DEVELOPMENT OF IOT PLATFORM FOR SUPPLY CHAIN MANAGEMENT

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Abstract

Internet of Things consists of a network of embedded things. These things could be a sensor or some device or could be a whole system. These things communicate with each other through the network and thus the name Internet of Things(IoT).

IoT can be generated using Vertical or Horizontal approach. Vertical approach is used in a application specific system. So, if an IoT system is built using this approach, then it is difficult to move it from one application to other since. This generates the need for a very generic approach which could be used for multi-domain applications. A generic IoT platform will be developed and it would be implemented for an application in Supply Chain Management.

Keywords: IoT; Horizontal Platform;IoT implementation.

I. INTRODUCTION

Internet of Things is one of the fastest growing technology in the past few years. With increasing use of devices in our dayto-day life and in industries there is a need to connect all these devices and create a smart network. When internet first came into our lives it brought tremendous revolution. It connected people from all around the globe. The next internet revolution has already began, this revolution would not only be about connecting people but also about connecting devices. These devices would be able to communicate with each other.

Scientists have also predicted that by 2020 almost 50 billion devices would be smartly connected over it. Internet of Things could be defined as a smart network made up of different electronic devices.

IoT can be used in various applications. Public safety, smart industries and environmental protection are all now possible by using IoT. Thus it is very important that we understand this new technology, the way it works, its applications and also contribute in its building process.

One of the areas where IoT system can work efficiently is in the Logistics Industry. Logistics industry faces many challenges because of the ever increasing demands of their customers. Customers now-a-days expect transparency in their orders and inventory in order to keep a check on their perishable and non-perishable materials. Customers also expect a tight security for containers with their materials. For this purpose the logistics companies have to keep a track record of when the containers were locked and when and where they were unlocked. On-time delivery is also an important challenge faced by these industries. That means, data containing full insight of each order and its associated item level details in real time are required by these industries. These challenges could be easily overcome by using an IoT system. IoT system can be used to monitor different assets in logistics with different technologies and medium. It can also easily handle large amount of data that is generated and can create various reports based on the data received. Thus an IoT system can be used to acquire data, to

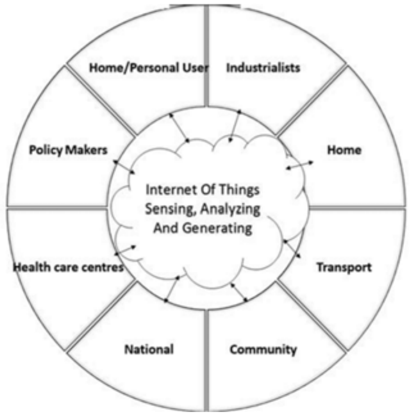

Fig. 1: Application areas of IoT

analyze it and to alert the logistics operators the whereabouts of their shipments. The use of IoT system in logistics tackles the old difficult problems in new and exciting ways.

This paper gives the details about the development of IoT platform. To test this platform we have implemented this platform for an application in supply chain management. Fig. 2 shows the detail description of the application that we are implementing. The temperature and humidity inside the truck is measured after every time interval and an indication is given whenever the door of the truck is opened or closed. The data can be viewed only by the authorized and authenticated users. Analysis is performed on the received data and a report is generated.

This paper is organized as follows: in Section 2 we have considered the basic block diagram of an IoT system. Section 3 gives a brief overview of different IoT systems that were available earlier. In Section 4 and 5 we have described the

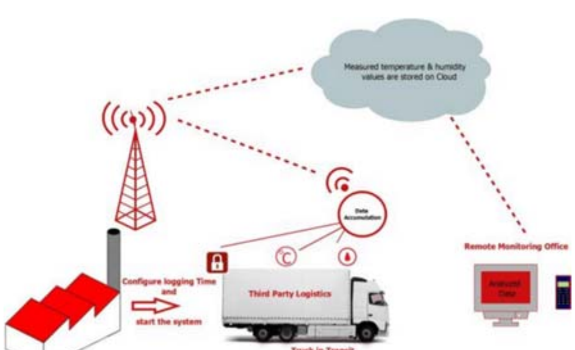

Fig. 2 Implementation of IoT platform for Supply chain management

proposed method and the implementation of the generic IoT platform. Section 6 and 7 contains our results and conclusion.

II. BASIC BLOCKS OF IOT SYSTEM

The basic building blocks of an IoT system consists of connected devices, local users, router, a remote user, a cloud solution and internet connectivity.

As shown in the fig.3 the connected devices are the sensors and other devices which are connected to each other either through wired connection or wireless connection. These are the devices that are to be controlled and managed using IoT system. The local user is the one who wants to interact directly with the device to either control it or to receive information regarding its operation. The router acts as a gateway that connects this network to the outside network i.e. Internet. The connection can be via ADSL, cable, cellular, etc. A cloud solution can be simple storage of data, flowing from connected devices, or can include complex analytic functions that are to be performed on received data. Remote user is the user who is not in the proximity of the device, but wants to control or receive information.

III. LITERATURE SURVEY

As IoT is still a new technology there is no standard way to build an IoT system.

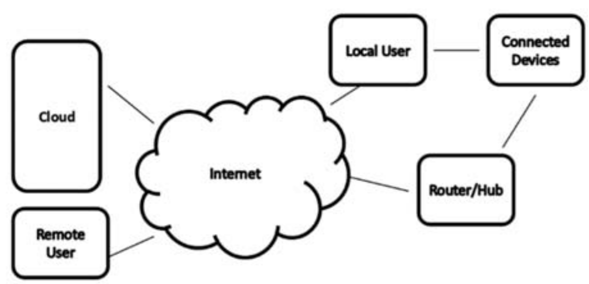

Fig.3 Basic building blocks of IoT system

The most common way to design an IoT system is by using Vertical approach. The systems which are built using vertical approach are application specific. Thus for every new application development, an engineer has to start building the system from a scratch. To avoid this a horizontal approach has to be used. This is explained in detail in [1]. A survey about how the wireless protocols could be a key enabler for broadening the idea of IoT from Vertical domain to Horizontal domain is done in [1]. The method proposed has some limitations and the most vulnerable were security and privacy challenges. The other important problems with the vertical approach are the interoperability and scalability. The system which is built using vertical approach cannot be used for any other system as this system approach is very application specific. These problem are listed out in [2] and the authors also described the need of horizontal platforms over vertical platforms. One of the way to achieve this horizontal approach suggested by [3] include a common service layer for the system.

The horizontal platform standardization is must for a boost in vertical industry applications as well as it is also useful for reducing the cost and time for development. We can come to a conclusion that the service layer compatibility is must for giving common service which is the main idea behind the horizontal approach.

IV. PROPOSED METHOD

The basic block diagram of an IoT system is shown in Fig 4. The nodes can be any sensing devices or systems which may or may not be remote in nature. These nodes form a network by using different protocols for wired and wireless connections. Microcontroller circuits along with some software framework can together be used as gateways. The interconnection between the nodes and microcontroller is done using binary protocols. The rules engine evaluates inbound messages published into IoT platform, transforms and delivers them to another thing or cloud, based on pre-defined rules. The rules engine can also route messages to cloud endpoints such as database, asynchronous events, etc. The decision making takes place in Rule engine. The Rules engine cannot continuously monitor the data of the remote sensor. Inorder to do so, a virtual component is created which works similarly like the remote sensor.

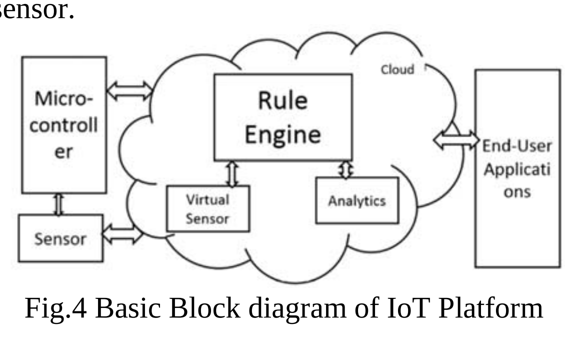

Fig.4 Basic Block diagram of IoT Platform

The Rules engine continuously monitors this virtual sensor and further evaluates the messages that are to be published. IoT platform includes the Registry and Device Shadows, so we can register anything we wish to represent in the cloud with a name, some attributes, and a persistent virtual 'shadow'. Here device shadow means a virtual device is created.

V. IMPLEMENTATION

The generic solution for IoT platform is mainly concerned with the service layer capability to serve the cloud as well as the devices according to their requirements. We are trying to build a generic solution such that the dependency of each layer in the architecture is minimum or negligible. This platform would also tackle some of the IoT challenges like Complexity and Security. The platform's architecture can be basically divided into two parts i.e. the firmware development architecture and the cloud architecture.

A Firmware Development

Fig 5 shows the building blocks of the stacks from the perspective of firmware development. Each of the blocks in the stack are mutually exclusive of the other blocks. Hence the code above the Transport layer is portable in nature. Each layer is associated with a queue or a ring buffer to communicate information to the upper layers. The stack is developed based on the requirements of the cloud. The network security features like SSL are hardware specific. All these layers in the architecture are required to be consistent with or without any OS e.g. RTOS.

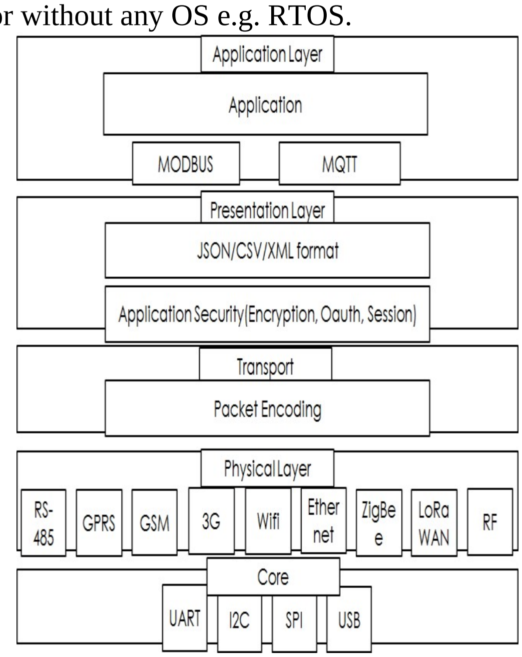

Fig.5 Firmware Development Architecture

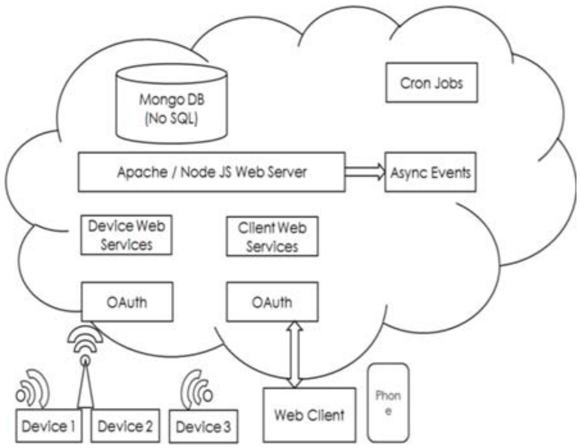

Fig .6 Cloud Architecture

B. *Cloud Architecture*

The cloud architecture shown in fig. 6 basically has two levels of security i.e. SSL and OAuth. The SSL is used to send encrypted packets over the network and OAuth is used to make sure that the access to the cloud is through a registered authorized user. All the data exchange from the device and client databases is done in JSON format.

MongoDB is the most popular open source implementation no SQL database. The codes are written in node js (javascript). It has a provision to raise asynchronous events. The device and client webservices are built using the MEAN stack (MongoDB, Express, Angular JS, Node JS). Asynchronous events and Cron jobs consists of the analytical part. Analytics are performed on the data collected in databases. The device data is encrypted using 32-bit AES before sending it on the network. 32-bit AES is used as it has lighter footprint i.e. requires less RAM and CPU power. The data in this part of cloud architecture is scattered and is raw so a low security makes sense.

C. *Device Connection*

Depending on the firmware architecture and the cloud architecture, the devices or the things are connected to IoT accordingly. The fig. 7 shows the procedure that is followed for device connection. The gateway is initialized and then it is checked if a device is available for connection. If it is present a registration request is sent by the device. If it is a new device then new registration is done, if the device information is available at the server then the device is authenticated and authorized to be connected to the server. Once the device is authenticated and authorized it is connected to the server.

VI. RESULTS

The IoT platform is implemented for the system shown in fig. 1. The sensors are registered as per fig. 7.After it is verified that the devices are registered they are authenticated and each device is given a unique token. This token can be used while device logging. The data received from the sensors is stored in database. Depending on the user requirement, data is extracted depending on date and time from the database. This extracted data is used to generate an analysis report which is as shown in fig. 8.

VII. CONCLUSION

There are many challenges faced while designing an IoT system. Some of these challenges are Security, Power Management, Connectivity, Complexity etc. Security being one of the measure challenge as most of our private data is sent over internet. It also has security issues such as different access and authentication control, network configuration issues, information management etc. Another challenge is the Power management. As most of the devices in IoT are battery powered we as designers need to design them with minimum power consumption. Reducing complexity is yet another challenge in an IoT system. Manufacturers want an easy connectivity for their devices. These all challenges are taken into consideration in our platform and we are trying to get the best and optimum solution.

The IoT application system for supply chain management provides its users with real time analysis of data and thus optimize procedures in it. With the help of the analytics it is possible for the stakeholders to maintain transparency with the customers. This application also helps in analyzing the shelf life of products that are transported in these trucks. Using the developed IoT platform helps the designer to add or remove devices with a ease, thus reducing the work load. We can conclude that the Generic IoT platform is must for the standardization of different IoT applications in various industries. This platform reduces the time consumed for developing an IoT application.

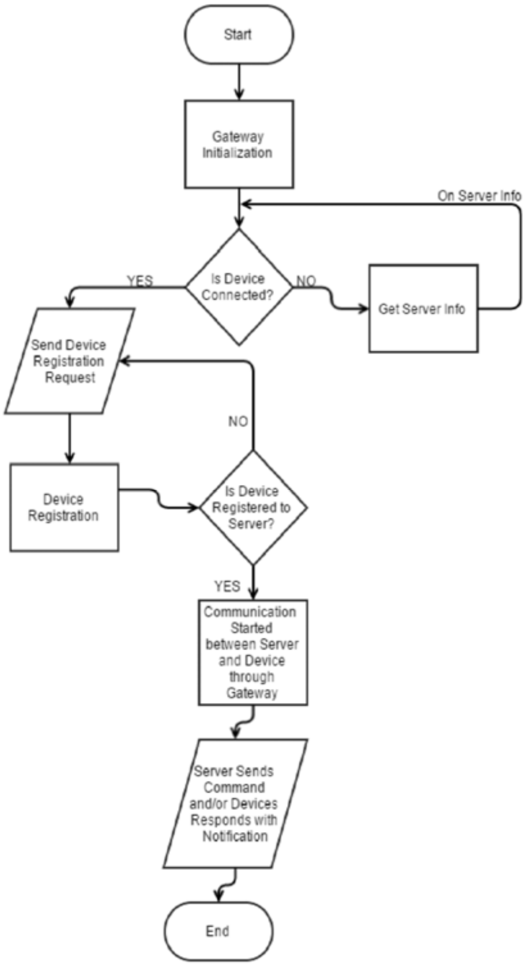

Fig. 7 Device Connection flowchart.

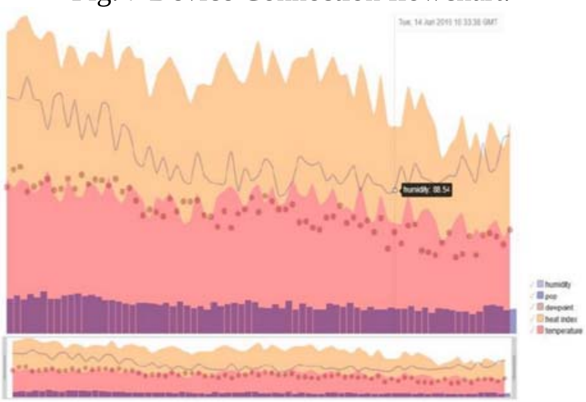

Fig. 8 Real time analysis of temperature and humidity data.

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