High-Traffic Advanced Metering Infrastructure Using ZigBee

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Abstract-The high-traffic advanced metering infrastructure (AMI) system for high rise building is develop called a ZigBee building area network (ZBAN). This system supports meter management functions such as Automatic Meter Reading (AMR). To provide for the high-traffic communication in these building area networks (BANs). The technologies for e-metering (electronic metering) are going through rapid changes. This paper presents design of High traffic advance meter using GSM &ZigBee. GSM is used for automatic billing & managing the collected data globally. The proposed system provides the facility of ZigBee for monitoring of meter readings regularly instead of visit of person to each house. A PC at control section end acts as a billing point which contains database & receives data through ZigBee. Meter reading from ZigBee enabled meter is sent to this billing point periodically & the reading is updated in database of PC. A graphical user interface (GUI) is designed which contains all billing information of each consumer. To implement BAN system is set up in a three-floor building. Based on the measured data; simulations were performed. This system provides the graphical user interface (GUI) so, it is easy to handle high traffic building area network. Current transformer and voltage transformer is used for the protection of the home appliances.

Keywords-Advanced Metering Infrastructure (AMI), Building area network (BAN), Multi-interface, Graphical user interface (GUI), ZigBee, Global System for Mobile (GSM).

I. INTRODUCTION

Electrical power has become indispensable to human survival and progress. Traditional meter reading process is inefficient. Each time a person from the service provider side come and collect meter reading and produce bill to the consumer. This system is problematic because of high traffic building area network as it requires man power, time consuming & causes error. It is costly when readings have to be collected from scattered rural areas. This method is inefficient for houses at top of higher buildings & there is a chance of missing bill, consumer not at home etc. Power management department cannot get real time data of electricity being used.

Here a new method of metering which utilizes two-way communications with ability to control and monitor meters is introduced which is called as Advanced Metering Infrastructure(AMI). The combination of automatic reading and two-way communication is called smart energy meter. Smart energy meters read the energy, records these readings continuously, then sends to billing point through GSM &ZigBee network. After calculating bill using web based system software at service provider side this bill. Registered users & service provider can monitor & analyze the generated bill of any month by sitting anywhere in the world.

II. RELATED WORK

Hoi Yan Tung. [1] Introduced advanced metering infrastructure (AMI) is an important milestone of smart grid development [1]– [4].

V. C. Gungor. [6] In which various smart grid communication technologies discuss.

F. Benzi. [5] Apart from smart metering, AMI also facilitates utilities to perform demand response, and thus energy demand is reduced.

P.T. A. Quang. [7] A wireless sensor network is a potential candidate for BAN, and it has been widely adopted in industrial automation which transmitted the data over large areas using its multi-hopping ability.

There are two types of AMR systems, wire-based and wireless. Power Line Carrier (PLC) & telephone line network (optical/cable) are wire-based AMR system and several related works are available. Many e-metering systems have now been proposed, based on GPRS, Bluetooth, GSM. Numerous amount of research focused on using GSM based meters.

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In [13], a GSM energy meter was developed and a database that provides the information to the consumer.

In paper [14], a ZigBee-GSM based automatic meter reading. system was developed, the meters are equipped with ZigBee that sends the data to a data collector device which uses GSM to communicate with the central computer.

In paper [15], GSM network is used effectively in this paper to control the electricity theft. If there is any type of electricity theft occurs.

III. HIGH TRAFFIC ZIGBEE BAN FOR HTAMI

The network, security and application layers. The ZigBee specification is an open standard that allows manufacturers to build up their own applications that require low power and low cost. Figure 1 throws some light on the overall uses of ZigBee:

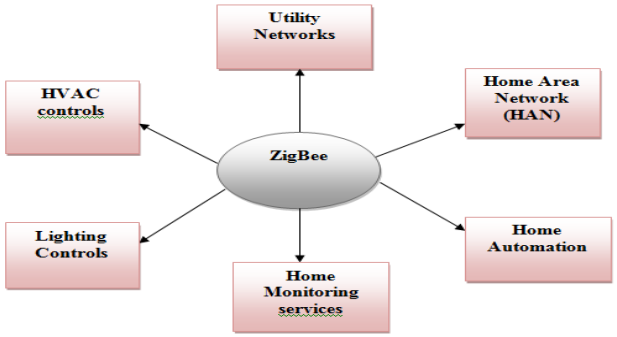

Fig.1 Use of ZigBee. [1]

IV. ZIGBEE TOPOLOGIES

Three network topologies are specified for ZigBee network; star, tree and mesh. The depth of a network depends on the network topology and is determined by the number of routers (hops) in the network from the coordinator to the farthest node here all of the three topology the mesh topology is used in this project.

A. *Mesh Topology*

In mesh, the coordinator is also at the top like that of tree. It consists of a coordinator, several routers and end devices connected as shown *in figure 3* Routers are used to extend network range like in tree. As shown, packets pass through multiple hops to reach destinations and communication between any source and destination in the network is realistic. Hence it is also called a peer-to-peer multi-hop network.

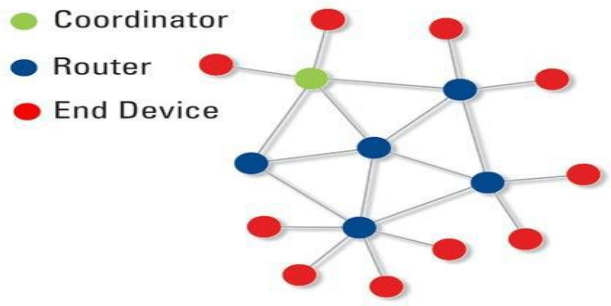

Fig 2: Mesh topology [1]

Moreover, a mesh network provides alternative paths for packet to reach its destination if a path fails. With reference to this, mesh network is usually also being described as a "self-healing" network. Thus adding or removing a node is made easier. Compared to star and tree ZigBee network configurations, mesh network is more complex and therefore requires more overhead and uses more complex routing protocols.

B. Benefits of mesh topology

1. You can move a lot of data around the network if the mesh is operating properly.
2. It is relatively power efficient, and thus allows for decent battery life.
3. There are plenty of low-cost mesh radio hardware out there, like ZigBee.
4. There is less of a connection setup delay with mesh networks.

V. BUILDING AREA NETWORK (BAN)

Here, microcontroller is backbone of our project. The ATmega16 microcontroller which is from AVR family & manufacturer of Atmel Co. and all the peripherals are connected to the microcontroller. ATmega16 is 8-bit microcontroller with RISC architecture. Also it has inbuilt ADC. It has +5V operating voltage, 1MHz in builds oscillator frequency, and active low reset.

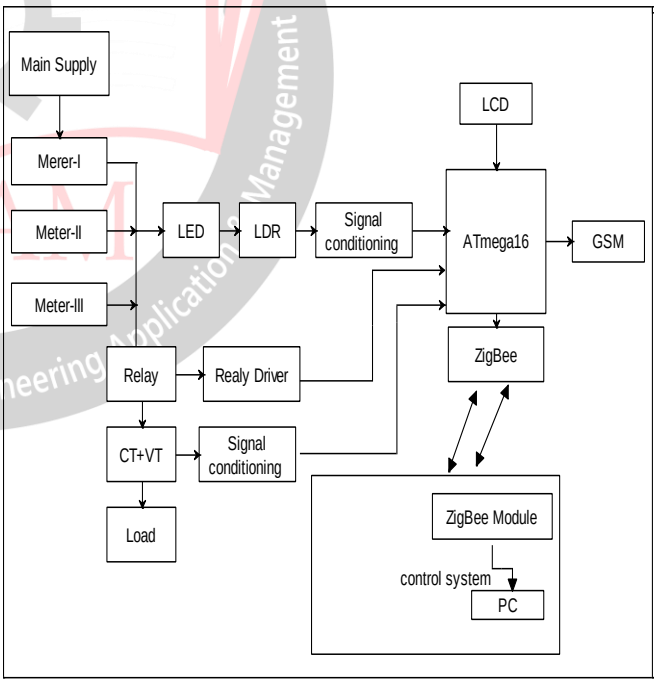

Fig.3.Block diagram of Building Area Network System

For measuring the current we used current sensor, as the output of current sensor is analog that's why we connect this sensor to ADC of microcontroller. 16X2 LCD is used to display the value which is connected to GPIO pins of microcontroller.

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ZigBee module is connected serially to microcontroller which is used for wireless communication. There are two transmitters and one is receiver which is connected to PC.

VI. DESIGN OF HIGH TRAFFIC ADVANCED METERING INFRASTRUCTURE USING ZIGBEE

The Circuit Diagram of high traffic advanced metering infrastructure by using ZigBee first of all to design a power supply Step down transformer is used for step down 230v AC ,5Amp to 12v AC, 1Amp its gives to Bridge rectifier. Bridge rectifier is used for rectifier ac secondary supply to pulsating ac using for diode value (1N4007) after bridge rectifier pulsating dc supply gives to filter capacitor.

Filter capacitor used for filter pulsating dc to pure dc Used 1000uf electrolytic capacitor. After filter capacitor output 12v dc. 12v gives to relay driver circuit and relay. And voltage regulator Voltage regulator is used for fix 5v. IC LM7805 used for voltage regulator, 5v gives to reaming all circuit. Relay drive (ULM2003) output is connected to AT mega 16 pin no.4 relay drive are shows condition of overvoltage & over current. There are three meters meter1, meter2 and meter 3 are in the transmitter side LDR and signal conditioning circuit :LDR (light dependent resister)After led flash LDR change his resistance we used voltage divider circuit for resistance to voltage conversion this voltage gives to LM358 op-amp circuit which is used as signal conditioning circuit .For LM358 we used POT (potentiometer) for gives reference voltage output of LM358 IC gives to microcontroller interrupt pin.AT mega 16 microcontroller used for controlling system and measuring parameter .For microcontroller reset circuit used for reset circuit we used 10uf capacitor and 10k resistor for generate active high pulse for power on reset purpose to microcontroller (For oscillator circuit we used 12MHZ crystal and 22pf capacitor for providing continuous 12MHZ frequency to microcontroller for working condition.) .

Working of this circuit is there are different types of loads connected meter. Meter 1 connected to lamp load Meter 2 connected inductive load and meter 3 is connected capacitive load when the supply is on the meter shows the reading on meter and also LCD by using GSM send the message to user side ZigBee module that fits inside the energy meters casing, and connects to it via the RS-232 interface. The software architecture permits bi-directional communication between the meters and the utility (Electricity provider). Additionally, one can access metering data from a web page. By using VB software. All record shows on pc in a receiver side.

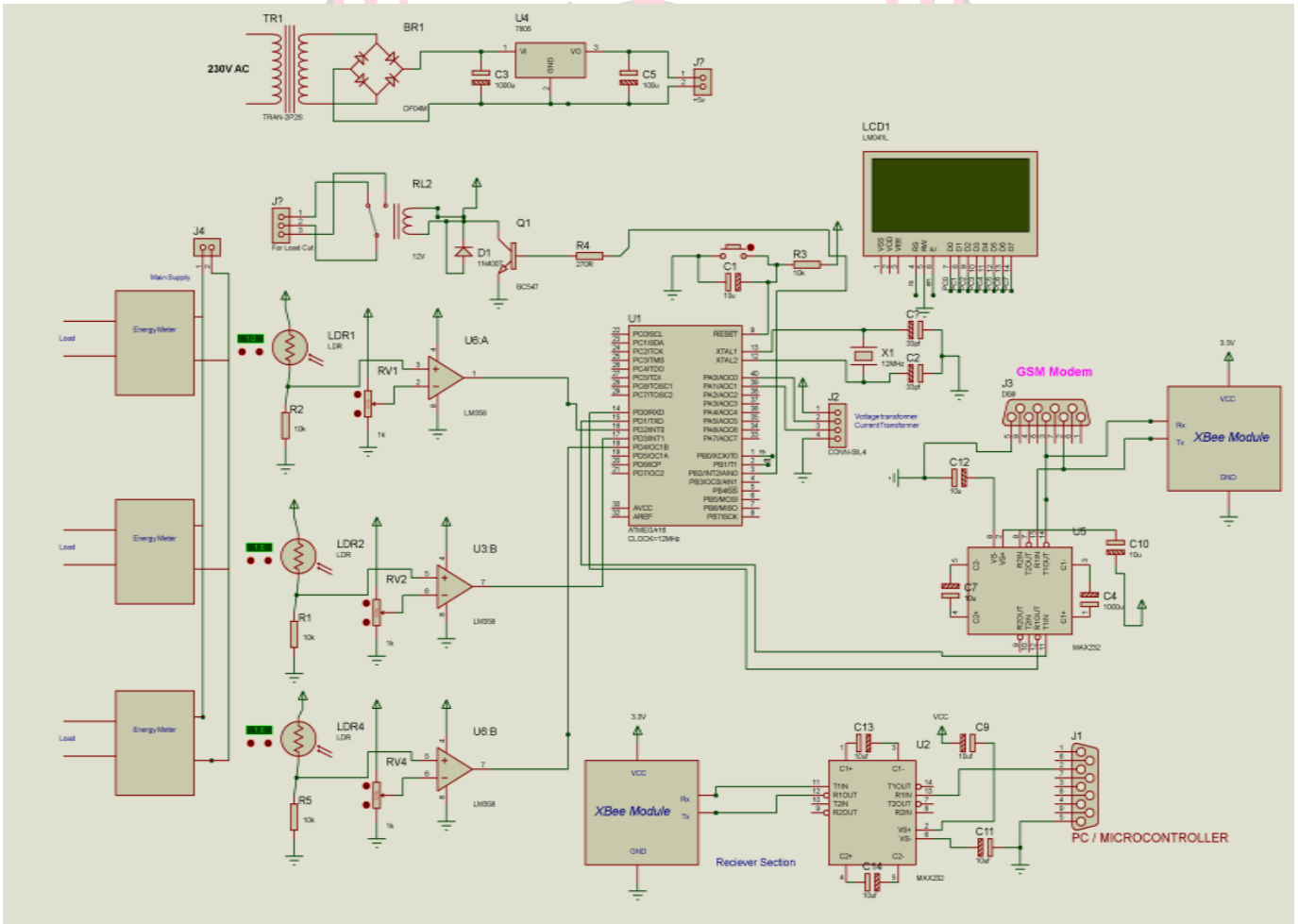

Fig: 4 Circuit Diagram of High Traffic Advanced Metering Infrastructure using ZigBee

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VII. FLOWCHART OF HIGH TRAFFIC ADVANCED METERING SYSTEM

The flow chart of high traffic advanced metering system is as shown in fig .4, fig. 5. It follows the following steps:

A. Step-I

The transmitter section shown in fig .5 three analog meters are connected in this project it gives a different types of load when the supply is ON. start the meters LED blinking LDR (light dependent resistor) collect the data from sensor meter LED and send to the ADC it gives the microprocessor (ATMEGA-16) output that is display on the LCD. The LCD displays the meter unit and amount of bill.

Relay driver connected to the microcontroller to check the condition of overload and over current due to which short circuit is created in the system. After checking the condition overload and over current if it is yes at that time then relay will be automatically switched and OFF the main supply. After completed one month to check the data if it is yes then send meter unit and amount of bill to user mobile by GSM and also send data at the receiver side using ZigBee module.

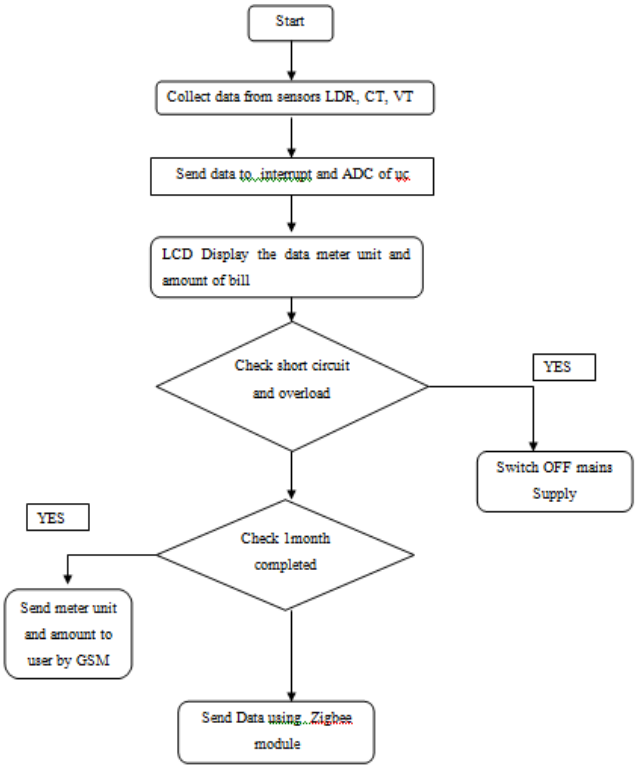

Fig.5 Flowchart Step-I

B. Step-II

Second side is a Electricity provider side(utility).All the data transfer by transmitter side ZigBee to receiver side ZigBeeThe reciver sectionshown in fig .6 data received by ZigBee at Base Station. The received data send to PC using serial communication. The VB read and display data also maintain database report file (.txt).

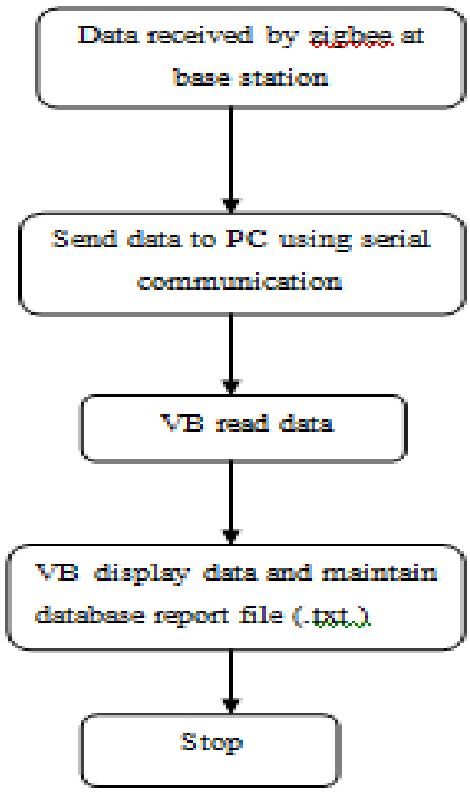

Fig.6. Flowchart Step-II

VIII. WORK ON PROPOSED SYSTEM

This project proposed architecture for an Advanced Meter Infrastructure (AMI), describe the Implementation of the required hardware, and presents the Design and Implementation of software architecture for it. We successfully build a small low power ZigBee module that fits inside the energy meters casing, and connects to it via the RS-232 interface. The software architecture permits bi-directional communication between the meters and the utility (Electricity provider). Additionally, one can access metering data from a web page. ZigBee is a good solution for an AMI system.

IX. RESULTS

By using Capacitive & Inductive load we are analyzing the output. to count blinks/units on meter level we are setup LDR (Light dependent resistor) circuit.

As show in the below diagram, Capacitive as well as inductive load are applied to system like household appliances to analyze proper functioning of system. System will work in such way that for 1000 blink it will down/count a unit so every 1000 impulses system will count as 1 unit. Counted units will display on LED screen.

The Experimental Hardware Setup of high traffic advanced metering system is shown in Fig (7).

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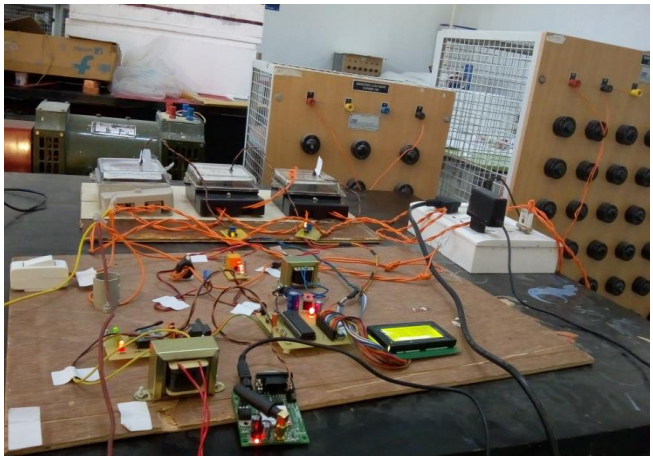

Fig: 7 Experimental Hardware Setup of High Traffic Advanced Metering System.

System will plot real time graph on computer system for each meter. It will give real time consumption/usage of electricity for a particular meter with billing amount.

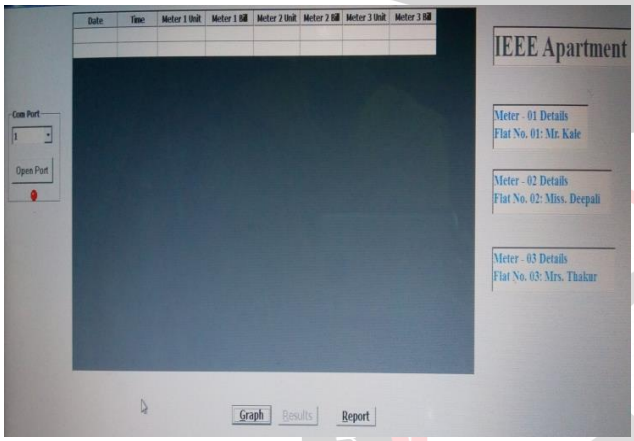

Fig: 8 GUIon Pc at Receiver Side

As show in above diagram, system will display real time consumption for each meter in unit as well as in currency denomination.

Graphical representation of particular entity like units will impart better understanding to system user so system will plot recorded units in graphical format.

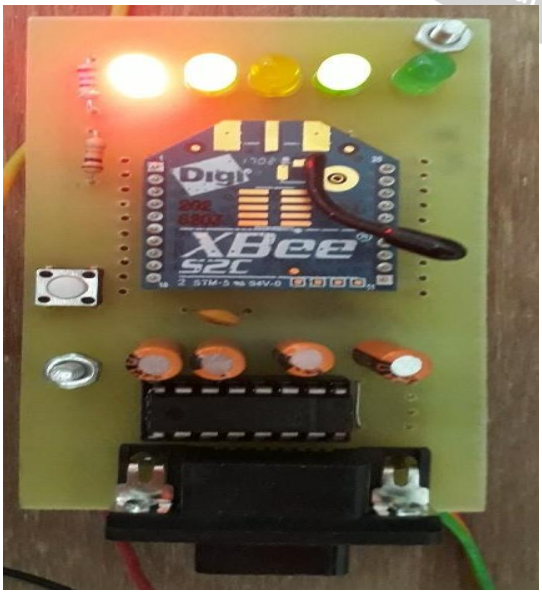

Fig:9 ZigBee Module

System is responds for range 26.3 – 28 meters' distance for data transfer, to make long distance interaction / communication we need to setup ZIGBEE interfaces in between.

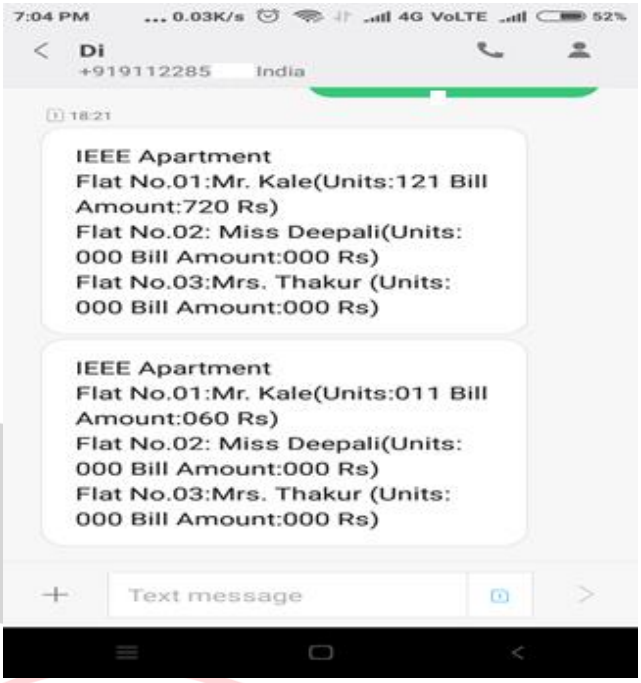

Fig:10 Result of Billing Message On Consumer Mobile

For every 3 units count system will send a billing message on consumer registered mobile. Messages will include number of consumed units with bill amount in currency denomination as show in Fig.10 image.

IX. CONCLUSION

ZigBee technology as a wireless sensor and control network is being considered as one of the most deployed wireless technologies in recent times as results of its attractive features to the users such as: open standard lightweight, low cost, low-speed, low-power, interoperability protocol, among others. A first BAN is presented in this project which suggested the peer to peer network. Here for experimental purposes three meters are connected which transmits the data to ZigBee receiver and ZigBee shows the total reading on PC as well as shown on the graph Unit Vs Time and Bill Vs Time. We can use such project for whole IEEE apartment to collect thee reading wirelessly is shown in Fig (10). To gain more insight, this project discussed the practical design of a BAN based on ZigBee.

Now days there are more & more cases/issue regarding electricity theft, human error while taking reading count for each household meter, Complaints about Consumer's Bills (over charged), manpower issue (taking reading or distributing bills).

Taking into account above couple listed issue or concerns from both side i.e. consumer as well as electricity provider we implement this project/system which will satisfy or

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create Win-Win situation for both i.e. consumer as well as electricity provider.

Following points get taken care/fulfilled of:

1. Consumers Side:
    - Over charged bill - Consumers will get proper unit of consumption & billing amount through message on registered mobile number.
    - Human error meter reading
2. Electricity Provider Side:
    - Human error while taking meter reading significantly reduced
    - Electricity theft
    - Manpower
    - Graphical representation consumer data
    - Bill Printing cost
    - Security & tampering equipment(Meter)

In future, we will provide more customers centric facility like email, power consumption per appliances, hourly consumption/usage data. And on Electricity provider side (utility) – Remotely shut-off user, power factor surveillance result in a lot of power saving for industrial sector. During emergencies, can create "partial outage" in non-exempt building to ensure the power remains available where it is most needed.

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