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# Monitoring Price Tag with Epaper by Using 6loWPAN and MQTT

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***Abstract: The Internet of Things (IoT) that will connect the digital world to the physical world.Internet of Things (IOT) of the most attractive subjects in both the research community and the public In this vision, trillions of embedded devices, also called smart objects, will be connected using the Internet Protocol (IP) and then be an integral part of the internet. A smart object can be any item equipped with a form of sensor or actuator, a tiny microprocessor, a communication device and a power source. Such a smart object can communicate its sensor readings to the outside world and receive input from other smart objects. Actually, all objects surrounding human beings may potentially be a part of the IoT. Contiki is pitched as the open source operating system for the Internet of Things (IoT), which is designed for use in particular with embedded and highly resource constrained devices.As a sub-domain, "Wireless price tag with customer survey" Networks have been attracting a lot of use in daily super markets and shopping malls. The resource is for to reduce time for workers and easy to update daily price and data for a particular product.In this project the "PHYNODE EPAPER" with 2 sensors, 1 is the temperature sensor and 2 is the proximity sensor is developed and implemented. Our main aim is also to reduce the power consumption.The tool is applicable to 6LoWPAN and MQTT technology.***
***Keywords: IoT, 6LOWPAN, PHYNODE-EPAPER, MQTT***

## I. INTRODUCTION

There is an increasing interest in using wireless communication with sensors and actuators in homes, office buildings factories, and even outdoors. Moreover, there is a desire to incorporate these devices as part of the internet so that these devices could be accessed from anywhere. These devices afford new ways of communicating between each other, with things outside of their own application scope, with existing infrastructure and ultimately the outside world. A broad for the IoT is therefore for everything we might need, whether we currently know it or otherwise, to be individually accessible across the internet. From this perspective, embedding a TXP/IP stack into these sensing and acting devices seems an attractive idea, which is reinforced by the new features IPv6 provides (such as the large address space and address auto configuration). Typical sensor devices are equipped with 8-bit micro controllers, code memory on the order of 100 kilobytes, and less than 20 kilobytes of RAM. However, the TCP/IP protocol suite was not originally intended for such devices; its requirements for the underlying link layers are generally too strong to be carried out by resource-constrained devices, while certain network layer features are too complex and resource consuming. The ultimate goal of this project is to develop the drivers for all the sensors present on the Phynodei.e CC2650 phy Wave in contiki OS and then make an application which sends the value of all the sensors to the Phygate (Gteway or edge router) i.e.AM 335x-Phytech Wega Board. This application sends the data using 6LoWPAN.

The below sections describes about phynode and Epaper in details

### *A. WSN*

WSN is a collection of autonomous nodes (with one or several sensors per node) distributed in an area with the capability to interact with other elements and share data with a coordinator(base station). The mission of the coordinator is to collect, process, treat and manipulate the information to get human-readable data.

## II. INTERNET OF THINGS (IoT)

The IoT creates an intelligent, invisible network fabric that can be sensed, controlled and programmed. IoT-enabled products employ embedded technology that allows them to communicate, directly or indirectly, with each other or the internet. This concept covers multiple protocols, systems and applications that make possible this connection between these devices called "things".

Looking at Gartner, IoT is on the top of peak of the hype cycle of emerging technologies, that means that at the day of today is a technology for start-ups that wants to be on the top of an specific market.

### *A. How it Works*

IOT is made of embedded devices and there are four main components of systems that support the internet of things:

*1)* The thing itself(the device)
*2)* The local network, which moves data in and out of the device. This may include a gateway to translate proprietary communication protocols to the IP family of protocols.
*3)* The internet itself
*4)* End user devices(desktop, laptop, smart phones) or enterprise data systems that receive and manipulate data(backend data analytics).

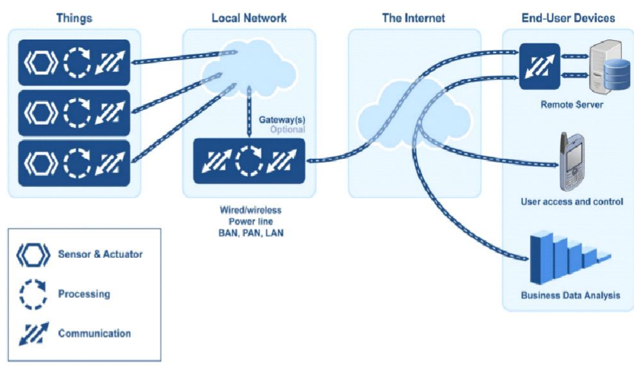


Fig-1 General set up of IOT

### *B. The Internet Protocol Suite*

The internet protocol suite is a set  of the communications suite. Incommunication protocols grouped for the first time in RFC 1122 and RFC 1123. It is often referred to as TCP/IP protocol stack due to the division into the abstraction layers of the communications suite. In this tack the information flows in both directions, but in such a way that each layer communicates only with the layer immediately above or beneath, by encapsulating the data on the way down and de-encapsulating it on the way up. In order for tis communication to occur, each layer requires the layer underneath to meet requirements, and has likewise to fulfill the requirements of the layer placed immediately above.
According to RFC 1122, the Internet Protocol Suite is divided into four abstraction layers: Link Layer, Internet Layer, Transport Layer, and Application Layer.

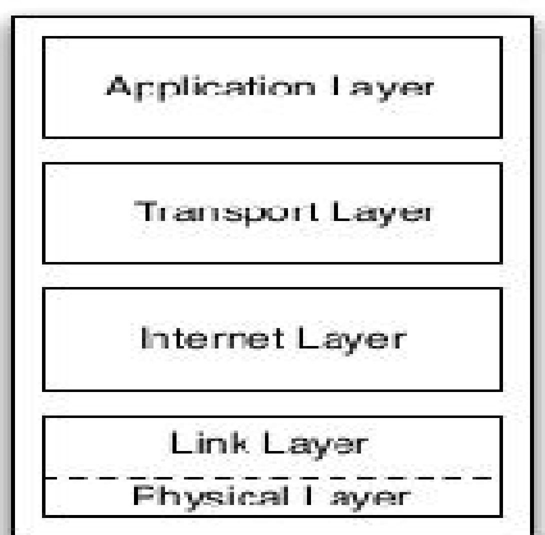


Fig.-2 The TCP/IP stack, including the Physical Layer (dashed)

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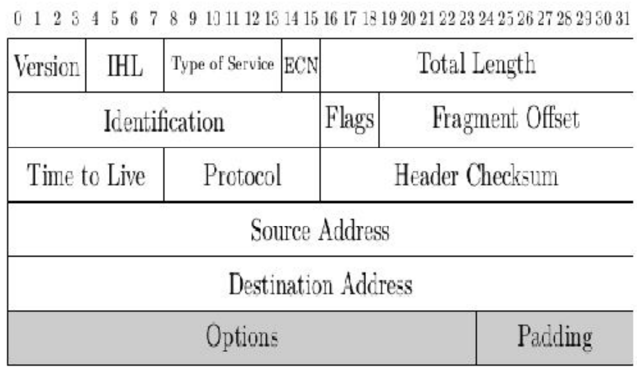
### *C. Internet Protocol*

The internet protocol (IP) is the principal internet layer protocol. It is connectionless, best effort, unreliable internet working protocol which provides the necessary functions to deliver a packet from a source to a destination (both identified by fixed length addresses) over a system composed of an arbitrary number of networks. It also provides mechanisms for packet fragmentation and reassembly, if necessary.

1) *IPV4:* Internet protocol version 4(IPv4) is defined in RFC 791. It uses 32 bit addresses, which limits the total number of ipv4 addresses to 232. Its header has variable length (due to the options field), as illustrated in fig below.

These two features (address length are variable length), together with the need for Flow Labeling capability constitute the main shortcomings/limitations of the protocol, and hence the reasons that have made necessary the definition of its next version (version 6).




zig- 3 IPv4 datagram header. Light grey coloured fields are optional

2) *IPv6 :*TheIP protocol version 6 (ipv6) is defined in RFC 2460(replacing its previous definition in RFC 1883). It was defined in1998 in order to succeed ipv4, with the goal of overcoming a number of ipv4 short comings, especially, for dealingwith the anticipated ipv4 address exhaustion. The primary changes from ipv4 to ipv6 are an increased address space, which is 18bits (allowing for up to2128-about 3.4 x1038) different ipv6 addresses), a simplified header fromat , with includes a fixed header – length and improved support for extension headers and options(allowing for more efficient packet forwarding and greater flexibility for introducing new options), flow labeling capability(with which the sender is allowed to request special handling by routers), and authentication and privacy capabilities. The ipv6 header format is described below and illustrated in fig4

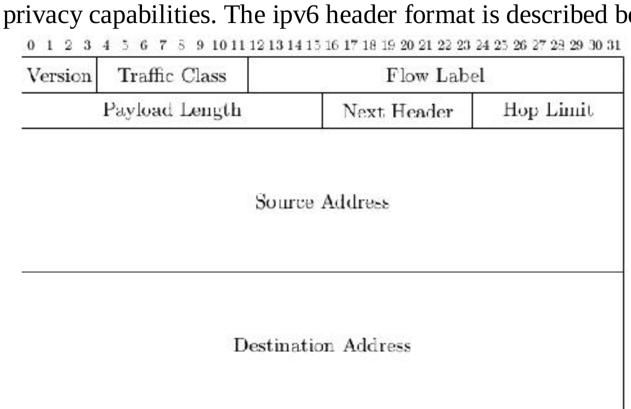



Fig-4 IPv6 Datagram Header

### *D. 6LoWPAN*

6LoWPAN is an intermediate layer that allows the transport of IPv6 packets over IEEE 802.15.4 frames. Although the term6LoWPAN stands for IPv6 over low power wireless personal area networks. Below figure depicts how an ipv6 packet is encapsulated into aIEEE 802.15.4 frame using the 6LOWPAN adaptation layer. TheIPv6 standard defines certain requirements for the link layers over which it is to be transported. However, the IEEE 802.15.4 MAC layer does not fulfill these requirements in certain points. Hence the 6LOWPAN specification defines not only the frame format for the transmission of IPv6 packets over IEEE

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802.15.4, but also the mechanisms to obtain a unique IPv6 address from either, 16-bit or 64 bit IEEE 802.15.4 MAC addresses (using stateless address auto configuration- defined in RFC 4862), and to overcome the limitations of IEEE 802.15.4.

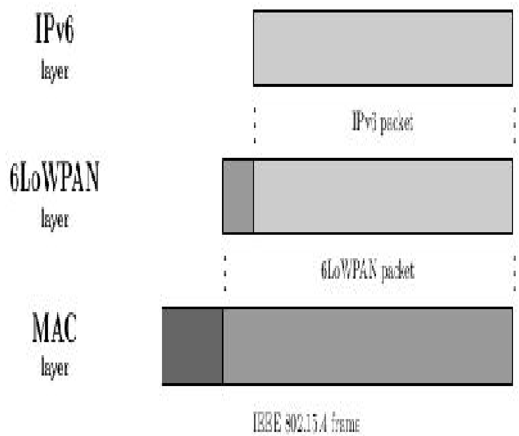


Fig-5. 6LoWPAN Intermediate layer

1) *6LoWPAN Motivations :* The minimum Maximum Transfer Unit (MTU) required for a link-layer transporting IPv6 packets is, as defined in RFC 2460, 1280 octets. This is far beyond the maximum IEEE 802.15.4 frame size, which is 127 octets. Of these 127 octets, the maximum MAC header size is 25 octets and, if IEEE 802.15.4 link-layer security is enabled, it may use up to 21 additional octets. This leaves only 81 octets available for IPv6 transport. As the IPv6 header length is 40 bytes, only 41 bytes are available for transport layers and so on. In order to meet the IPv6 minimum MTU requirements, 6LoWPAN defines a fragmentation and reassembly mechanism that allows splitting IPv6 packets at the 6LoWPAN adaptation layer into smaller fragments that can be handled by the link-layer, with this process being transparent to the Internet layer. However, applications using 6LoWPAN are not expected to use large packets, hence, in order to avoid fragmentation as much as possible, 6LoWPAN defines an IPv6 header compression mechanism .

## III. OPERATING SYSTEM

### A. *Operating system*

An operating system act as an intermediary between the user and hardware. The purpose of an operating system is to provide an environment in which a user can execute programs in a convenient and efficient manner.
An operating system is a software that manages the computer hardware. The hardware must provide appropriate mechanisms to ensure the correct operation of the system and to prevent user programs from interfering with the proper operation of the system.

### B. *Contiki OS*

Contiki (Kon-Tiki) is an IPv6 ready, open source WSN lightweight operative system, design to be highly portable and memory efficient. Contiki is written in C programming language and has an event-driven kernel, but is also capable of handling per-process multithreading and interposes communication, achieved by combining the benefits of both event-driven systems and premptible threads.
Contiki contains two communication stacks: uIP and Rime. uIP is a small RFC-compliant TCP/IP stack that makes it possible for Contiki to communicate over the Internet. Rime is a lightweight communication stack designed for low-power radios.

### C. *Parts of the operating systems*

1) Kernel
2) Device Drivers
3) User Interface
4) System Utilities

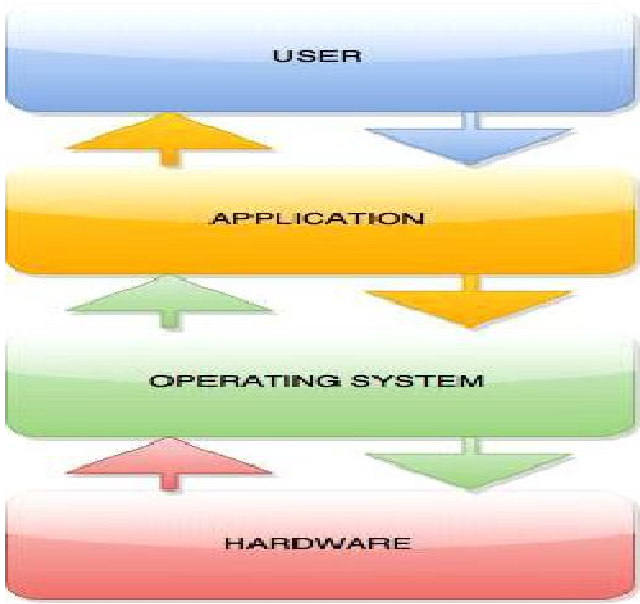


Fig-6 General OS Design Architecture

## III. HARDWARE

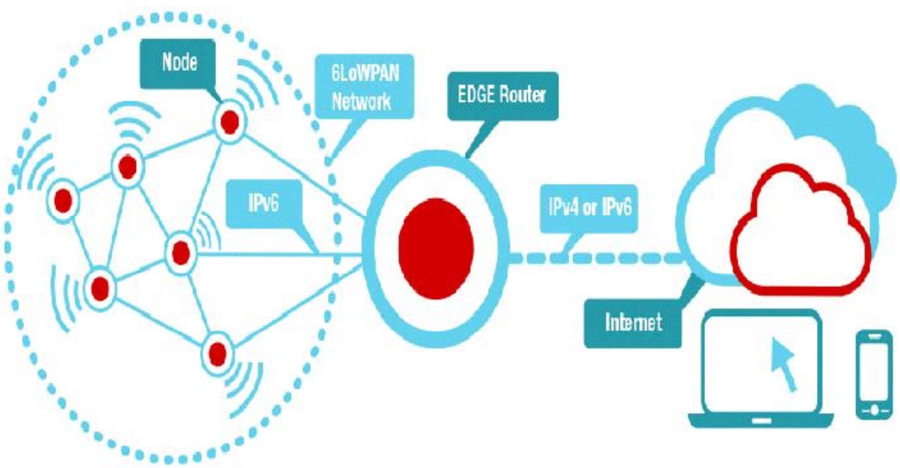


Fig-7 General hardware setup

### *A. Node*

From light bulbs to smoke detectors, the wireless sensor nodes (often called motes) usually have a microcontroller as a CPU that is not very powerful because the main focus of those nodes lies in minimal power consumption since they are often designed to run on battery power for very long periods of time. And even though the microcontroller and all other components of nodes are designed as low power devices, running them all at full power at all times would still consume way too much energy. each node carries an IPv6 address. Nodes typically require small amounts of memory and processing power, and can be implemented using a wireless MCU. We call a node as a Phynode which is a yellow board from Phytec with a MCU from TI i.e. CC2650 . It consists of total 8 sensors like humidity, temperature, accelerometer, etc.

### *B. Phynode*

Phytron board is using as a phynode. The MCU in the phytron board is using as a phynode. The CU in the Phytron is TICC2650. It consists of 8 sensors that are RGB-LED, Magnetometer (MAG3110FCR1), Accelerometer (MMA8652FC) Pressure sensor (MPL3115A2),color light sensor (TCS3772770), Capacitive Button, humidity (HDC1000) and IR thermopile Sensor(TMP006).

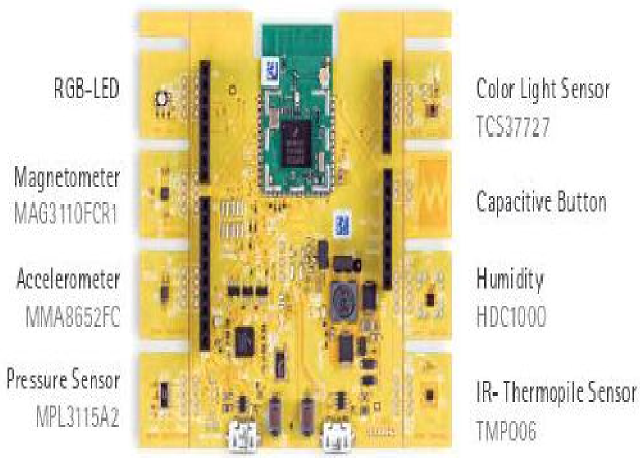


Fig-8: Phynode

*C. Phynodeepaper.*

phyNODEePaper is based on a phyWAVECC2650 and can be integrated through SPI into existing networks BLE or IEEE802.15.4|6LowPAN. It also has a user-configurable button, temperature sensor as well as a proximity sensor. We designed it with energy efficiency in mind in order to ensure operation with a button cell or a lithium cell in AA format. Therefore, the graphical ePaper display only uses energy during the updating process.Once the content is displayed, phyNODEePaper can be switched off for a configurable amount of time. Exemplary uses for ePaper Node are configurable name tags, price tags or information items for building automation.

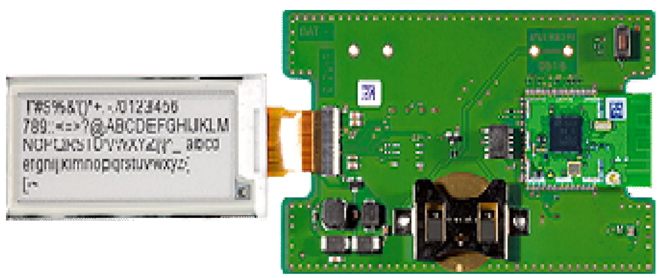

Fig-9Phynodeepaper

## IV. IMPLEMENTATION

*A. Proposed Method*

In the existing the method sensors are used and additionally in the proposed method epaper technology is used to reduce the power consumption.

1) *ePaper:* This epaper is the latest technological advances made by the Industrial Technology Research Institute (ITRI) in flexible displays.It is active matrix organic light-emitting diode display and we develop a rewritable, environmentally friendly thermal printable epaper.Theepaper, devised to reduce traditional paper consumption.Rewritable electronic paper, and a full R2R(Record to report) process with 100µm-thick exible glass substrates
2) *Procedure:*Initially develop the epaper with the help of passive LED’s and then insert the 2 sensors in the same phynodeepaper,1 is the temperature sensor and 2 is the proximity sensor.The temperature sensor to monitor the how much temperature in particular place, and proximity sensor is the by using to detect how many persons to visit particular product.
3) *Project Modules:* N The below figure shows the block diagram of the complete project which consists of mainly three modules

*a)* Phynode Epape
*b)* WEGA Gatewa
*c)* Mobile/Computer

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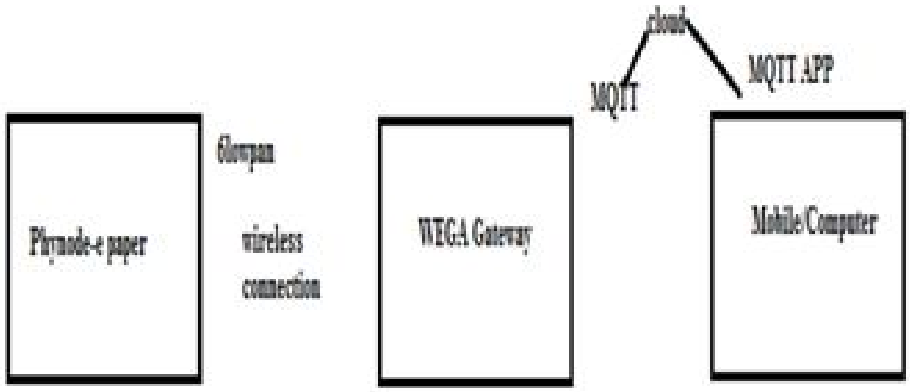


Fig-10Block Diagram of Monitoring Price Tag Using E Paper

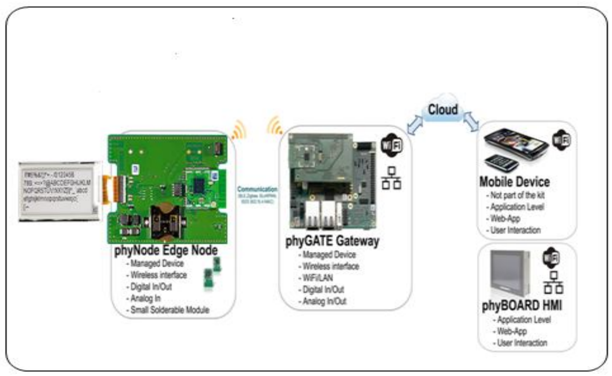


Fig-11 Picture Based Project Implementation

4) *Paper Passive Led Display:* By using passive LED Once the content is displayed in phyNODEePaper
The graphical ePaper display only uses energy during the updating process. Once the content is displayed, phyNODEePaper can be switched off for a configurable amount of time.


Fig-12Passive led epaper display

Fig-13Epaper

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5) *MQTT*

a) MQTT is a machine-to-machine (M2M)/"Internet of Things" connectivity protocol.

b) MQTT(Message Queue Telemetry Transport) is a publish-subscribe based "light weight" messaging protocol for use on top of the TCP/IP proctocol .It is designed for connections with remote locations where a 'small code footprint' is required and/or network bandwidth is limited.

c) Publish-subscribe means when a thing publishes the message in a topic. A topic is like a channel where each thing subscribed to that topic will receive that message. You can imagine this like a Twitter of Things.

d) We collect the total data with a MQTT application in mobile, tab's or computers.

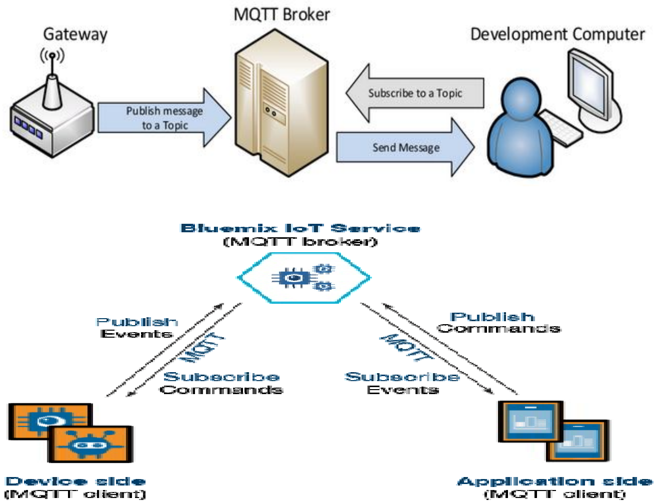


Fig-14 Representation of MQTT

## V. RESULTS

### A. Results

The main goal of this project was to develop the driver for all the sensors present on the Phynode and develop an application to collect the data from sensor of phynode and send it to phygate.

So the drivers of some sensors are developed successfully and to see the results one demo application is develop which is sending the phynode data to the phygate.

After the compilation of all the developed drivers and application we get the binary Image of Contiki. We ported that binary Image to the phynode using the Open OCD debugger. After the porting of the Contiki OS on the phynode, it started booting and collecting the data by using sensors and start advertising the data to the air. Image of the advertising node is shown below in Fig below. The indication of the advertising is the RGB Led which glows to advertise the data.

Fig-15 Advertising using RGB LED

For showing the results one prebuilt python script is used at phygate. 6LoWPAN Protocol and converts the received raw Data of sensors and show the result on the console of the phygate.

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The results of some sensors data using the android application whose screenshots are shown below:

*B. Input Images*

Complete input data updating process steps.

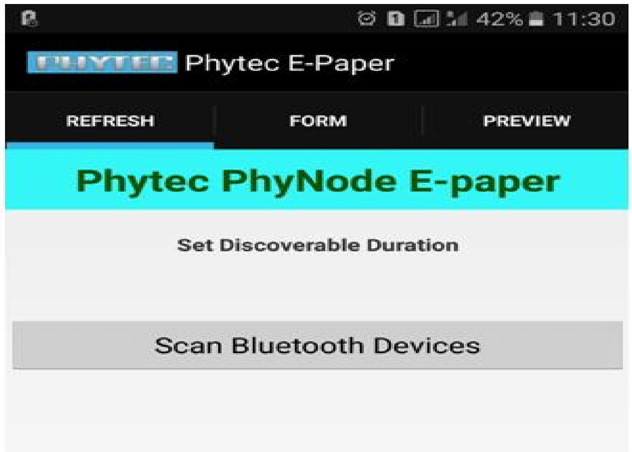


Fig-16 Input Image ForPhytecEpaper

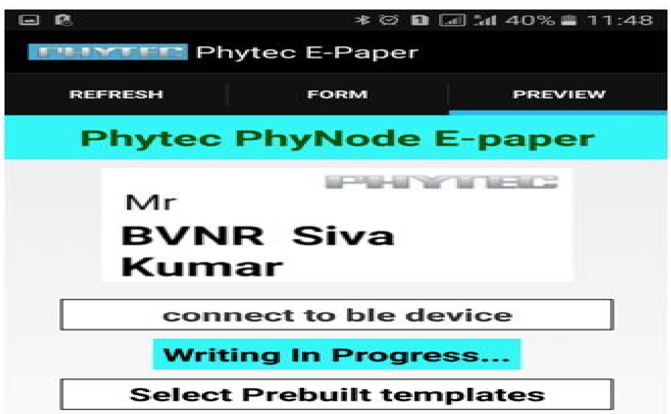


Fig -17 Input Image with Writing In Progress

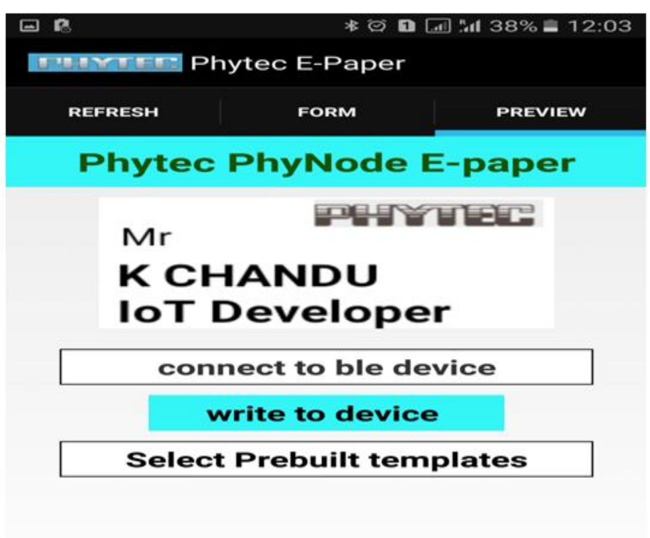


Fig-18 Input Image Write To Device

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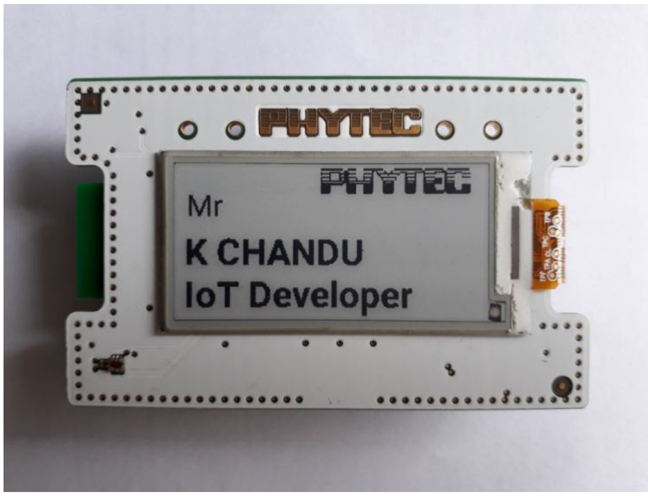
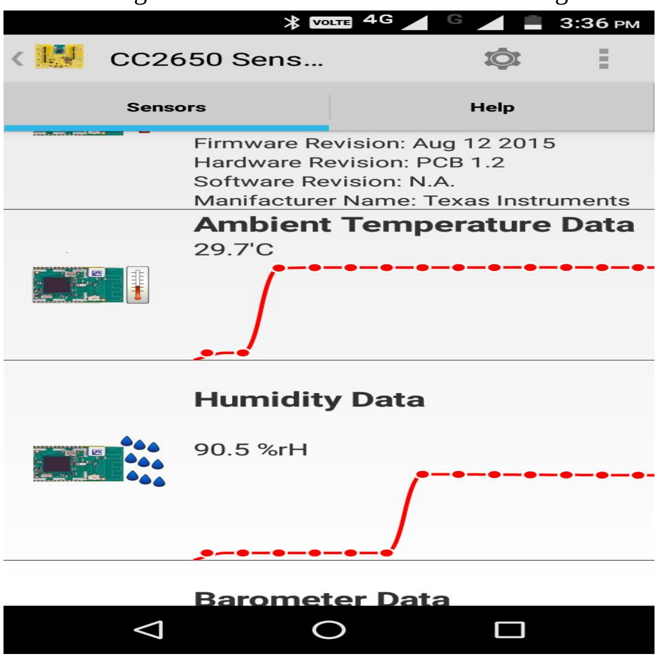
*C. Output Images*

The below images shows the output results using phytec board.


*D. Output Images of sensors*

The temperature, humidity, accelerometer and light sensor data are shown in below images



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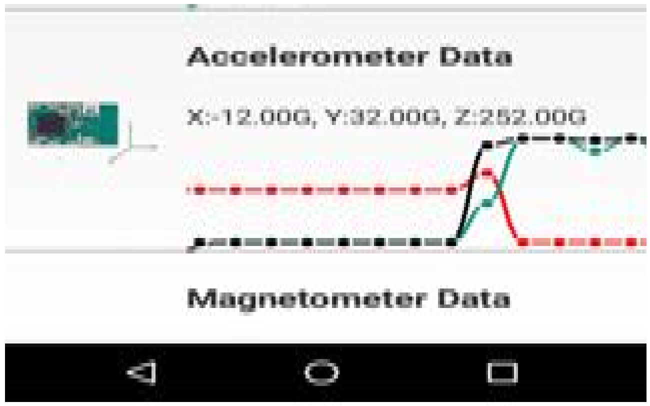


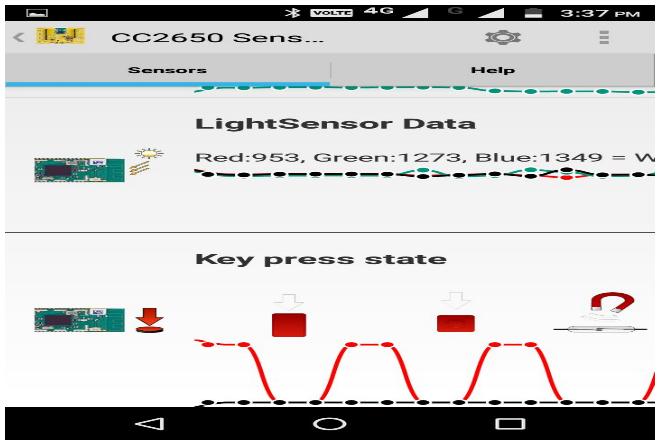


## VI. COMPARISON GRAPH

Figure below shows the power led supply which has heavy power lose.

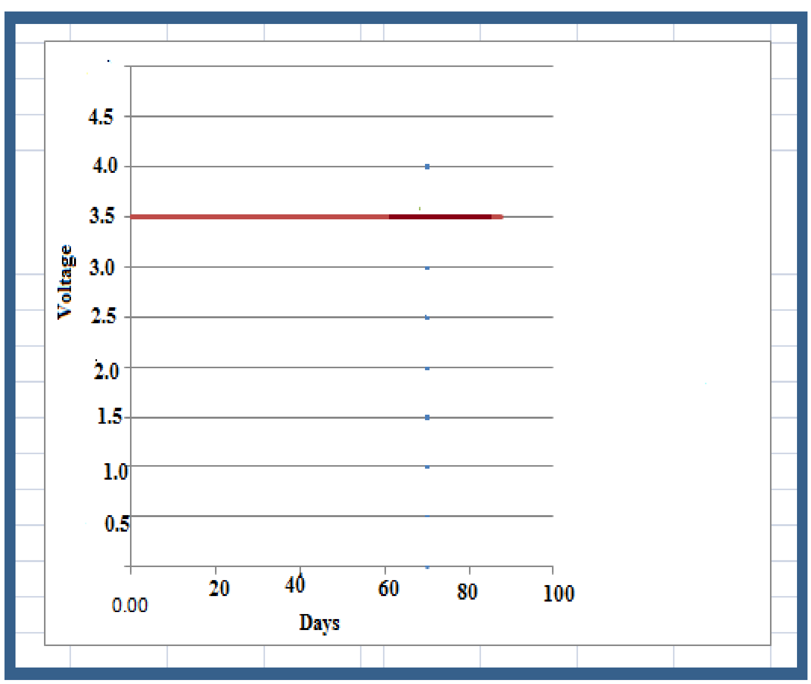


Fig-19 Power Led Display

Figure below shows the passive led display which has very low power lose.

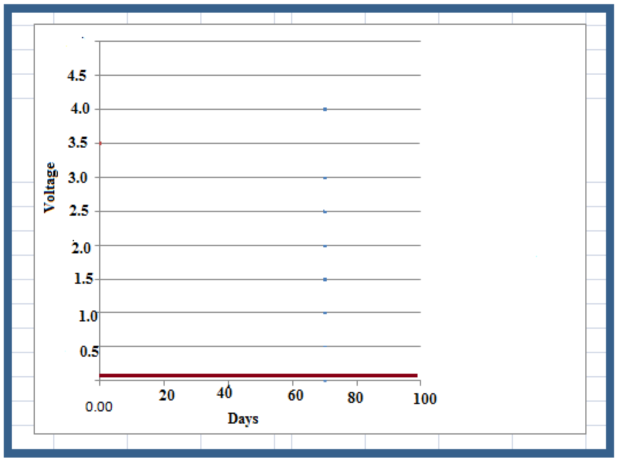


Fig-20 Passive Led Display

## VII. CONCLUSION

From the project result it is very useful in supermarkets, shopping malls and etc. and to develop phynodeepaper based on IoT technology using 6loWPAN,MQTT and phyGATE-AM335x this things. The same time we can write and read the data in epaper display.And also only read the data of temperature sensor, proximity sensor and etc sensor data.

## VIII. FUTURE SCOPE

To adding the different sensors in prize tag automatically to analyse the surrounds.By using epaper we can develop flexible products mobile and TV display.ebanners and esignage. ecards, ebadge, etags, etickets. We can develop with wireless connections this total products based on IoT.

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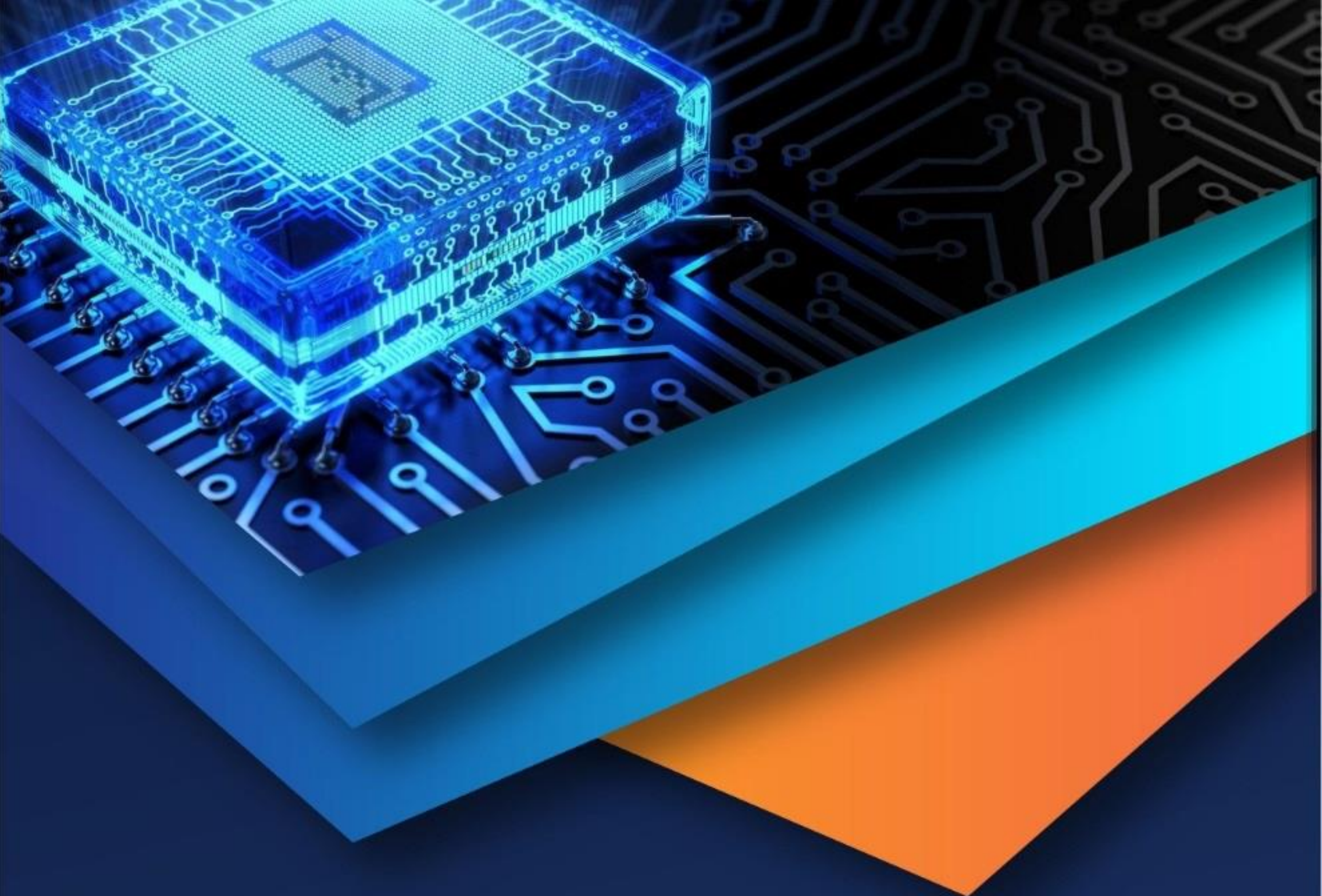
*Now I am research in speech and image processing technologies.*



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