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### IOT BASED ENERGY MANAGEMENT SYSTEM - A SURVEY

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#### ABSTRACT

Energy saving is one of the main challenge in our day to day life. Energy saving can be done only when the energy consumed by the load is monitored. Once monitored, suitable control methods can be adopted to operate the load in the optimized way to save energy. Even though there are lot of technologies and solutions available to effectively monitor and save energy consumption of load in house or industry, the Internet of Things (IoT) technology is proposed to monitor and minimize energy consumption of load. The proposal is to design an Internet of Things (IoT) based Energy Management System in which data is collected from smart energy meter using GPRS network and displayed on web page. The proposed system is suitable for data collection and control the load in the Internet of Things (IoT) environment. In this survey we have analyzed several other energy management systems and compared the limitations and learned about how to establish the IoT architecture.

**Keywords:** *IoT, GPRS, Energy Management System, Embedded system, GSM.*

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#### I. INTRODUCTION

In the past decade, energy saving has been one of the critical issues in designing electronic appliances or devices. The Future is moving towards the smart energy management which require changes from energy usage and energy supply. Reducing the amount of energy required to deliver various goods or services has become essential. For the energy management of domestic consumers the smart meter is need of the hour.

The smart meters are an embedded system which incorporates microcontroller in their implementation. The main purpose of the microcontroller is to simplify the system design and provide flexibility.

Up to present, many energy monitoring and control methods have been proposed. An emerging technology brought about rapid advances in modern wireless telecommunication is Internet of Things (IoT). It has attracted a lot of attention and it is expected to bring benefits to numerous application areas including industrial wireless network systems.

IoT is defined as a kind of network which not only can connect the objects, can be fully automatic, can collect, transmit and process information intelligently but also can realize the scientific management at anytime and anywhere through a variety of sensing devices and the Internet. The basic characteristics of IoT are: networked, instrumented, automated and intelligentized.

Based on this understanding, an energy management system based on Internet of Things is designed in order to improve the energy management levels and to do a better job in saving energy. The energy management system based on IoT can solve the problems of collecting, transmitting, saving, and controlling of the massive data in energy running processes by using a variety of techniques such as smart meters, communicating networks, software, databases and so on.

Energy management system and embedded data acquisition system to display on web page using Global Packet Radio System (GPRS) is designed. Compared to other networks the data from remote or unattended location can be collected easily. Collected data can be viewed, monitored, and controlled anywhere from the world through internet

connection using IoT technology. In this proposed design ARM is adopted as core controller, because it will scan information in parallel and in real time with high speed.

After designing the proposed Energy Management system, the IoT concept using GPRS Gateway and Remote server has to be studied and established.

## **II. LITREATURE SURVEY**

- [1] In this paper Energy control system used in Residence was developed using wireless smart socket, home gateway, user interface and Internet of Things (IoT). Smart socket has inbuilt Zigbee communication module used to communicate with home gateway. Smart socket will measure the connected device parameters and send to home gateway. Home gateway will send the control message to corresponding sockets using cloud server situated remotely. This system operates in four control modes, named as peak time control, energy control, automatic control and user control. Implementation results shows that 43.4% of energy reduction used by some home appliances in one week.
- [2] Smart home appliance control system was developed in the IoT environment. Smart controller is the main part of this system. Modules are connected through Zigbee interface to the central controller using the Radio frequency of 433MHz. Controller is connected to the Server, Personal computer or mobile phone through internet and wireless router via Wi-Fi interface. Using this system can able to control and monitor the energy consumed by the appliance in the home.
- [3] This Paper focus the user role in the field of operating smart things which is based on Internet of Things (IoT). Here Smart building energy management system is taken as example to explain about the energy saving to the user. Smart building energy management system implemented and showed the energy saving up to 23.12%. User needs and feedback to the system for further improvements are explained here.
- [4] Internet of Things (IoT) based Industry energy monitoring system designed with digital meters, communication networks, software, and database. Main goal of this paper is management and remote monitoring of energy data. System architecture consists of three layers. In first layer serial bus technology is used to connect the device and instrumentation based on Modbus communication protocol, which is implemented using RS-485 and it is connected to the server. In second layer the signal received from the meter by server is send to the IPC. Third layer consists of data monitoring and management function. Implementing webpage Microsoft SQL server is used as database.
- [5] Residential area energy management system based on Internet of Things (IoT) design is proposed in this paper, which is based on some pre defined rules and components. In this paper they have designed two types of web portal. One is consumer web portal, in which the map shows the house location, registered appliances, and power consumed by that appliance, which is used by the consumer. Second one is Electric utility web portal in which the location of that house, about the house details, and the power consumption of that house. This will be used by the Electric utility provider to check whether any of the houses is consuming more electricity.
- [6] Now a day's network security is a major concern in the field of telecommunication network while transmitting or receiving of any data. In this paper they have described about the network security vulnerabilities in Supervisory Control and Data Acquisition (SCADA) system and energy management system (EMS). They have analyzed many issues related to security and gave solution for creating an competent information security to SCADA and EMS used in power industry.
- [7] This paper focus the smart home energy management based on Zigbee. Using sensors they have collected information through personal area network for monitoring controlling the appliances used in smart home. Collected information is processed using microprocessor. They have developed their own routing protocol to improve performance of this system. This system will be used by a smart home or an office to control their electrical appliances. In this system data will be stored locally and cannot be viewed by remote user.
- [8] This paper energy management system model generated based on state variables. These state variables are defined based on the appliances characteristics. They have also developed virtual sensors for this system. Virtual sensors are developed based on Internet of Things (IoT). Using this sensors and state variables they have measured the energy consumption of each appliance. Based on these measurement analysis of energy

consumption of each appliance connected in an industry or a house was made. Based on the analysis result they have given solution for energy usage reduction. This method is purely software based there is no hardware involved.

- [9] Energy management and data acquisition system were developed in this paper using IoT environment. Here the required data is collected from the devices using the wireless sensor networks. Collected data can be identified and stored using Zigbee network. Stored data can be processed Concepts of Internet of Things (IoT) are applied using embedded processor. Communication between the processor and the server uses GPRS network. The above system proposed in this paper used to collect the data from the processor and send the SMS and Mail continuously to the web page
- [10] This paper focus the monitoring and controlling of energy in both network and consumers point. Implementation of the system based on their SCADA and hardware system for measurement of power consumption and load control. Energy monitoring and control was done using Programmable Logic Controller (PLC). Smart phone or an industrial computer is used to implement the communication with users. Using this system they have implemented energy management on domestic consumer in real time

**III. PROPOSED IOT BASED ENERGY MANAGEMENT SYSTEM ARCHITECTURE**

IoT based Energy Management System consists of Energy Meters with GPRS Module, GSM Service provider (Airtel, Aircel, BSNL, etc.), Internet cloud server, and a Personal Computer. Fig. 1. Shows IoT based Energy Management System Architecture.

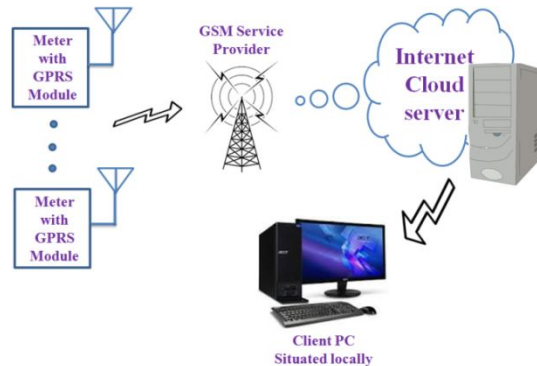


Fig. 1. IoT Based Energy Management System Architecture

**A. Hardware Architecture**

Hardware architecture consists of 32 bit Microcontroller based on ARM Cortex M4 core, Mains input (PT and CT), 2 row 16 character LCD, GPRS Module, Relay driver, Keys, and Power supply unit based on SMPS. Fig. 2. Shows the hardware architecture of the proposed system.

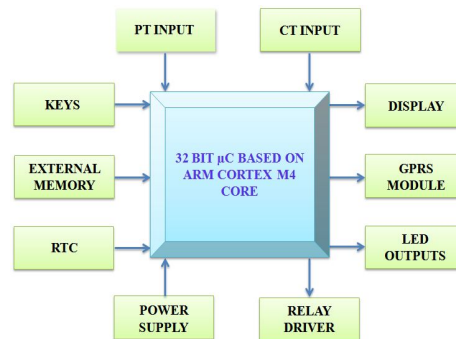
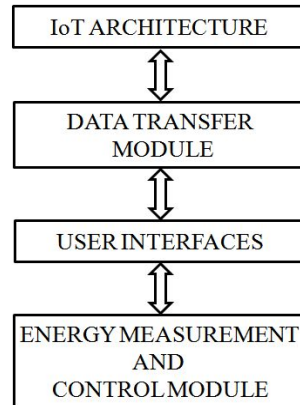


Fig. 2. Hardware Architecture

**B. Software Architecture**

Software architecture consists of 2 modules. First module consists of energy measurement and control, user interfaces, and data transfer module. This module is proposed to be developed with embedded C and IAR embedded workbench. Second module is the IoT architecture it was proposed to be implemented using .NET Framework as front end and MySQL database as back end. Fig. 3. Shows the software architecture of proposed system.

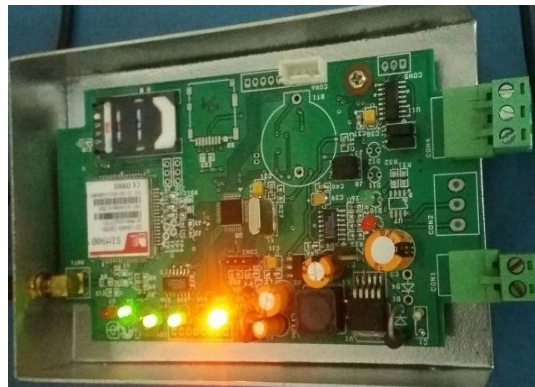


**Fig. 3. Software Architecture**

**IV. ESTABLISHMENT OF IOT ENVIRONMENT**

**A. GPRS Gateway**

Fig. 4. Shows the photograph of GPRS Gateway used for establishing the Internet of Things (IoT) environment study.



**Fig. 4. GPRS Gateway Photograph**

**B. Configuration Window**

Fig. 5. Shows the GPRS Gateway configuration window designed for IoT environment study.

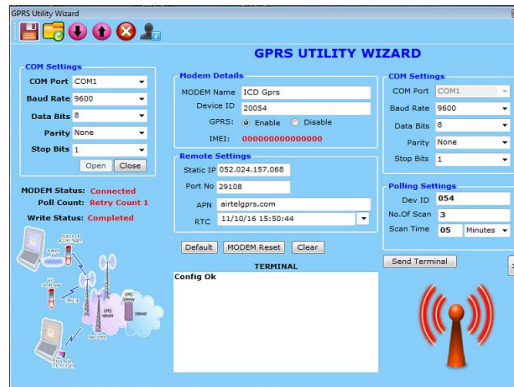


Fig. 5. GPRS Gateway Configuration Page

### C. Data Viewing Page

Fig. 6. Shows the Resulting Page designed for viewing the data transmitted from GPRS Gateway through remote server.

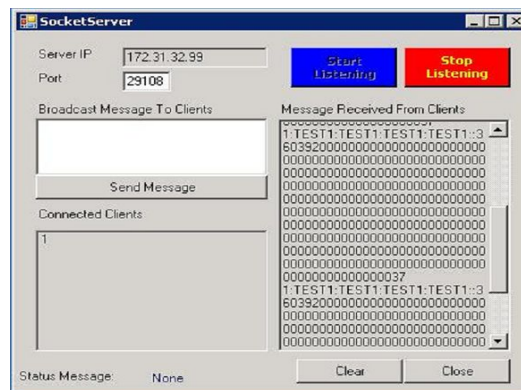


Fig. 6. Data viewing Page

## V. CONCLUSION

The recent literature surveys were reviewed to find various features and characteristics of the IoT systems. This survey paper describes an IoT based energy management system and data acquisition system to display on webpage using GPRS. IoT is the core concept of this Energy Management System project. Smart meters, GPRS Gateway, GPRS communication network, web based software, database and other related technologies are used in this work. The IoT architecture is implemented using GPRS Gateway, .NET Framework, and MySQL database.

## VI. FUTURE WORK

To develop the proposed design and to illustrate the developed system by connecting practical load and demonstrate the data on web page. Implementation of IoT based energy management system plays an important role in the scheduling, monitoring, controlling, optimization of enterprise energy, and improving organization / labor productivity. It has the advantage of low power consumption and make it easy to implement with high speed.

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