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Survey on IOT based Smart Electricity Meter Control and Surveillance for Prediction Future Meter Consumption using Machine Learning

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Abstract: ***Electricity is the spirit of today's worldwide, and presently is going to be digitally so electricity is a very important factor. production and allowance of electricity exist a primary lesson of electricity commission but it is also significant to estimate the energy manipulated by the consumer that is taking a task and generates a charge. In the current strategy taking a reading and creating bills is manual works. It is extremely time-consuming. Power appropriations are one of the largest difficulties in India. Periodically user not spent bills on period so the electricity committee worker cut the power supply manually. In this topic sometimes fraud is done by the user or that employee which leads to the loss of electricity committee. In some districts cameras similarly used to snatch scanning but it is a very problematic strategy and not so user peaceful, to avert these difficulties, we recommended a wireless network for smart electricity meter and billing system using IoT. We similarly operated the sprints to cut down the energy supply of unpaid employee which would be regulated wireless using the IoT theory. Scanning will be carried automatically and stoners get the information through message using GSM.***
Keywords: Electricity prediction, save energy, power consumption, smart electricity meter

I. INTRODUCTION

The world is improving towards automated wireless technologies, which choose not only to decrease human struggles but is assisting in creating systems automated and worthwhile. A system is said to be intelligent when it can conclude what to do without any instruction and can function automatically. An Electric or Energy meter measures the total electrical power in units used by the equipment which consume electrical energy from the main power supply. Electromechanical and Electronic meter are two types of meter Available in the market to calculate unit consumption. Electromechanical meters are generally used in village regions, where the use of recent technology are not as huge as it is in towns. Electromechanical meters have evolved out of duration nowadays. Electronic meters replace electromechanical meters. This meter comprises an LCD/LED to display the reading. Calibration LED is utilized on the meter which indicates the units consumed. Manpower is assigned to read the meter and remark down the reading. The reading on the meter is gaining which is used to produce the electricity bill. The IoT Based Smart Electricity Meter and billing System performs an identical job without human actions. IoT Based SEM system is regulated using Arduino Mega, which is a microcontroller board. The motive behind selecting this board is its efficiency and memory. It is better efficiency in terms of memory and GPIO.

The data attained is accordingly mailed to the cloud through the internet. Data obtained can be effortlessly mailed wirelessly over an extended length without any commotion disruption utilizing the internet. As the data is immediately mailed to the cloud there is no incident of spectrum and duration difficulty and is highly valid and profitable because of no human interference. Additional wireless technologies extremely as Zigbee, Bluetooth etc. remember restricted expanse, therefore, cannot be utilized over extremely long distances effectively. This experiment envisages the use internet and the theory of IoT by which the stingy station, as adequately as stoners, reside updated with the recently expended units, altering the current difficulties encountered by the electricity committee and the stoner.

A. Usage of Arduino & GSM for Smart Energy Metering and Power Theft Control

As the population increases one of the most common problem that is Energy theft increases in countries like India where consumers of energy are increasing consistently. Due to energy theft the utilities in electricity system are destroying the amounts of revenue each year. The concept and working of new automated power metering system is reveal when the user uses newly developed designed AMR, can be used for energy measurement but electricity theft will be increased. So, the administrative losses because of not regular interval check-out at the consumer's residence.

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We cannot go to every customer's door to door to check and solve out theft as it is quite impossible., A new procedure is followed in this paper which is based on MICROCONTROLLER Atmega328P to solve it by remotely disconnecting and reconnecting the service of a particular consumer and to control and detect the energy meter from power theft. A message will be sent automatically by an SMS through GSM module to the utility central server and a separate message will send back to the microcontroller whenever unauthorized activities detected so that it will disconnect the unauthorized supply. The non-technical losses, billing difficulties, and voltage fluctuation complication needs to be deal when a unique method is implemented by interspersed the GSM feature into smart meters with Solid state relay.

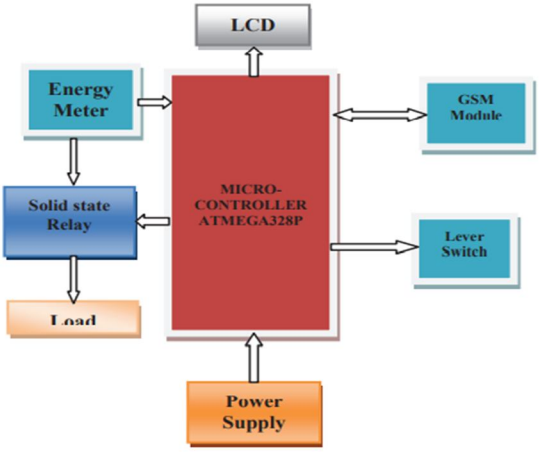

Fig.1 Architecture Diagram [1]

There will be precise reading as a wireless data protocol will be used for a smart energy meter which works on communication directly & in consumer premises there would be no need for a meter reader to take energy meter reading. In the divergent ways with the GSM module smart energy can be operated. Following are the many types of merits and demerits of smart energy meter such as:

1) New smart energy meters send reading which is precise reading from user about customer's energy usage to utility on the regular interval in sequence where it will be reduced labor cost for taking reading in consumer address and bill will be proper
2) The utility can remotely disconnect the power supply of a particular consumer if the consumer did not pay the energy bill within time and the service will continues to the consumer when the payment is done. Therefore, we can cut off the energy and again reconnect their connection remotely without wasting time or sending an employee.
3) Service provider will receive a message if anyone tries to open the meter and also cover the button automatically release because we have connected lever switch for tampering attempt detect
4) The customer equipment can be protected by the help of SSR supply when the power quality is not maintained from the distribution supply

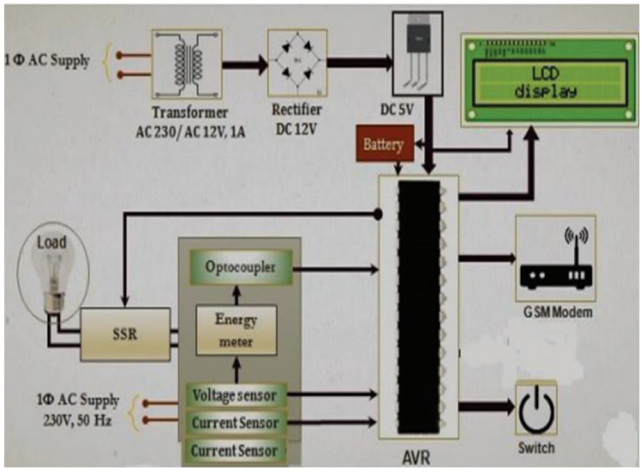

Fig.2 AVR system Implementation Circuit Diagram [1]

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'An Arduino (microcontroller), GSM modem, digital energy meter and SSR are consist in the proposed system. We need to turn on the SSR and connects the energy meter to load via SSR after switching power on Arduino and GSM modem. After this we need to read through the EEPROM and the current data to be displayed. The Arduino will check each Reading from voltage and current sensor with respect to PT and CT. The message via SMS will be send if there is any difference in value between CT's connected in phase and neutral line when Arduino will turn OFF. IF the bill for the power supply is not clear by the customer, then here the Arduino helps the utility for power disconnection; this is a benefit to monitoring their daily/monthly consumption, voltage fluctuation and get disconnected from the supply from the customer feedback point.

B. Internet of Things (IOT) Based Energy Meter

The current domestic energy meter readings have had to face many problems because it has had much complexity in constructing it, it is too narrow bandwidth, it has low rate and it doesn't really communicate at the same rate as quickly as possible. All these problems can be solved with our Automatic meter reading system which is efficiently wireless and has a better communication between Electricity board, it consists of IOT i.e.: Internet of things in which it transmits the electricity consumed by the consumer and the bill information which can be calculated with the help of ARM7 microcontroller.

This efficient way of microcontrolling the electricity which gives the advantage to the electricity board section to control the household devices straight through the head office and it is pretty transparent with the bill information with the consumer which is also backed by Global system for mobile communication.

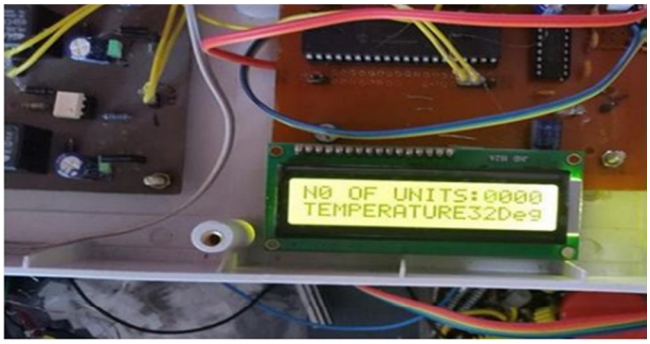

Fig.3 LCD display of IoT energy meter No. of units consumed [2]

The power consumed by the consumer and the billing information is shared with the consumer with a consistent basis by the help of IOT i.e.: internet of things and can be monitored by Electricity board section and can be helped to track the power theft occurred in the consumer's power supply and sent directly to the electricity board section.

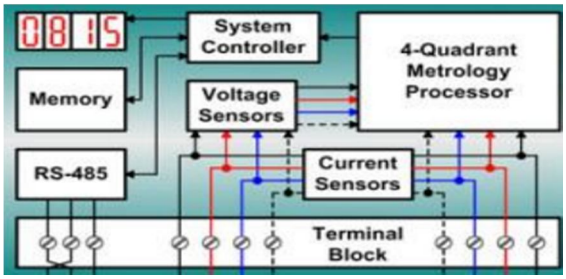

Fig.4 Energy meter functional block [2]

IOT has been proven to be cost effective as compared to the SMS in which this is about to consume lower costs which is going to efficiently be monitored with the help of android application or web portal service provided by Electricity commission board. Customers can also pay their bill through an online service with the help of UPI or other banking services provided in the application itself. This Android application can also help to make reliable and accurate reading values collected with the help of meters and it can be viewed in the application itself. This provides advantage in which it doesn't require human intensive work and which are easy to be maintained in the main server which is central server. This system is more transparent and proven to dismiss the tampered meters which are manipulated or theft has been involved. The server is able to determine that some error has occurred in the system and can be reported to the engineers in Electricity board. It has become easier because the values are stored in the central database and are made accessible to anyone, anywhere in this entire world.

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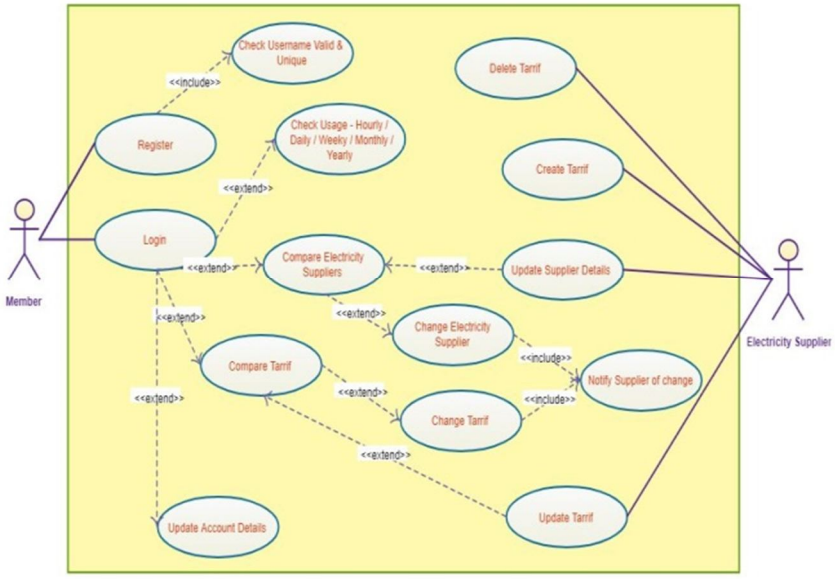

Fig.5 Use case Diagram [2]

C. Smart Electricity Allotment in the Residential region: Internet of Things (IoT) based Developed Metering Infrastructure, and cloud Analytics

Energy is the base of any development in our society. The demands for the requirement of energy have increased significantly and the installed plants for energy generation are comparatively low as compared to demands.so worldwide countries have adopted smart metering method because of rise in people and less infrastructure having not so sorted results. The Government Of has taken a initiative to develop 100 smart cities across India, that will require a proper power management in all the homes and business areas.so this project will require Smart metering system that will provide petabytes of data on various parameters like prepaid bill, readings, more electricity drawn, pilferage, damages etc. This will require an infrastructure of information technology industry available everywhere at any time and will require a huge cloud system that can be changes according to needs for storage and power needs. The end users that can be benefited with these will be citizens, companies that distribute it and the data will help the making of policies & its makers. This paper looks for the identification of current energy development programs in India, look for information and communication technology with focus on cloud and IOT to be adopted in all countries and make the list of the things we can fetch from such things or parts.at the end we have listed some advices by authors that can improve energy saving, reduction in cost of its operations and focus on customer for analytical benefits.

The smart electricity distribution module for citizens suggested by authors will have following components.

1) *Prepaid metering Module:* A prepaid smart meter will be electrical component that will record the usage of the electricity and will send and upload the data by GSM or by Wireless networks after some specific intervals central control unit which will further send in for bill and monitoring purpose.it can be a full duplex or two-way communication between control unit and meter that will get inputs and will do actions from control unit. The following measures will be followed for data which thereafter increase efficiency in use.

a) The average load and high load in current, voltage and watt
b) Get to know the consumption according to time
c) Billing will be done from many sources like be it main power or dc power
d) Tempering or damage to meter and its data changes in frequency, voltage and wat
e) Fast recharge by prepaid services.
f) Configuration of meter to allow switch off meter remotely if somethings happen
g) Offers for data to promote happy hours and low-rate hours from central units directly

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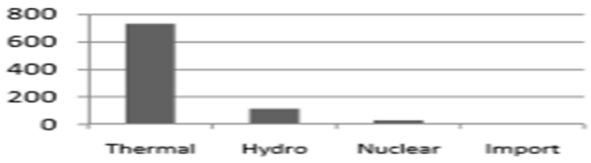
2) *LED Street Light Management System Module in Residential Apartments:* LED lights installed on street in residential apartments are increasing and they give 50% energy saving because of increased efficiency of converting energy to light. On other hand they have more life of 50,000hours as compared to CFL with only 8000 hours of life. The integration of IOT based sensor technology in LED street lights will reduce the usage of electricity by again 50% with increased meter accuracy, radio range and reliability with the proofs by authors of industry findings. The control unit in street lights will ensure the brighter lights in the dark corners or more brightness in indoor lights than the lights which are in sunlight where it can be supplied. The day having sunlight will require less bright lights than the lights in rainy or cloudy day. Same as the brightness required at 6.00pm shall differ in winter as compared to 6.00 pm in summer days.at the last the brightness requirement from 6.00 pm to 12.00am and then further to 5.00am will change as sun rising will occur. So, the street light that are installed now lack this system and will not be managed by smart systems management.
3) Sub Station Transformer and DG Health tracking system device inside the residential groups IED (intelligent electronic devices), RTU (remote terminal units) and relays are the components used for monitoring of substations and creating units and transmitting data of electric al network. focus will be on the components in contact with each other rather than transferring data to control centers and close on getting any issue immediately.
4) *Cloud Storage And Insight Driven Analytics:* The storage that will be required for such project having huge data transmission having millions of prepaid meters giving 1mb of information and getting half of same as input in every 15min will be lots of them. And making it for 5 years will go to 30 petabytes of data or same as big data.



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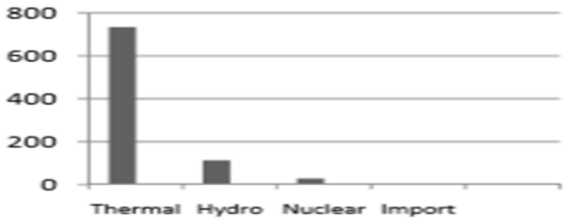

Fig Demand vs Availability Jan 2015

Fig.6 Demand vs Availability [3]

5) *IOT Based Smart Electric Meter:* Electricity has a very important role in human daily life. The usage of electricity comes to 3rd number after china and America with 5.5 percent global share in 2016.because of manual work we have a lot of problems in our meter billing infrastructure. This system will give data on power cut, meter reading and alert on exceeding the electricity usage beyond specified limit by internet of things. Such ideas are being taken into action to reduce the humans going to take readings manually and to reduce the technical problems in bills. This all information and data will be given by electricity board to the consumer like pre planned power cuts, bills, bill amount. On paid amount will be conveyed by messages.in smart meters that are already installed nowadays give the data about usage of electricity with its costing.in proposed meter system meter will give consumption on daily basis, it's costing, billing details and payment details by internet of things. This smart meter not only decreases the power cut issues and Laboure cost for taking citizens electricity consumption in regular intervals but also increases energy saving by alarm systems and meter accuracy by reducing errors and maintenance.

a) *Flow Chart of Proposed System:* Today's current model is time and energy consuming and requires a lot of Labours. The proposed system eliminates the Laboure requirement and it saves cost and time. The proposed system has the data if energy usage on daily basis, billing and payment through IOT, details of preplanned shut down, alert devices when energy goes beyond certain limits and shut down of power when people are not at their home to prevent wastage of energy.

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b) *System Description:* A unique id will be given to every meter. This will be interlinked with customers mobile number, that will constantly monitor meter. The usage will be sent to power station through control unit by server and bill details will be sent back from power station to energy smart meter.

- *Energy Consumption on Daily Basis:* In current meter it shows the usage from when meter is installed.in this new smart meter system the daily energy usage will be calculated by Arduino microcontroller and will be displayed in LCD. Also, it will be sent on mobile too.
- *Billing and Payment Through IoT:* Bill details of usage will be sent to consumer on monthly basis by web server using IOT and a message text on GSM module also. The bill payment will be done by web server. This will totally help in manual dependency of collecting reading.
- *Alert Systems:* Certain limit will be available to smart meter beyond that usage alarm system will warn that electricity is being theft and will alert the customer to check for it.
- *Internet of Things:* Arduino is the important platform for learning IOT. Arduino will be connected to internet and controller. When ethernet is connected and up login to raspberry pi to develop IOT platform. Python language is used to develop. raspberry pi sends electricity usage data to internet connected server to monitor usage of that device. Cloud storage and web hosting will be used to store the data and allow access to the other programs and monitor the data. The controlling signal will be sent to same raspberry pi by same server to turn off or ON the meter.

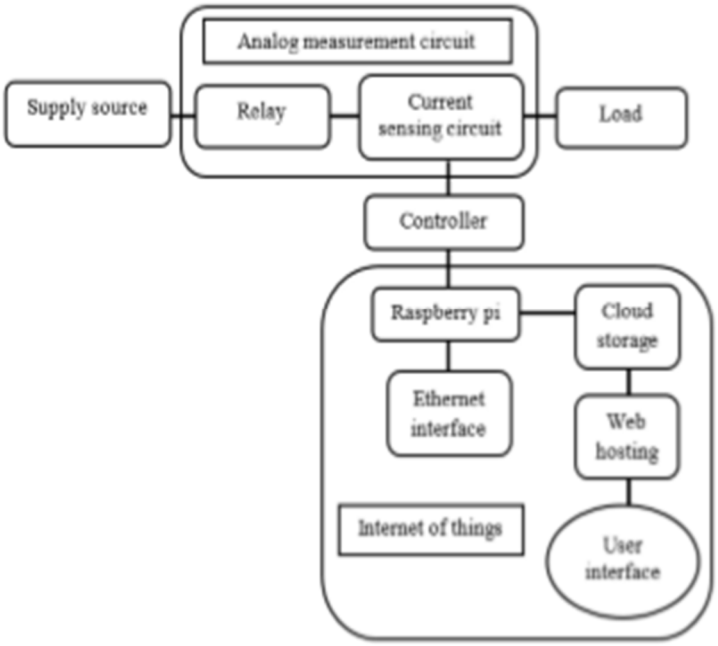

Fig.7 Proposed Block Diagram [4]

6) *Smart Billing System Framework For Economic Internet Connectivity:* We know that nowadays internet is plays very important role in day-to-day life as well as for economic development, Also, many working organizations and industries and business are depending on internet. In this paper we have we introduced the new bill collection system using internet service network how they implement the bill. This paper gives you the clear idea and framework for implementing bill on the service system network. Many researchers have illustrated their opinions on billing Internet service but implemented or framework of this principle is not definite. In this paper, we have chanced to give a framework prototype that suites for the scenarios for the corporate world to the local user. This framework is pretended as a scenario on QualNet HSRP model based on RFC 2281 This theory such as multihoming, overlay architecture with optimal multipath routing policy forms the new method known as smart billing system with cost-effectiveness services for customers. The results presented are on the current existing IPv4 Infrastructure, network type and also enforced for IPv6 based network to present-day technology and billing method strategy for the corporation network.

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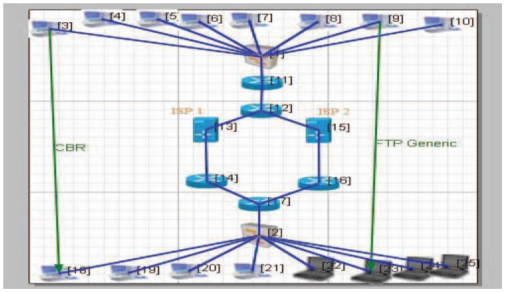

Fig.8 Architecture of Multihoming Network Topology [5]

Multi home-based network topology framework as shown in figure 1 is a replica of present software and hardware enterprises. This network topology is represented as a scenario that allows the user to specify all the network elements and conditions under which the network will operate. We have made the configuration setting and the important steps in configuring our topology mimic the existing company infrastructure required for our study.

7) *Microcontroller-Based Automated Billing System:* Electricity is a prior role in day-to-day life of peoples. This system helps to measure bills of public utilities like electricity, gas and telephone/mobile recharge services automatically by single integrated board system. This idea being used to reduce human effort to collect the monthly reading and less technical problem related to billing process. This system contains hardware's like digital energy meter, microcontroller chip etc. the energy meter gives the consumed energy along with its amount rupees to pay on daily basis. This system reduces power issues as well as labor cost. The billing and power information updated by using Internet of things and it being monitored by the Electricity Board part. This system occurs durable and understandable to maintain.

8) *Based on Arduino home automation utilizing the Internet of things (IoT):* This paper introduces a low cost, adjustable and durable home automation system with more protection using Arduino microcontroller, with IP connectivity throughout local WIFI for example, controlling and accessible devices, by the correspondent user remotely using Smartphone Applications. the recommended system is server self-reliant and uses IOT supervision human desired appliances and starts from industrialized machines to consumer goods. As we see how much is the importance of Internet in our daily life. It became source full or useful thing of daily life. Similarly, the IOT is one which is taking place in digitalization or in making our life easier. Here, we presented same thing of IOT or it is part of IOT which make your house handling appliances easier. In this project we are taking the help of WIFI network or one system esp. 8266-01. In this technique we connected this system to the home appliances in sequence such as:

a) Fan
b) Light
c) Room heater
d) Tv set.

As we know already IR technique in tv remote, which makes us to handle TV in easier way. In future we can say that the IOT will take place of our old sources of things which we using for delays such as switches.

System Design

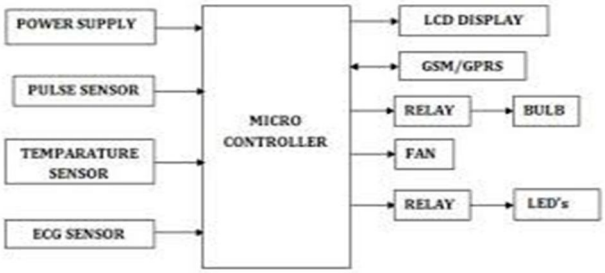

Fig.9 Home automation system [7]

Gives a suggestion about the system of home automation system. The four differently equipment extremely as fan, light, room heater and TV are operated remotely using WIFI and throughout an application established on Android or iPhone.

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9) *Arduino and GSM Based Smart Energy Meter for Advanced Metering and Billing System:* It became our need or our it is the only way to integrate automatic system via wireless application. As we all are using electricity which has unit called meter which calculate our daily, monthly consumption of electricity. As this is a conventional process or technique to calculate electricity, so it has some loopholes to. As we know sometimes the electricity bill of meter is calculated much here than of, we actually consumed/or we used. Then its parallelly leads the stress on consumer who is the payable of that 'X' amounts. Because of this the electrical man who could not cross check the electricity bill and he already advise to cut the electricity of than person house. To overcome this issue, we are going to introduce this technique which is accurate, and to handling easier and any one can operate this graphic by simple installing this. A smart meter works by communicating directly with wireless data protocol with your energy supplier so the organization will always have a precise meter reading and you do not have to take a meter reading yourself.

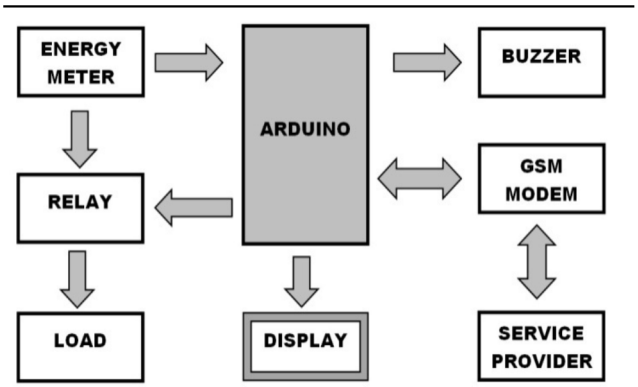

Fig.10 Block diagram of the proposed smart energy metering system [8]

II. ANDROID DEVICE

The main hardware protocol for Android occurs the ARMv07 or ARMv8-A architectures with x86 and x86-64 architecture. The android is SoC (system on chip) established microprocessor. the android committee is given sets of various modules and detectors like Wi-fi, Bluetooth, accelerometer. The android is eligible for interfacing with outward modules utilizing the USB wire. It is powered by an interior 5V battery which is chargeable and interior storage ROM. The phone remembers a specification of a 1 GHz single-core ARM Cortex-A5 processor and a 300 graphics processor and reaches in inbuild with 512 MB of RAM and 4 GB of internal storage out of which 2 Gigabit is earned accessible to the stoner. The interior storage can be improved to 32 GB through the intention of a microSD card.

Fig.11 Android Smart Device [9]

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III.RELAY

He Single Pole Double Throughput Relay(30A) is a high-quality SPDT. The Relay includes a coil, one common terminal, one commonly shut terminal, and one commonly open terminal. When the coil of the relay is at rest (not energized), the ordinary terminal and the commonly shut terminal remember a continual supply. When the coil is stimulated, the common terminal and the commonly open terminal have a continual supply. The relay's coil is rated up to 5V and the connection is rated up to 30A (250VAC, 30VDC). You can utilize it to regulate high existing appliances

Fig.12 Relay Module [9]

IV.METHODOLOGY

In this system with increased efficiency and robustness. the user requires to enroll first, accordingly the data of the user will be reserved in the cloud. the access to the internet is via android which has a distinct MAC id so the exchange of meter can't be possible. the billing will be automated through sever based unit. For defaulter, consumer electricity connection can be cut through a relay on the electric meter. Thus, the manual job gets prevented.

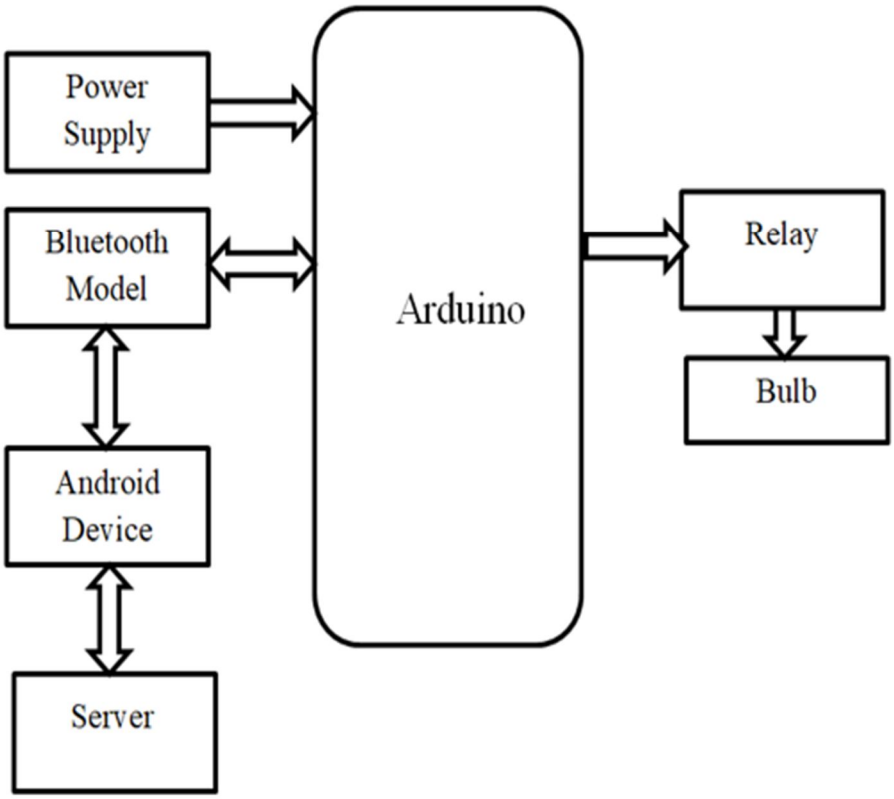

Fig.13 Block diagram of smart energy metering system.[10]

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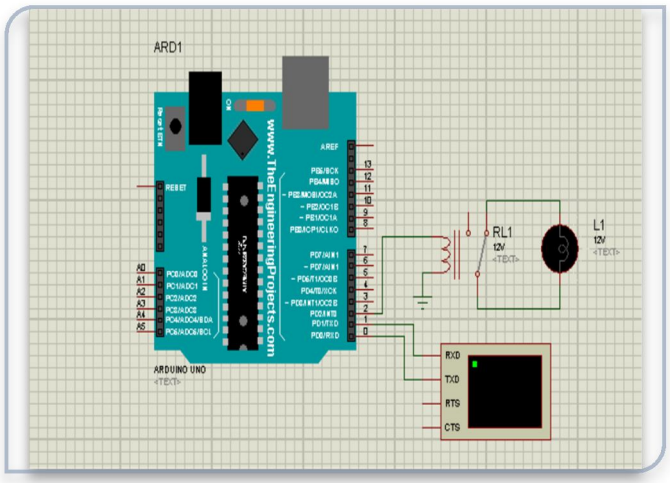

Fig.14 Layout diagram[10]

A. The proposed network functions subsequently:
B. The stoner is reported on the server via lawful server admin..
C. Earlier the stoner is enrolled, the stoner is distributed an unusual meter id and the username password.
D. The username password and meter id need to be arrived in the smart meter android appliance to determine whose meter is attached to the server.
E. As the stoner logs in and the meter being turned on, the SMS from android appliance GSM is sent to users registered mobile where the inbuilt android GSM card is used for mailing SMS by phoning SMS Manager Class in android appliance
F. As the Meter is begun, the timer and the meter unit scanning rises and as the timer improves every moment the unit also expands, and this boosts unit value is instantly sent to the server along with the price of those destroyed units.
G. The stoner when begins the meter, the unpaid date is automatically established to 1 month after the enrollment period and the meter bulb can be turned off hardly when the rightful date is crossed and the bill dignity is unpaid.

V. ADVANTAGES OF SMART METERS

A. Excluding manual meter reading
B. Regulating the electric system more rapidly
C. Making it feasible to utilize energy resources too efficiently
D. Giving real-time data useful for stabilizing electric loads and diminishing power outages (blackouts)
E. Allowing dynamic pricing (raising or decreasing the expense of electricity based on demand)
F. Preventing the capital expenditure of assembling new power plants.
G. Assisting to optimize revenue with existing resources
H. Decreasing pollution from automobiles driven by meter readers.

VI. DISADVANTAGES OF SMART METERS

A. If you have SMETS 1, it may misplace smart functionality after you shuffle
B. In-Home Display may be FALSE
C. They won't deduct your bills independently.
D. Smart meters may not function if you have an inadequate signal in your region
E. Some suppliers can't assist smart meters.

VII. APPLICATION

A. The system can be used in Domestic and Commercial region for electric supply.
B. For Gas supply lines as well as Water supply.

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VIII. CONCLUSIONS

The standing system has some the problems like manual work, Human errors, inaccurate meter reading, corruption, Power theft. In the proposed system the electricity connection to each user will be provided only to the registered user and energy consumption, in the unit is transmitted to the server which will be used to estimate the bill. Furthermore, the bill will be sent via IoT (Internet of Things).

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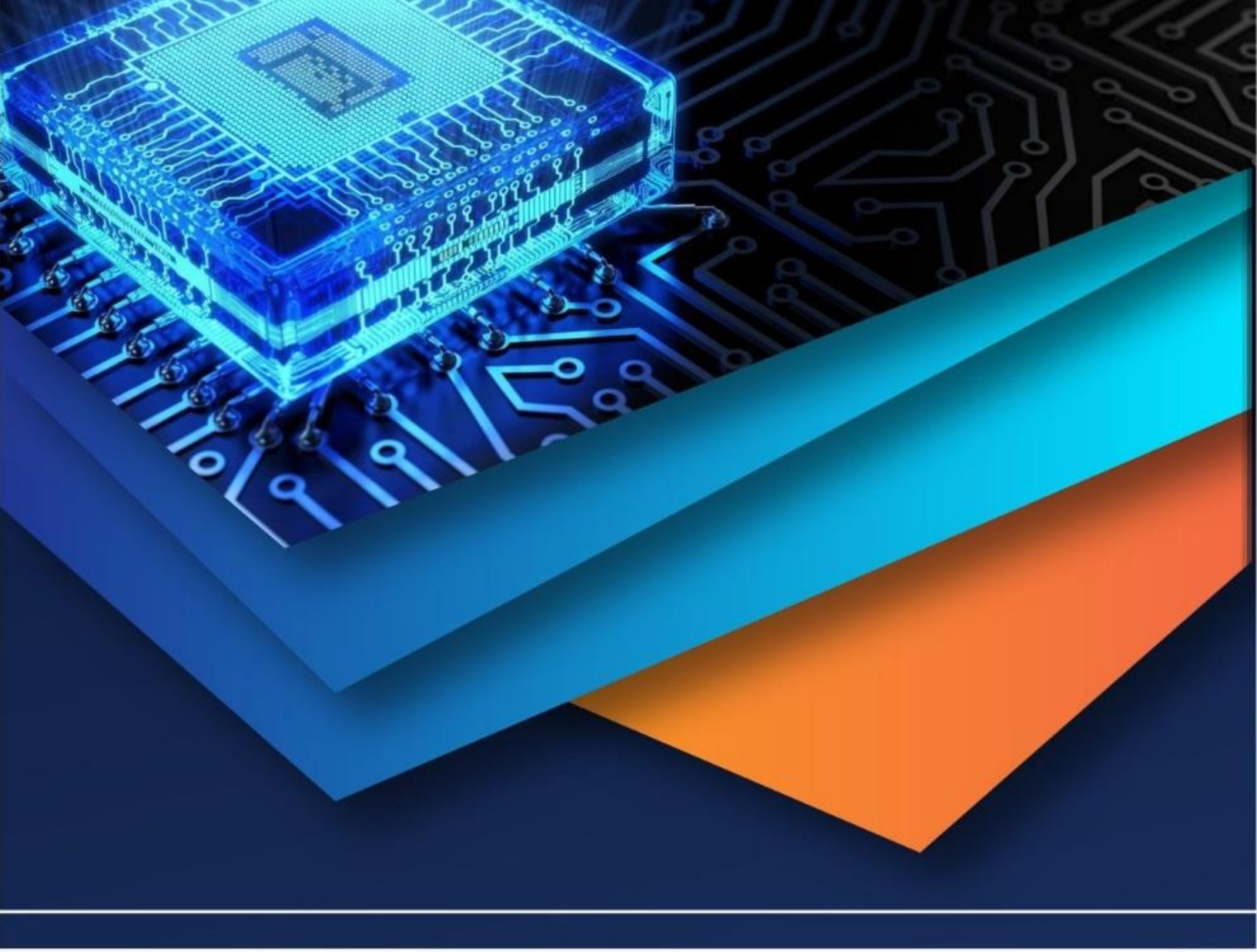

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