Internet of Things(IoT) Integration and Testing with the Sample Application

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Abstract— In today's world in one are the other way everyone and everything is connected to each other by means of a technology called the Internet. Most of us started treating the internet as a living entity which is always getting changed and evolved every day. Most of the startup businesses and new application are getting created continuously. Moreover, the internet is growing and also changing the outlook. Due to cheaper and pervasive broadband connectivity, the manufacturers are producing the smaller devices with the variety of onboard sensors integrated and which become more powerful in nature. Because of generation of more devices which are connected together by means of the internet will lead to a new technology called IOT i.e. Internet of Things. It mainly deals with physical objects integrated with the smaller embedded devices which can able to collect the data and make it available for the analysis. The main intention of this project is to identify the steps to integrate the IOT with the sample embedded application.so that it will give us the idea on how to integrate the application with the IOT.

Key words: Component; IOT, Kaa, IPV6, Internet of Things, Kaa IOT

I. INTRODUCTION

The Internet of Things (IOT) can be defined as the network of Physical entities or objects which are equipped with electronics, software, sensors, and a network connection between objects and devices can be able to collect data and exchange with the other object or device.

The Internet of Things basically works using the existing network infrastructure, sensing and controlling the devices remotely. It creates an opportunity to the physical objects and computer-based systems to have direct integration between them, it, in turn, resulting in high efficient, accurate, and economical communication mechanism for the devices. In this type of infrastructure, each object is distinctly identified with its distinct embedded operating system. According to the estimation made by the experts by the end of 2020 around 50 billion objects will be connected to the network infrastructure.

In today's world in one are the other way everyone and everything is connected to each other by means of a technology called the Internet. Most of us started treating the internet as a living entity which is always getting changed and evolved every day. Most of the startup businesses and new application are getting created continuously. Moreover, the internet is growing and also changing the outlook. Due to cheaper and pervasive broadband connectivity, the manufacturers are producing the smaller devices with the variety of onboard sensors integrated and which become more powerful in nature. Because of generation of more devices which are connected together by means of the internet will lead to a new technology called IOT i.e., Internet OF Things. It mainly deals with physical objects integrated with the smaller embedded devices which can able to collect the data and make it available for the analysis. The main intention of this project is to identify the steps to integrate the IOT with the sample embedded application.so that it will give us the idea on how to integrate the application with the IOT.

II. LITERATURE SURVEY

The Internet of Things term was coined by Kevin Ashton executive director of the Auto-ID Center: He had done a presentation on the title "Internet of Things" at Procter & Gamble (P&G) in 1999.He presented the new idea of RFID in P&G's supply chain to the Internet and this was the good way to get executive attention.

In 1999 Neil Gershenfeld spoke about the IOT in his book "When Things Start to Think" from the MIT Media Lab and also he established the center for Bits and Atoms in 2001 "in retrospect, it looks like the rapid growth of the World Wide Web may have been just the trigger charge that is now setting off the real explosion, as things start to use the Net."

In 1999 research-oriented Auto-ID Labs was established as the successor to the MIT Auto-ID Center, which was initially founded by Kevin Ashton, David Brock, and Sanjay Sarma. They developed the Electronic Product Code(EPC), that was RFID-based global item identification system which is developed to replace the UPC bar code.

Neil Gross Business Week in 1999:"In the next century, planet earth will don an electronic skin. It will use the Internet as a scaffold to support and transmit its sensations. This skin is already being stitched together. It consists of millions of embedded electronic measuring devices: thermostats, pressure gauges, pollution detectors, cameras, microphones, glucose sensors, EKGs, electroencephalographs. These will probe and monitor cities and endangered species, the atmosphere, our ships, highways and fleets of trucks, our conversations, our bodies--even our dreams."

In 2000 LG announced that they are going to launch the first refrigerator which will be connected to the Internet. In 2002 David Rose and others created The Ambient Orb which was in a race with the MIT Media Lab is released one of the Ideas about IOT in NY Times Magazine naming it as the idea of the Year. The Orb monitored the dynamic parameters like personal portfolios, the Dow Jones and other data sources and changed its color.

During the year 2003-2004 the term, IOT was mentioned in mainstream publications like Scientific American, The Guardian, and the Boston Globe. The Internet of Things term started to appearing in book titles for the first time from the Projects like Internet0, Cooltown and the Disappearing Computer initiative seek to implement some of the ideas. The US Department of Defense deployed the RFID in a massive scale in their Walmart and Savi program.

In 2005 UN's International Telecommunications Union(ITU) published its first report on the topic of IOT."A new dimension has been added to the world of information and communication technologies (ICTs): from any time, any place connectivity for anyone, we will now have connectivity for anything. Connections will multiply and create an entirely new dynamic network of networks – an Internet of Things"

In 2005 the company Violet founded by Olivier Mével and Rafi Haladjian and they were the manufacturer of the Nabaztag and it is now a part of Aldebaran Robotics. This company builds a rabbit which has Wi-Fi enabled the feature and it was able to provide notification and can be able to speak with human about news headlines, RSS-Feeds, stock market reports and work as alarm clock etc. And then these guys thought that we were able to connect the rabbit with the internet in the same way we can connect anything with each other through the internet protocol.

During the year 2006-2008 the EU has recognized the technology called IOT and the First IOT conference was held in Europe. In 2008 IPSO Alliance was launched by a group of companies and their main aim was to boost the use of IP (Internet Protocol) for enabling the Internet of Tings in smart objects network. The Alliance has a membership of around 50+ bigshot companies including Sun, Fujitsu, Intel, Bosch, Ericsson, SAP, Cisco, and Google.

The year 2008-2009 is called as the Born year for the Internet of Things. According to the survey by Cisco Internet Business Solutions Group (IBSG), more devices or things were connected to the internet when compared to people. The Growth rate of the number of objects which are connected to the Internet was 12.5 billion in the year 2010 and the of the world's population is 6.8 billion. In 2008 U.S. National Intelligence Council made a survey and published that the Internet of Things as one of the "Attention-seeking Civil Technologies" which will have an impact on the US interest by 2025.

From 19xx-Present lot of IOT platforms like objects which speak, Standard protocols like Dash7,6LoWPAN and hardware and software like TinyOS, Contiki has developed but nowhere it has captured the timelines of these projects.

In 2010 Wen Jiabao a Chinese Premier who planned to make a major investment on IOT by understanding that IOT will be the key industry for China in future. In 2011 IPV6 was launched Publicly and this new protocol was able to allow for 2128 addresses i.e. approximately 340 undecillion or 340,282,366,920,938,463,463,374,607,431,768,211,456. Steven Leibson said, "we could assign an IPV6 address to every atom on the surface of the earth, and still have enough addresses left to do another 100+ piles of earth." On this networking, Topic Cisco, Ericsson, and IBM made a large investment to start the initiative of marketing and producing the educational impact on the topic. Arduino and other HW platforms were grown-up and build accessibility between IOT and DIY'ers and Acquisitions invested on the making use of IOT on Space organization for IoT platform Pachube and it is being acquired. The company Mocano which was owning the IOT security has raised the round of funding's in their company.

In 2014 the term IOT was added to the 2011 annual Gartner Hype Cycle. Usually, they track technology life cycles from "technology trigger" to "plateau of productivity". The IOT hit the Hype Cycles' "Peak of Inflated Expectations" in 2014.That was the time when the IOT based communities started extending their network through social networking sites like LinkedIn and platform _connect i.e. the UK's Technology Strategy Board networking. Europe showed the continued and extended support on the subject of ICT-FP7 Work Programme.UK government grants around £5m to develop the IOT in the UK to IoT-A and digital future directives. China Started funding in the field of research and development for Internet of Things through the education institutions like the Chinese Academy of Sciences and Shanghai Institute.

There was an initial level discussion by the IOT developing companies about IOT standardization through the brand name called IOT-GSI (Internet of Things-Global Standards Initiative) and the main approach was to standardize the technical development of internet of things over a global scale. Because of this some of the new projects got added as part of this standardization they are namely Interviews, Presentations, Events, Videos and Twitter Posts should have IOT news covered in their topic.

III. WORK DONE BY EARLIER WORKERS

As per 2013 Survey about the Internet of things growth, the magnitude of the growth rate of Internet of things is due to the concurrency of IOT being communicated across multiple technologies'. i.e. Starting from basic step of the internet to the Wireless communication and from embedded computing systems to the micro electro mechanical systems. The main philanthropist and contributors for the IOT are control systems, wireless sensor networks, automation which includes home and building automation and also the traditional embedded computing systems etc.

In Early 1982 Carnegie Mellon University there was Coke machine which is connected to the network of smart devices and it was the one of the internet-connected appliance which is able to report the trader about its current stock and newly loaded drinks in the machine were cold are not. In 1991 Mark Weiser's seminal paper on pervasive computing title "The Computer of the 21st Century" and also the PerCom and UbiComp produced the present vision of IoT.Reza Raji author in 1994 described the concept in IEEE Spectrum as "[moving] small packets of data to a large set of nodes, so as to integrate and automate everything from home appliances to entire factories". During the year 1993-1996, many companies proposed solutions like Novell's NEST or Microsoft's at Work. In 1999 the World Economic Forum at Davos Bill Joy predicted and presented the Device to Device (D2D) communication as part of his "Six Webs" framework presentation.

In 1999 Auto-ID Center at MIT and also market-analysis publications made the concept IOT more popular by their publications. Kevin Ashton is one of the founders of the Auto-ID Center determined Radio-frequency identification (RFID) as one of the preconditions for the internet of Things connected objects. In daily life, the human being is connected with the more objects and people: they, in turn, provided with identifiers, so computers keep manage and maintain the status of them. The things can be tagged using the NFC (Near field communication) technology, QR codes, digital watermarking, barcodes.

In its intuition, one of his dream of implementing the Internet of Things by attiring all entities in the world with tiny

identification devices or machine-readable gadgets would be able to transform the daily life activities. For example, the constant invention becoming pervasive in nature. Using the existing network infrastructure to be able to interact with objects can be altered based on the present customer needs.

IV. HARDWARE AND SOFTWARE MODEL

Block diagram consists of four blocks namely

1) IOT Software Server/Cloud
2) Raspberry pi Board Endpoint SDK Application
3) IOT Console in Browser
4) Web Dashboard / Browser

1) IOT Software Server /Cloud:

This is the Ubuntu Linux /Windows Server where Kaa IOT Sandbox instance is setup using the vmimage or through the installers.

2) Raspberry pi Board Endpoint SDK Application:

This Raspberry Pi Board is integrated with the IOT Sandbox instance through an endpoint SDK API.So that the communication between the IOT Sandbox and the Raspberry pi board established through the endpoint sdk.

3) IOT Console in Browser:

Through this browser IOT sandbox instance will be controlled.

4) Web Dashboard/Browser:

Through this web dashboard the data or instance of raspberry pi is displayed and controlled.

A. Block Diagram and Explanation:

The IOT integration platform diagram consists of four blocks which are explained above. IOT Software Server/Cloud where the Kaa IOT sandbox instance is setup using the vmimage or installer. Once the Kaa sandbox instance is created using the oracle virtual box which is installed on the server /cloud. The Sandbox instance will be accessed through the Browser which is here termed as IOT console in Browser and sandbox can be controlled through the same.

The basic concept of the Kaa sandbox is that the endpoint SDK is developed for the application to integrate with the sandbox. So that sandbox can collect the data of Raspberry pi and provide the analytics of the same to display it on the web dashboard. IOT sandbox has the database to store the data which is being captured from the sample applications which are integrated to the sandbox through internet. Apache Webserver is installed on the Raspberry pi board, so that it can be accessed in Web dashboard/ browser.

As per the block diagram the IOT software cloud platform can be accessed through the Browser. The Sample application which is being developed is the Notification application and SDK will be deployed on the Raspberry pi. So that the notification which is send through the IOT software cloud will be displayed on the Raspberry Pi webserver console to be able complete this task. The Notification application endpoints are defined in the IOT Software cloud platform through the browser. i.e. Notification Topic, Notification schema using schema. json, created the profile for endpoint SDK and also the java code required for sending the notification from IOT cloud to endpoint SDK. After this created the endpoint SDK required for the Raspberry pi and deployed the same on the same. Now when we send the notification from the IOT Software cloud it will be displayed on the Raspberry Pi Webserver console which is being viewed through Web Dashboard/Browser in the block diagram.

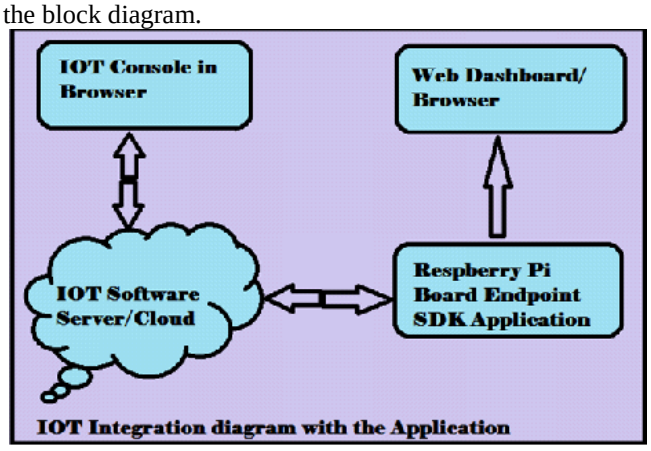

Fig. 1: Block Diagram

B. Hardware and Software Specification:

Hardware Specifications:

- Raspberry pi for the Sample application/End point SDK
- Ubuntu Linux /Windows operating System for the Server /cloud
- A Power Supply (Micro USB)
- A Network Cable
- A HDMI Cable to connect to the Web browser
- An SD Card (4GB)
- An SD Card reader for your computer

Software Specifications:

- Kaa IOT OVA Image for Sandbox/ installer
- Oracle Virtual Box for running Kaa IOT VM
- End point SDK/API plugin for Raspberry pi
- Apache 2.4.10 Webserver for Raspberry pi board
- Web browser for controlling Kaa sandbox and Raspberry pi
- Putty SSH client to connect to a Raspberry Pi
- Raspberry Pi Debian Image
- Windows32DiskImager

V. SCOPE AND TASKS INVOLVED

Main goal of the paper is to show how to integrate the IOT with the sample embedded application. It involves the following scope for this paper and also tasks involved in project development to be completed successfully.

- Identifying the IOT Open source software
- Identifying the Sample application for integration
- Development of plugin to integrate application
- Hosting IOT Sandbox on Server /cloud
- Installing the software requires for sample application.
- Integrating and testing the IOT with the Sample Application
- Validation of the output

VI. TEST PLAN

Kaa IOT software is the one of the open source IOT platform which is used in our project to host a Kaa IOT sandbox instance on the Server or cloud. So that it can be accessed and controlled from the web browser through URI. Raspberry Pi Board is used for the sample application to be integrated with the Kaa sandbox. The Raspberry Pi and Kaa sandbox is connected over the internet through Wi-Fi network. HTTP(S)

based and TCP based transport protocols are used for the communication. TCP based protocol is well suited for the low latency and overhead. It has capability to securing the data packet using hybrid encryption with 2048-bit RSA and AES-256.

An Endpoint SDK or API is developed for the Raspberry pi to integrate with the Kaa IOT Sandbox instance. Initially the SDK is written in the C++ programming language and it cross compiled to java API using the cross compiler. After cross compilation the Endpoint SDK/API is deployed on the Raspberry pi to connect to the Kaa sandbox. So that communication between Kaa and Raspberry pi is established through the Wi-Fi or Xbee network to collect the data from the Raspberry pi. Apache Webserver is installed on the Raspberry pi and data can be displayed on the web browser.

VII. TEST RESULT

This is the Final output screenshot which shows that the message sent from the IOT Sandbox platform is displayed on the enpoint SDK which is deployed on the Raspberry Pi

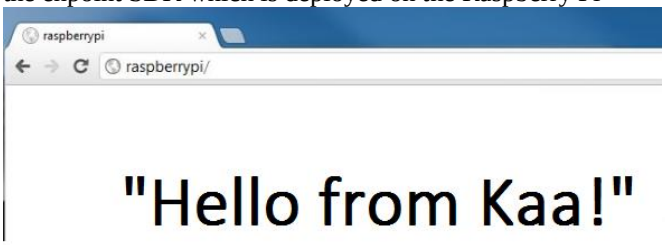

Fig. 2: Final Output on Raspberry Pi Board Dashboard

This is the Final output screenshot of the notification demo application.

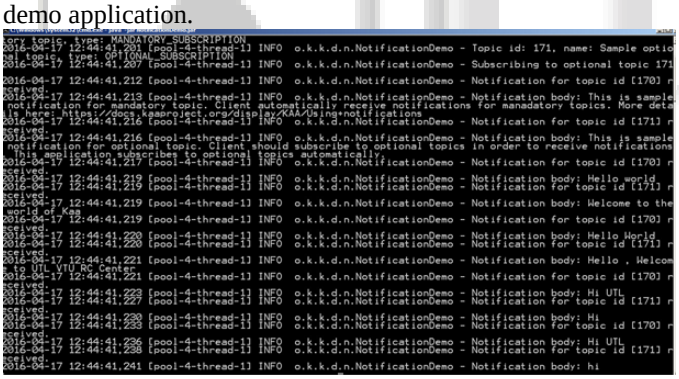

Fig. 3: Final Output of Java based application

VIII. CONCLUSION AND FUTURE SCOPE

According to objective of this paper, understood the basic concept behind the internet of Things. In today's world how the IOT is being evolved and innovation is taking place in the field of internet by making use of the concept called IOT. Implementing this concept to make the human day to today work easier. This paper work can be concluded with the following points.

- Hosted the Kaa IOT open source Software on the Server /cloud
- Endpoint SDK/API is developed for the integration of Raspberry Pi with Kaa IOT Sandbox
- Integrated the Raspberry Pi with the Kaa IOT Sandbox by means of Endpoint SDK
- Developed the Notification demo desktop application for the Raspberry Pi
- Deployed the Notification demo application on Raspberry Pi and tested successfully.
- Documented each steps involved in the integration.

In this paper the simple notification demo application is integrated with the Raspberry Pi and also on the desktop. In future this integration can be extend to wearables, Health care industries, consumer electronics and agriculture.

ACKNOWLEDGMENT

The successful completion of a task means that, the task has inherited the guidance and knowledge of many people who directly or indirectly helped for the completion of paper. It's my duty to express appreciation to all those who helped me in completing this paper.

I would finally like to extend my thanks to all the teaching and non-teaching staff at VTU Extension Centre, UTL Technologies Limited and also my friends and well-wishers in our company for helping me directly or indirectly in the completion of my project.

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