFID tags can be active, passive or semi-passive/active. Active tags are powered by battery while passive ones do not need battery. Semi-passive/active tags use board power when needed. Active RFID[14] readers have their own battery supply and can instantiate the communication. RFID is the first technology used to realize the M2M concept (RFID tag and reader).

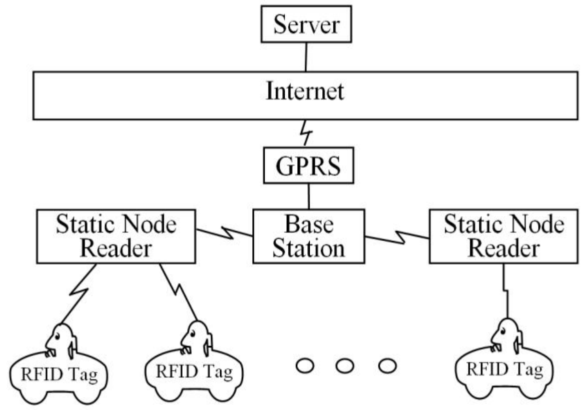

Figure 2: RFID-based sensor network

A passive RFID [7] system is composed of a digital device called tag, embedding an antenna and an IC-chip with unique identification code (ID), and a radio scanner device, called reader. Despite the RFID technology is currently mostly applied to logistics of goods, the very recent research is exploring other paths with the common goal of extracting physical information about tagged objects[15] and nearby environment through low-level processing of electro-magnetic signals received and backscattered by the tags. RFID systems could, therefore, permit to implement, in a simple and efficient way, the last few meters of the IoT concerning the pervasive quantification of the person's interaction with the environment [17].

3. COAP IN IOT

Constrained Application Protocol (CoAP): The IETF Constrained RESTful Environments (CoRE) working group
Created CoAP, which is an application layer protocol for IoT applications. The CoAP defines a web transfer protocol based on REpresentational State Transfer (REST) on top of HTTP functionalities. REST represents a simpler way to exchange data between clients and servers over HTTP. REST can be seen as a cacheable connection protocol that relies on stateless client-server architecture. It is used within mobile and social network applications and it eliminates ambiguity by using HTTP get, post, put, and delete methods. REST enables clients and servers to expose and consume web services like the Simple Object Access Protocol (SOAP) but in an easier way using Uniform Resource Identifiers (URIs) as nouns and HTTP get, post, put, and delete methods as verbs. REST does not require XML [8]for message exchanges. Unlike REST,

CoAP is bound to UDP (not TCP) [3]by default which makes it more suitable for the IoT applications. Furthermore, CoAP modifies some HTTP functionalities to meet the IoT requirements such as low power consumption and operation in the presence of loss and noisy links. However, since CoAP has been designed based on REST, conversion between these two protocols in REST-CoAP proxies is straightforward. The overall functionality of CoAP protocol as shown in below Figure 3:

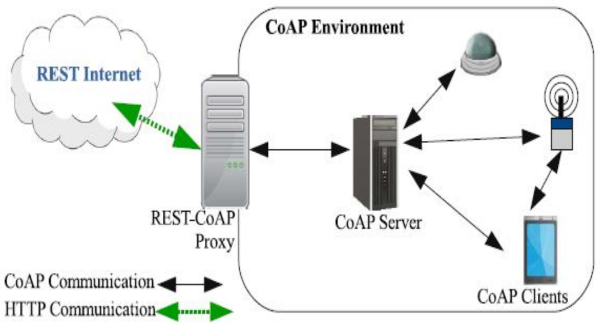

Figure 3: CoAP Functionality in IoT

4. 6LOWPAN

Low power Wireless Personal Area Networks (WPANs) which many IoT communications may rely on have some special characteristics different from former link layer technologies like limited packet size (e.g., maximum 127 bytes for IEEE 802.15.4), various address lengths, and low bandwidth. So, there was a need to make an adaptation layer that fits IPv6 packets to the IEEE 802.15.4 specifications. The IETF 6LoWPAN working group developed such a standard in 2007. 6LoWPAN is the specification of mapping services required by the IPv6 over Low power WPANs to maintain an IPv6 network. The standard provides header compression to reduce the transmission overhead, fragmentation to meet the IPv6 Maximum Transmission Unit (MTU) requirement, and forwarding to link-layer to support multi-hop delivery. Datagrams enveloped by 6LoWPAN are followed by a combination of some headers. These headers are of four types which are identified by two bits: (00) NO 6LoWPAN Header, (01) Dispatch Header, (10) Mesh Addressing and (11) Fragmentation. By NO 6LoWPAN Header, packets that do not accord to the 6LoWPAN specification will be discarded. Compression of IPv6 headers or multicasting is performed by specifying Dispatch header. Mesh addressing header identifies those IEEE 802.15.4 packets that have to be forwarded to the link layer. For datagrams whose lengths exceed a single IEEE 802.15.4 frame, Fragmentation header should be used. 6LoWPAN removes a lot of IPv6 overheads in such a way that a small IPv6 datagram can be sent over a single IEEE 802.15.4 hop in the best case. It can also compress IPv6 headers to two bytes.

5. OTHER PROTOCOLS IN IOT

5.1 Message Queue Telemetry Transport (MQTT):
MQTT [9] is a messaging protocol that was introduced by Andy Stanford- Clark of IBM and Arlen Nipper of Arcom (now Eurotech) in 1999 and was standardized in 2013 at OASIS.MQTT aims at connecting embedded devices and networks with applications and middleware. The connection operation uses a routing mechanism [10] (one-to-one, one-to-many,many-to-many) and enables MQTT as an optimal connection protocol for the IoT and M2M[13].

5.2 Extensible Messaging and Presence Protocol (XMPP):
XMPP [11] is an IETF instant messaging (IM) standard that is used for multi-party chatting, voice and video calling and telepresence. XMPP was developed by the Jabber open source community to support an open, secure, spam free and decentralized messaging protocol. XMPP allows users to communicate with each other by sending instant messages on the Internet no matter which operating system they are using. XMPP allows IM applications to achieve authentication, access control, privacy measurement, hop-by-hop and end-to-end encryption, and compatibility with other protocols.

5.3 Advanced Message Queuing Protocol (AMQP):
AMQP Is an open standard application layer protocol for the IoT focusing on message-oriented environments. It supports reliable communication via message delivery guarantee primitives including at-most-once, at-least-once and exactly once delivery. AMQP requires a reliable transport protocol like TCP to exchange messages.

5.4 Z-Wave:
Z-Wave is a low-power wireless communication protocol for Home Automation Networks (HAN) has been used widely in the remote control applications in smart homes as well as small-size commercial domains. This protocol was initially developed by ZenSys (currently Sigma Designs) and later was employed and improved by Z-Wave Alliance. Z-Wave covers about 30 meters point-to-point communication and is specified for applications that need tiny data transmission like light control, household appliance control[18], smart energy and HVAC, access control, wearable health care control, and fire detection. Z-Wave operates in ISM bands (around 900 MHz) and allows transmission rate of 40 kbps. The recent versions also support up to 200 kbps. Its MAC layer benefits from a collision avoidance mechanism. Reliable transmission is possible in this protocol by optional ACK messages.

5.5 IEEE 802.15.4:
The IEEE 802.15.4 protocol was created to specify a sub-layer for Medium Access Control (MAC) and a physical layer (PHY) for low-rate wireless private area networks

(LR-WPAN). Due to its specifications such as low power consumption, low data rate, low cost, and high message throughput, it also is utilized by the IoT[16], M2M, and WSNs. It provides a reliable communication, operability on different platforms, and can handle a large number of nodes (about 65 k). It also provides a high level of security, encryption and authentication services[24]. However, it does not provide QoS guarantees. This protocol is the base for the ZigBee protocol[20] as they both focus on offering low data rate services on power constrained devices and they build a complete network protocol stack for WSNs. IEEE 802.15.4 supports three frequency channel bands and utilizes a direct sequence spread spectrum (DSSS) method. Based on the used frequency channels, the physical layer transmits and receives data over three data rates: 250 kbps at 2.4 GHz, 40 kbps at 915 MHz, and 20 kbps at 868 MHz Higher frequencies and wider bands provide high throughput and low latency whereas lower frequencies provide better sensitivity and cover larger distances. To reduce potential collisions, IEEE 802.15.4 MAC utilizes the CSMA/CA protocol. The IEEE 802.15.4 standard supports two types of network nodes: Full and Reduced Function Devices. The full function device (FFD) can serve as a personal area network (PAN) coordinator or just as a normal node. A coordinator is responsible for creation, control and maintenance of the network. FFDs can store a routing table within their memory and implement a full MAC. They also can communicate with any other devices using any available topology. The reduced function devices (RFD)[23] on the other hand, are very simple nodes with restricted resources. They can only communicate with a coordinator, and are limited to a star topology.

6. HOW IOT USEFUL TO MANAGE VEHICLES:

Internet of Things (IoT) is helpful to manage different type of vehicles [19]. Now a day's transportation is most important in every aspect. At the same time to prevent accidents and find out problems which are occurred at the time of driving vehicles. Every vehicle is built with different type of sensors for getting information during its travel. For example a truck contains some sensors, those sensors are useful to measure daily conditions of truck, about with how much speed vehicle is going, and what is the present condition of the truck, Air condition in Tyres, how much weight carried by the truck, engine status, fuel status all these information is stored in database. By using this information the vehicle manufactures find out the problems and solve those problems by introducing new efficient vehicles in future, and produce better products. And this information also useful to vehicle driver to predict what type of problem may arise in his driving . This vehicle information is collected by sensors and posts that data to server via its nearest Wi-Fi router.

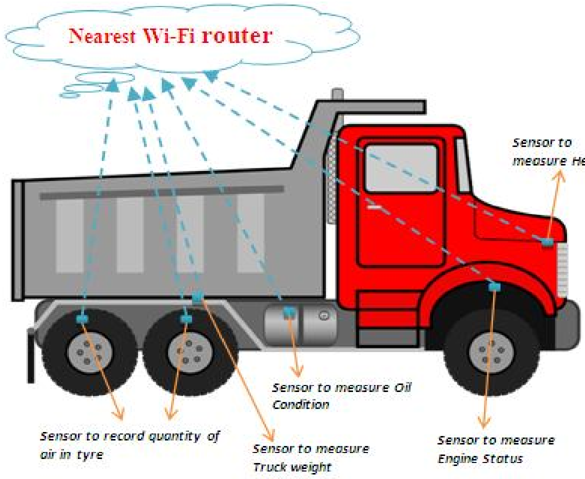

Figure 4: Sensor network to manage Vehicle through IoT

This type of vehicle management is very much useful to prevent accidental problems which are occurred at the time of vehicle driving. Basically sensors collect the data at regular intervals and post that data to server via wi-fi router. If any problem occurred during vehicle travelling that problem is easily identified based on the data which is collected and posted by sensors. For example sometimes vehicle is fired due to its oil leakage, so this can be prevented through IoT, by measuring condition of oil tank at regular intervals.

7. IOT HARDWARE DEVICES

Different types of Single Board Computers (SBCs) integrated with sensors and built-in TCP/IP and security functionalities are typically used to realize IoT products (e.g., Arduino Yun, Raspberry PI, Beagle Bone Black, etc.). Such devices typically connect to a central management portal to provide the required data to customers. One of the key learning platforms for IoT is the Raspberry Pi[21]. The RasPi is a popular platform because it offers a complete Linux server in a tiny platform for a very low cost. In fact, one of the most difficult parts of using Raspberry Pi for learning about IoT is picking the right projects with which to begin. The following figure shows the view of Raspberry Pi 2 – MODB.

Figure 4: Raspberry Pi 2 - MODB

Windows 10 IoT Core is a new edition of Windows targeted towards small embedded devices and maker boards such as Raspberry Pi2. IoT core is designed to work with low-level bus interfaces such as I2C, SPI, and USB. You can write a Universal Windows Application using a variety of programming languages in Visual Studio to rapidly create maker projects. You can use Windows 10 IoT Core to read sensor data, control actuators, connect to the cloud, create IoT applications and much more. The Starter Pack from Adfruit includes parts to get you started. Some other boards are also available to perform IoT operations; those are PanStamps, TinyDuino, RFDuino[22], Intel Edision, UDOO etc.

8. CONCLUSION

In summary, one vision of the future is that IoT becomes a utility with increased sophistication in sensing, actuation, communications, control, and in creating knowledge from vast amounts of data. This will result in qualitatively different lifestyles from today. What the lifestyles would be is anyone's guess. It would be fair to say that we cannot predict how lives will change. We did not predict the Internet, the Web, social networking, Facebook, Twitter, millions of apps for smartphones, etc., and these have all qualitatively changed societies' lifestyle. Especially for healthcare system, it is most useful to every human. So health problems are easily predicted at the beginning stage based on IoT healthcare system.

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Author Profile

B.SobhanBabu[1] M.Tech, (PhD scholar in KLUniversity) and working as Assistant Professor in Department of Information Technology, Gudlavalleru Engineering College, Gudlavalleru, AndhraPradesh.

T.Ramanjaneyulu[2] M.Tech, working as Assistant Professor in Department of Information Technology, Gudlavalleru Engineering College, Gudlavalleru, AndhraPradesh.

I. Lakshmi Narayana[3] M.Tech, working as Assistant Professor in Department of Information Technology, Gudlavalleru Engineering College, Gudlavalleru, AndhraPradesh.

K.Srikanth[4] M.Tech, working as Assistant Professor in Department of Information Technology, Gudlavalleru Engineering College, Gudlavalleru, AndhraPradesh.

D.Hema Sindhu[5] M.Tech, working as Assistant Professor in Department of Information Technology, Gudlavalleru Engineering College, Gudlavalleru, AndhraPradesh.