IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 6 Issue 6, June 2019
ISSN (Online) 2348 – 7968
www.ijiset.com

An Efficient Security Enhanced NB-IoT Connections In Hospitals

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***Abstract*—IoT refers to the Internet of Things which is the network of sensor equipped objects for the data transfer without human interactions. IoT applications are increased in the day to day life very effectively. There are used many types of application in healthcare for recent years. Here proposes the connections of objects in the hospitals in a security enhanced manner with low power, low cost ,wider area coverage. For providing it here use the NB-IoT communication protocol. NB-IoT is the LPWA technology provided by 3GPP(180KHz). It mainly focus on monitoring injection monitoring system, heartbeat and temperature in hospitals. The main contribution of this paper is to provide the security through symmetric encryption.**

***Index Terms*—IoT;NB-IoT;Hospital-security enhancement; Data encryption.**

I. Introduction

Since 1999,the IoT technology got introduced and over these years it has increasing the applications in various sectors such as industrial, agriculture,smart city , home appliances,medical field and so on.According with this, also improved the machine learning,cloud computing and big data processing . The applications of IoT increases all over the world causes the tremendous number of IoT devices and data in the universe.So it leads into the machine type communications(MTC).MTC can be divided into 3 types according to the distance.The distance less than 10m coverage called short-distance MTC. RFID, Bluetooth, UWB are lies under this category.The MTC distance between 10 m and 100 m is called medium-distance MTC. WiFi and ZigBee are lies under this category.Long distance high data rate MTC include 2G/3G/4G technologies.LPWA technology includes in the long distance low data rate technologies which is more suitable in smart city,smart parking,hospitals etc [16]. NBIoT is a leaner and thinner version of IoT. It takes a narrow band of frequency for its operation. In Release 13, 180kHz is allocated for NBIoT [15].

II. RELATED WORKS

A. IoT IN HEALTHCARE

F.Fernandez et al[1] ,in this paper it is mainly focused on the system engineering decisions space for the healthcare to handle various issues in the healthcare .So here taking verity of dimensions to handle it. In this proposed model they included the factors such as SWOT (strengths, weaknesses, opportunities, and threats) analysis, vision, context, mission, value chain, consumerization, marketability, revenue streams, segments, distribution channels etc. It says for the IoT initialization have to focus on the five nonfunctional requirements .Those are Simplicity, Staying Power, Stability, Security and Standards. It says about how the properties such as redundancy, reliability ,antenna range, robustness are affecting in the physical environment.

The available wearable devices are mainly used for monitoring of heart rate, blood pressure etc.In future chemical sensors are used for monitoring metabolic activities such as breath and sweat. The nodes must be cost effective with some characteristics such as form factor, size, weight, power consumption, mobility and ergonomic requirements; IP IK protection degrees, battery lifetime; connectivity; processing and positioning requirements; multi modulity and communication range; throughput and latency constraints; self-healing and EMC requirements; cost constraints.

N.Kumar[9] et.al firstly described various types of health architectures mHealth, 6LoWPAN based healthcare system, Constrained application protocol based architecture, IEEE 11073 health standard based architecture. And also described about the design of various types of health care system such as blood glucose monitoring systems, temperature monitoring systems, healthcare systems for the elderly, electrocardiogram, heart monitoring systems, heart Rate Monitoring. The main parts of the IoT are the sensors such as accelerometers, gyroscope, magnetometer ,ECG sensors and they are supported by different hardware platforms such as Galileo Platform, Arduino , Raspberry Pi, Microcontroller based Systems such as PIC18F4550 microcontroller, other HW platforms such as IOIO-OTG. The proposed method is based on the intel curie based healthcare monitoring system. In this healthcare system Curie is based Intel Quark core(32MHz) and which is mounted on Arduino 101 and it can connect with various sensors using 14 digital IO pins. Curie has inbuilt accelerometer and gyroscope.The various measurements from sensors can forward to health server.

S. Baker.et.al [5] includes the complete description about how the IoT improves in the healthcare system. By comparing many papers it says the security problem of the large amount of sensitive data. This paper proposed a model with 4 parts. Physiological conditions are sensed by the wearable device which is transmit into the central node using short range communications. These data send LPWAN work station to the cloud storage and machine learning section for storage. The proposed Model has Potential Use Cases like rehabilitation aiding, chronic condition management, monitoring parkinsons diseases .It includes various types of health monitoring sensors and the details of calculation that sensors ie pulse sensors, Respiratory Rate Sensors, Body Temperature Sensors, Blood Pressure, Pulse Oximetry Sensors, other Wearable Sensors(ECG sensor, (EEG) sensor. It includes the comparison of the two short range communication standards ie BLE(Bluetooth Low

Energy) and ZigBee (XBee Module). In these papers it may get the complete aware of the IoT in healthcare and it focuses on technologies,opportunities ,challenges and system design of the IoT in healthcare.

V.Alagar[8] et.al proposed 2 concepts.1. Security and privacy architecture for HIoT. 2. Context-sensitive role-based access control scheme. The Supervisory System (SS) model is the highest priority to manage all applications and it will provide necessary policies to handle the data.Data will not be only from healthcare ,it may have from various resources. data may be come from 2 resources (1) HIoT that is certified by the Intelligent Trusted Authority (IAT) of HIoT for security of HIoT, and external sources that are evaluated and filtered by the Authorization Unit in the Supervisory System. HIoT Analytic Component (HIAC) has diffrent security analysis for interconnection among the devices .Even though it is outside, for safety it will managed by SS.HIAC has four layers . These are Storage Layer (SL), Logical Layer (LL), Application Layer, and Presentation Layer (PL) Intelligently guided by an Intelligent Controller(IC) and an Intelligent Trusted Administrator (ITA) with the help of id and context information.

A.Mdhaffar[4] proposes IoT-based health monitoring approach for resolving Cost of communication links, Data privacy issues,monitoring of parameters. Here the LoRa WAN LPWA technology is used as the communication protocol. Zappia et.al[11] says RFID technologies are mainly used for patient identification and monitoring and patientdrug compliance .This paper is based on CEP engine which can reduce the problems according to the modules. CEP engine is in the form of hierarchy where the data stored here according to the priority.Here it will keep the most dangerous patient details in the upper level of representation and RFID messages will be in the lower side of hierarchy. CEP engine can be handled by the Lightweight Stage-based Event Processor (LiSEP), a general-purpose java-based CEP engine for some requirements. The main application of this method is patient tracking and drug administration Patients wear RFID wristbands.It contains registration ID and other information.

B. NARROW BAND IOT

In LTE Rel-13,for supporting low power wide area machine type communication with two types of features introduced.One is eMTC(enhanced MTC) and other is NB IoT(NarrowBand IoT).The bandwidth of eMTC is 1.4 MHz .Here eMTC operates in-band as part of the wide band LTE carrier.It can enhance the coverage,indoor support.NB-IoT is introduced from existing LTE standard. The design of NB-IoT is based on LTE. So NB-IoT can support many functionalities in LTE.It optimizes to low-cost,low-power and low-data rate.NB-IoT can be deploy in three operation modes inband, guard-band, and stand-alone.[15].

C. NB-IoT IN HAELTHCARE

S.K. Routray[3]et.al proposed method for continuous data collection from patient,NB-IoT modules are attached to the wearable devices and the collected data will transmit using the transmit antenna to the servers, for data storage and monitoring these parameters. By checking this doctors can take appropriate diagnosis.The device structure, and the server structure says the implementation of process.

S. Anand [2] et.al points 3 issues.1. Lack of robust real-time service provisioning 2. Bandwidth insufficiency 3.Wearable devices are not always safe. In NB-IoT, the security of its applications can be get through the provisions provided in Release 13.Here the NB-IoT architecture has 6 different layers: physical, medium access control (MAC), radio link control (RLC), packet data convergence protocol (PDCP), radio resource control (RRC) and non-access stratum (NAS). Upper layers are responsible for the security.NAS layer will handle it.Access control and resource allocation are provided by PDCP and MAC layer .Thus it can improve its security.RLC layer provides the mobility.RRCs are same in both LTE and NB-IoT.NB-IoT limitation such as real time application can be overcome by using 6LoWPAN and CoAP.

Eventhough, the latest version of NB-IoT is better than all other available LPWA technologies. So NB-IoT is better for all the applications such as healthcare,industrial applications.

Y.Lin[10] et.al proposed system it has 2 main components,ie NB-IoT UE and IoT Platform. NB-IoT UE is encompassed with security chip and NB-IoT communication module. The security chip has a PUF circuit and and an algorithm for the encryption of data.So the data will pass to communication module through the security chip. These 2 modules are coordinated by a PUF scheme. The IoT platform includes cryptogram server, UE information server, message queue management server, and a license server. The UE information server is responsible of storing the information and challenge-response pairs of each PUF circuit on UE.

D. NB-IoT IN HOSPITALS

Since NB-IoT is the LPWA technology it has many impacts on hospitals. There are lot of sensors equipped devices are used to monitoring the patients, for checking the vital parameters. Mainly it uses for the health monitoring such as heart beat monitoring, temperature monitoring ,blood pressure monitoring etc. So with lower power consumption the various types of wearable devices can connect to the patients body in effective manner.There are some of the applications scenarios also discussed [6].The parking area can be control using NB-IoT by providing the space before the patient arrive to the parking area by the patient ID. Also provides the authentication to the staff for the entry of particular departments by providing wearable devices.And by using NB-IoT enhance the application such as Out-patient medical treatment, outdoor posture recognition and tele-medicine monitoring.

III. EXISTING SYSTEM

Mdhaffa et al[17] introduced a health monitoring system using LoRa WAN. IoT-based health care systems(IoT4HC) .It

consists of four main components.

The first component is the Data Collector to collect the data from medical sensors and sends to second component of IoT4HC, the Analysis component. After analyzing this information it goes to Treatment Plans Generator, to generate appropriate treatment plans. At last the Treatment Plans Executor will evaluate it with the help of medical expert.

H.Zhang et al [6] introduced an injection monitoring system with three components. 1) The monitoring terminal; 2) The initialization unit; and3) The monitoring platform.In the first section using infrared sensor it will collect the drops in infusion system and send these counts to the monitoring platform.It is already set for 20s to collect these information.From these information monitoring platform cross checking these data and convert into milliseconds.For the conversion it will use a learning algorithm.So it will get the correct coefficient of drops in it.

It can coordinate the monitoring terminal to a bed number by the initialisation unit. Firstly initialisation unit read bed number from E2PROM and monitoring terminal send this bed number along with it may add some identification to the platform. Before the monitoring terminal is used, we put it on the initialization unit to read the bed number written in the E2PROM of the initialization unit by four copper pillars. Then the monitoring terminal sends its identification and the corresponding bed number to the monitoring platform and completes the binding process.

The existing system has the following challenges.

- Accuracy and Reliability of Data
- Security and Privacy
- Wireless Communication Interference
- Energy Consumption of Terminals

IV. Proposed System

Since NB-IoT is the low power wide area network technology it is very suitable to use in healthcare related sectors for the maximum collection of data and processing with low cost.So compared to other protocol like zigbee, Bluetooth,Lora,LTE it is very efficient emerging technology in the hospitals for connecting all the devices over long distance with minimum power and cost.The introduction of sensing devices will reduce the employment cost,increase the monitoring of all equipment in a timely manner.The security handling is the main issue while handling the sensor data. So in the proposed system provides the connections in hospital by NB-IoT in a secured manner. Since the hospital data is very sensitive such as patient related data.Here it provides security over the transmission of each data by symmetric encryption(AES encryption).

V. Architecture of the NBIOT-Based Hospital Monitoring System

Here designs some of the intelligent things are connected in hospital by LPWA technology for minimum cost with wide coverage.Fig.1 shows the architecture.

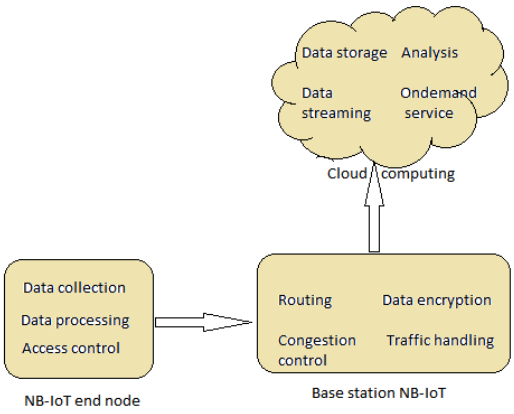

Fig. 1. Architecture of NB-IoT based HMS

A. NB-IoT end node

In this section it will collect the various types of NB IoT end node data such as vital parameters includes blood pressure, temperature ,heart beat monitoring data and all other sensor equipped data.From this module all collected data will pass into the next BS NB-IoT.

B. Base Station NB-IoT(BS NB IoT)

In this base station , routing, congestion control,traffic scheduling will handling.After these it will enhance the security of data. data.For security enhancement here provides symmetric encryption.Here the data will encrypt using AES.

C. Cloud computing

The encrypted data will stores in the cloud computing layer for further processing.while retrieving the information it will decrypt the and send to corresponding authenticated users.

VI. Design of the NBIOT-Based Hospital Monitoring System

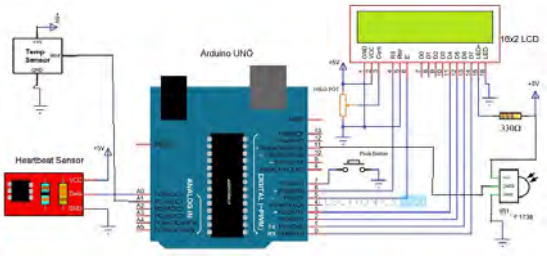

Fig. 2. Board design

The hospital monitoring system is composed of(fig.2):

- Arduino uno Micro controller
  Arduino uno is a microcontroller with 6 analog input and 14 digital input or output pin. It is based on the ATmega328.And it can used real time application such as IoT projects. It also contains a, a USB connection, a

power jack, an ICSP header16 MHz quartz crystal and a reset button.

- Heartbeat Sensor
  Heart beat sensor(pulse playground) is designed to give digital output of heat beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats Per Minute(BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse.
- Temperature Sensor
  LM35 device is used for calculating temperature This device having an analog output voltage proportional to the temperature.
- IR Sensor Here use the IR sensor for calculating the drug content in the injection monitoring system
- 20*4 LCD Display for showing the digital output.
- Android web application
  In this web application it included the the hospital management system.Main modules of this systems are admin,doctor,user and laboratory.The Data log section contains all the real time data from the various sensors for detecting heartbeat,temperature and injection monitoring.And these all data can be encrypted from the base station for the highly confidential data of the patient.These data can be encrypt and decrypt for authorized employees. Fig.3 shows the data flow diagram of the hospital web application.
- ESP2688 node MCU
  NodeMCU is an open-source IOT platform refers to Lua based firmware developed for ESP8266 Wi-Fi Soc by Espressif Systems.NodeMCU is implemented in C and is layered on the Espressif NON-OS SDK.

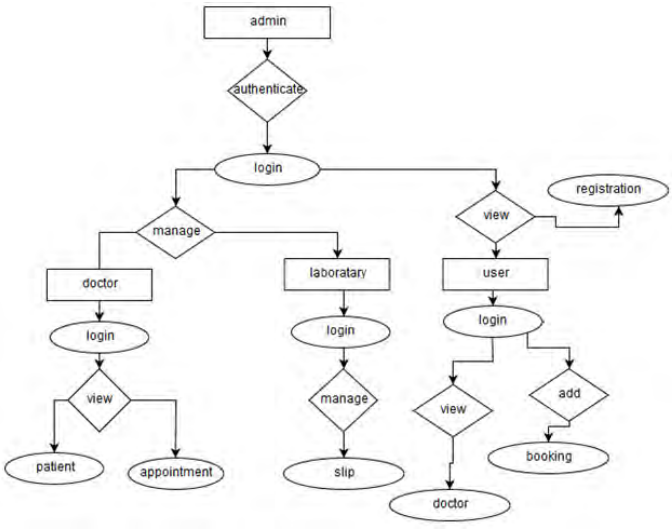

Fig. 3. Flowchart of android application

VII. HARDWARE IMPLEMENTATION

There are 3 parts for this hospital monitoring system based on NB-IoT.

- NB-IoT end node
  Here designed this end node for the collection and processing of various sensor data by creating the NB-IoT connection. So this section consist of temperature sensor, heartbeat sensor, IR sensor, Arduino uno microcontroller, Narrow-Band wireless transmitter(fig.4).

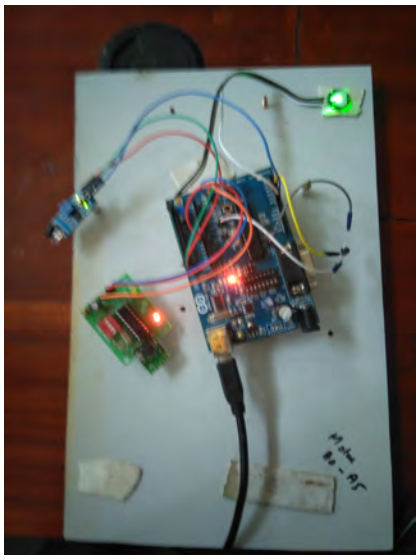

Fig. 4. End node design

- NB-IoT base station
  The main duty of the base station is the routing of the packet from end node to the cloud computing layer.Here contains Arduino uno microcontroller,Narrow-Band wireless transmitter and WiFi ESP8266 node MCU(fig.5).

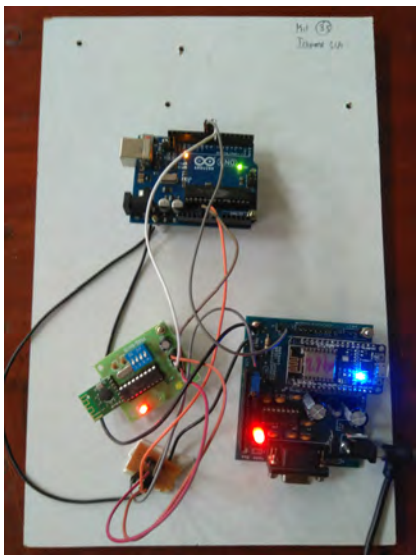

Fig. 5. Base station design

- Cloud Computing
  In this layer it included a web based android application. It contains the datalog web pages where the data from heartbeat sensor,temperature sensor and IR sensors are comes from base station NB-IoT are stored an encrypted using symmetric encryption(fig.6).

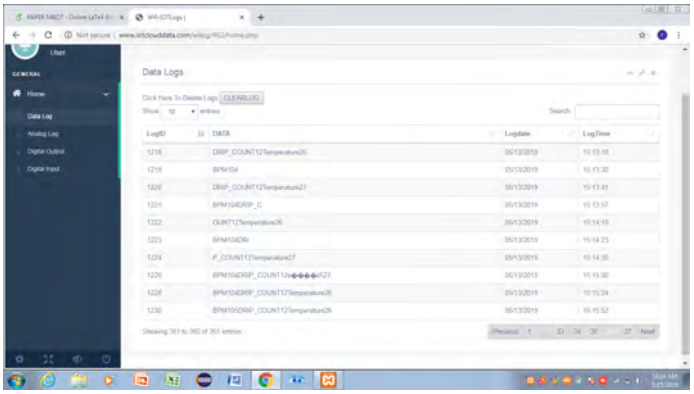

Fig. 6. Real-time monitoring of sensor data

VIII. CONCLUSION

Here designed the miniature of the NB-IoT based hospital monitoring system and implemented in the hardware.Since here used the NB-IoT protocol it could reduce the manufacturing cost,amount of data and increase the wider coverage,indoor coverage and operation life.For providing security here introduced the symmetric encryption(AES).

By giving priority to the security of NB-IoT data in the hospital sector can increase the efficiency of the entire medical system.In the future need to concentrate on the latency problem by introducing the caching technique in various layers.

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