Advance Energy meter for EB power shutdown Avoidance System

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***Abstract*— In recent years, power management is one of hot topic and the power shutdown is a major issue for Domestic Power Consumers, the studies of wireless technology are more and more popular such as RF wireless sensing network. Zigbee wireless sensing can control and monitor power in the home ie(Energy Meter). In our system the Arduino interfacing circuit collects data and transmit it to the EB central computer. In winters, there is less load on the supply units , low requirement of electricity but in Summer season, people use A.C.s, coolers, fans, etc. which increases load on supply units resulting in their breakdown due to excessive load . Hear the EB central computer transmit an Essential signal to all domestic Energy meter which get's changed in to essential mode which deliver current only to essential things like fan and lights and automatically shutdown the current to non-essential things like A.C etc. In business, we can save power and to distribute uninterrupted power in our country by using this system.**

***Index Terms*— wireless technology, RF wireless sensing network, Zigbee , Arduino interfacing circuit,**

I. INTRODUCTION

In spite of tremendous advances in technology and computing, one sector that is still found to be lacking of a proper solution is the use of technology for making efficient use of electricity in India. This generation is facing quite a lot of problems due to electricity scarcity. In today's situation one of the major problems for which we are still not able to find a proper solution, is electricity scarcity. Electricity being an essential part of human life today, needs better management and allocation techniques than the existing systems, such that it will be possible to ensure maximum utilization of the available electricity, thus ensuring almost no power cuts. Mostly load shedding occurs because of excessive usage of power at peak hours. This project proposes a technique that forces people to use lesser power at peak hours, thereby supplying each consumer the necessary power rather than cutting it off for a few. Power shut generally happens at peak hours when there is a high demand for power, while only a lesser amount is available at the supply system. This project proposes a system that would force people to use lesser power at peak hours or at a deficient time period, thereby supplying everyone with the necessary power instead of cutting it off when the available power is finally drained.

II. RELATED WORK

Author in [2] investigated that there are about forty five industrial centers present in India and about 400+ small scale industries present all over India. To the shocking information almost all the small scale industries are located in the major cities of India like Mumbai, Delhi, Chennai, Bangalore etc. Around these industries there are about few thousands of area have been covered industrial areas.

We know that all the industries will be using the three state phase and many domestic area are still using two phase state in India. But due to the small scale industries present in the domestic areas the houses in and around these areas are also using the three phase line which is leading to the high consumption of load at the power supply units.

In an average there is an usage of four tube lights, three fans , an A.C in each and every domestic house. In addition to it there are other high load devices which consumes high power like washing machines, geezers etc.

III. LITERATURE REVIEW

a) Smart Meter

A smart meter is an electronic device that records consumption of electric energy in intervals of an hour or less and communicates that information at least daily back to the utility for monitoring and billing. Smart meters enable two-way communication between the meter and the central system. Unlike home energy monitors, smart meters can gather data for remote reporting. Such an advanced metering infrastructure (AMI) differs from traditional automatic meter reading (AMR) in that it enables two-way communications with the meter. Communications from the meter to the network can be done via fixed wired connections (such as power line communications) or via wireless. In using wireless, one can opt for cellular communications (which can be expensive), Wi-Fi (readily available), wireless ad hoc networks over Wi-FI, wireless mesh networks, low power long range wireless (LORA), ZigBee (low power low data rate wireless), Wi-SUN (Smart Utility Networks), etc. Smart meters provide a way of measuring this site-specific information, allowing utility companies to introduce different

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prices for consumption based on the time of day and the season.

Utility companies propose that from a consumer perspective, smart metering offers potential benefits to householders. These include, i) an end to estimated bills, which are a major source of complaints for many customers ii) a tool to help consumers better manage their energy purchases - stating that smart meters with a display outside their homes could provide up-to-date information on gas and electricity consumption and in doing so help people to manage their energy use and reduce their energy bills. Electricity pricing usually peaks at certain predictable times of the day and the season. In particular, if generation is constrained, prices can rise if power from other jurisdictions or more costly generation is brought online. Proponents assert that billing customers at a higher rate for peak times will encourage consumers to adjust their consumption habits to be more responsive to market prices and assert further, that regulatory and market design agencies hope these "price signals" could delay the construction of additional generation or at least the purchase of energy from higher priced sources, thereby controlling the steady and rapid increase of electricity prices. There are some concerns, however, that low income and vulnerable consumers may not benefit from intraday time-of-use tariffs.

An academic study based on existing trials showed that homeowners' electricity consumption on average is reduced by approximately 3-5%. The ability to connect/disconnect service and read meter consumption remotely are major labor savings for the utility and can result in large layoffs of meter readers

b) *Zigbee*

Zigbee is a high-level communication protocols used to create personal area networks with small, low-power digital radios, such as for home automation, medical device data collection, and other low-power low-bandwidth needs, designed for small scale projects which need wireless connection. Hence, Zigbee is a low-power, low data rate, and close proximity (i.e., personal area) wireless ad hoc network.

The technology defined by the Zigbee specification is intended to be simpler and less expensive than other wireless personal area networks(WPANs), such as Bluetooth or more general wireless networking such as Wi-Fi. Applications include wireless light switches, home energy monitors, traffic management systems, and other consumer and industrial equipment that requires short-range low-rate wireless data transfer.

Its low power consumption limits transmission distances to 10–100 meters line-of-sight, depending on power output and environmental characteristics. Zigbee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. Zigbee is typically used in low data rate applications that require long battery life and secure networking (Zigbee networks are secured by 128 bit symmetric encryption keys.) Zigbee has a defined rate of 250 kbit/s, best suited for intermittent data transmissions from a sensor or input device.

c) *ZigBee Network Layer*

In ZigBee, the network layer provides reliable and secure transmissions among devices. Three kinds of networks are supported, namely star, tree, and mesh networks. A ZigBee coordinator is responsible for initializing, maintaining, and controlling the network. A star network has a coordinator with devices directly connecting to the coordinator. For tree and mesh networks, devices can communicate with each other in a multihop fashion. The network backbone is formed by one ZigBee coordinator and multiple ZigBee routers. RFDs can join the network as end devices by associating with the ZigBee coordinator or ZigBee routers. In a tree network, the coordinator and routers can announce beacons. However, in a mesh network, regular beacons are not allowed. Devices in a mesh network can only communicate with each other by peer-to-peer transmissions specified in IEEE 802.15.4.

i. Network Formation

Devices that are coordinator-capable and do not currently join a network can be candidates of ZigBee coordinators. A device that desires to be a coordinator will scan all channels to find a suitable one. After selecting a channel, this device broadcasts a beacon containing a PAN identifier to initialize a PAN. A device that hears beacons of an existing network can join this network by performing the association procedures and specifying its role, as a ZigBee router or as an end device. The beacon sender will determine whether to accept this device or not by considering its current capacity and its permitted association duration. Then the association response can be carried by its beacons. If a device is successfully associated, the association response will contain a short 16-bit address for the request sender. This short address will be the network address for that device.

ii. Address Assignment in a ZigBee Network

In a ZigBee network, network addresses are assigned to devices by a distributed address assignment scheme. After forming a network, the ZigBee coordinator determines the maximum number of children (*Cm*) of a ZigBee router, the maximum number of child routers (*Rm*) of a parent node, and the depth of the network (*Lm*). Note that $Cm \geqq Rm$ and a parent can have (*Cm-Rm*) end devices as its children. In this algorithm, addresses of devices are assigned by their parents. For the coordinator, the whole address space is logically partitioned into *Rm+1* blocks. The first *Rm* blocks are to be assigned to the coordinator's child routers and the last block is reversed for the coordinator's own child end devices. In this scheme, a parent device utilizes *Cm*, *Rm*, and *Lm* to compute a parameter called *Cskip*, which is used to compute the starting addresses of its children's address pools. The *Cskip* for the ZigBee coordinator or a router in depth d is defined as:

$$Cskip(d) = \begin{cases} 1 + Cm*(Lm-d-1), & \text{if } Rm=1 \quad \Lambda\ \Lambda\ \Lambda \quad (a) \\ \dfrac{1 + (Cm-Rm-Cm)*Rm^{Lm-d-1}}{1-Rm} & \text{or} \quad \Lambda\Lambda\Lambda \quad (b) \end{cases}$$

The coordinator is said to be at depth 0; a node which is a child of another node at depth *d* is said to be at depth *d+1*. Consider any node *x* at depth *d*, and any node y which is a child of *x*. The value of *Cskip(d)* indicates the maximum number of nodes in the subtree rooted at y (including y itself).

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For example, in Fig. 1, since the *Cskip* value of B is 1, the subtree of C will contain no more than 1 node; since the *Cskip* value A is 7, the subtree of B will contain no more than 7 nodes. To understand the formulation, consider again the nodes *x* and *y* mentioned above. Node *y* itself counts for one node. There are at most Cm children of *y*. Among all children of *y*, there are at most *Rm* routers. So there are at most *CmRm* grandchildren of *y*. It is not hard to see that there are at most $CmRm^2$ great grandchildren of *y*. So the size of the subtree rooted at *y* is bounded by

$$Cskip(d)=1+Cm+CmRm+CmRm^2+\ldots\ldots+CmRm^{Lm-d-2}, (2)$$

since the depth of the subtree is at most Lm-d-1. We can derive that

$$\text{Eq. 2} = 1+Cm(1+Rm+Rm^2 + \ldots\ldots + Rm^{Lm-d-2})$$
$$= 1+Cm(1- Rm^{Lm-d-1})/(1-Rm)$$
$$= \text{Eq. 1(b)}$$

Address assignment begins from the ZigBee coordinator by assigning address 0 to itself and depth d=0. If a parent node at depth d has an address A_{parent}, the nth child router is assigned to address $A_{parent}+(n-1)\times Cskip(d)+1$ and nth child end device is assigned to address $A_{parent}+Rm\times Cskip(d)+n$. An example of the ZigBee address assignment is shown in Fig. below. The *Cskip* of the ZigBee coordinator is obtained from Eq. 1 by setting d=0, Cm=6, Rm=4, and Lm=3. Then the 1st, 2nd, and 3rd child routers of the coordinator will be assigned to addresses 0+(1-1)×31+1=1, 0+(2-1)×31+1=32, and 0+(3-1)×31+1=63, respectively. And the two child end devices' addresses are 0+4×31+1=125 and 0+4×31+2=126.

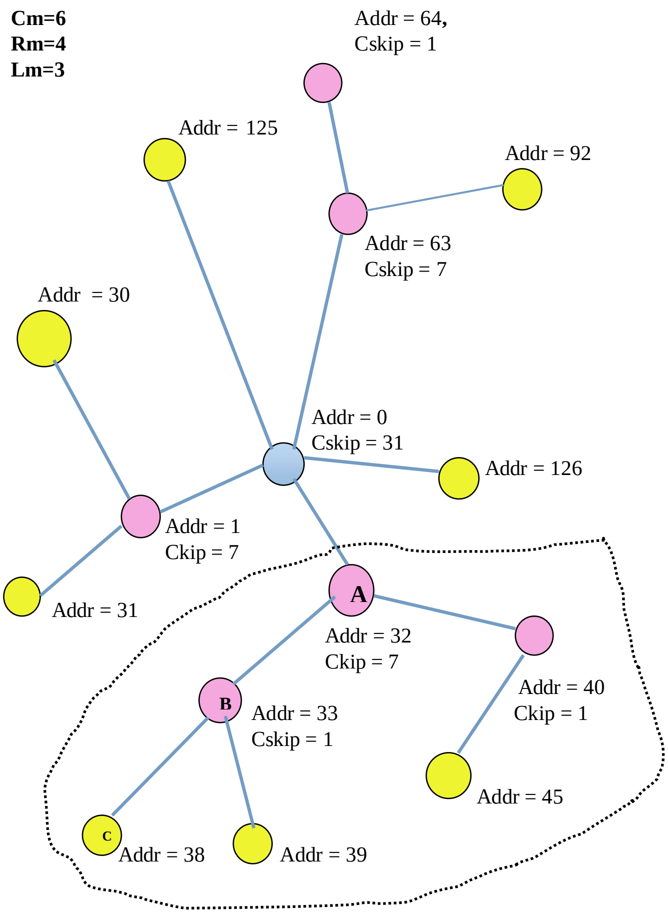

Fig 1 An address assignment example in a ZigBee network

IV. Existing System

With growing population, electric power is one resource that is not available in sufficient amount for the people in India. This leads to major problems like power cuts for hours together, which cause lot of inconvenience to consumers. Such is the scenario that, nowadays power cuts have become a part of life both in cities and elsewhere. Power cuts happen because of uncontrolled and uneven distribution of electricity.

At present, a method called smart grid system is being implemented and used, by which they switch over between electric networks that are laid to transmit power at different voltages. In detail, smart grid is a power distribution system in which the electric board authorities control the distribution of power for any particular area without considering the nature of the customers.

Even though this method is advantageous to a certain extent, it has a lot of disadvantages too. The main drawback is that this method uses huge manpower to control and monitor power distribution and the cost of installation is also very high. This method uses two or three network connections which pass different voltages and the electric board authorities switch over between these networks based on the availability of the power. Thus, it includes a large cost for installation since two or three networks have to be implemented. Moreover, this method does not detect power thefts as the security level is the same as that of the existing system.

V. Proposed Methodology

❖ *Power Cut Avoidance*

Load shedding often occurs because of excessive usage of power at a particular point of time which could, on an average be controlled within limits. This happens most commonly during peak hours when there is a demand for excessive power and because of this, deficiency occurs in the supply system. This creates a need to force people to use lesser power during peak hours, thereby supplying everyone with the necessary power and avoiding power cuts that would have occurred otherwise. This is possible by switching off unwanted devices that are left on, during peak hours. For example, the electric water heater could be used at non-peak hours rather than at peak hours when power would be needed for a few other devices that have to be used unconditionally. Similarly in a commercial setup, high power machines could be shut off at peak hours leaving the other necessary devices like lights and fans on. To implement this, each and every consumer, be it home or commercial, is fitted with a special device that has an embedded controller in it. This device is capable of receiving real time instructions from the EB through zigbee communication at any point in time, using a wireless link. The device has a power cut off feature and also a display and an alarm built into it, and it is capable of replacing the existing EB meters.

The EB Office on the other hand has a computer based system, from which it can track the available power and transmit data to the consumer device accordingly. For example, if the power available is lesser than the demand

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during peak hours, then the EB end would transmit information to the consumer end device indicating that their power consumption should be reduced to a certain maximum limit. There can even be a higher power tariff for operation at peak hours than at normal hours. In extreme cases, power could be cut off directly if the consumer does not comply with the instructions from the supply end. Thus this system can very effectively and efficiently ensure power availability to various consumers causing them least inconvenience. The controller we use here is ARM 7 LPC2148. We fit this in all the consumer units (residences and commercial units alike) and the module used for communication is Zigbee which consists of a transmitter and receiver. GSM is used for mobile communication. That is, it sends and receives messages with details about the bill. Thus, even if the electricity that is available is of a meager amount, it is shared among all the consumers and it is left to them to use it wisely, that is to use the available electricity only for the need of the hour, thus ensuring almost no power cuts or very minimal power cuts.

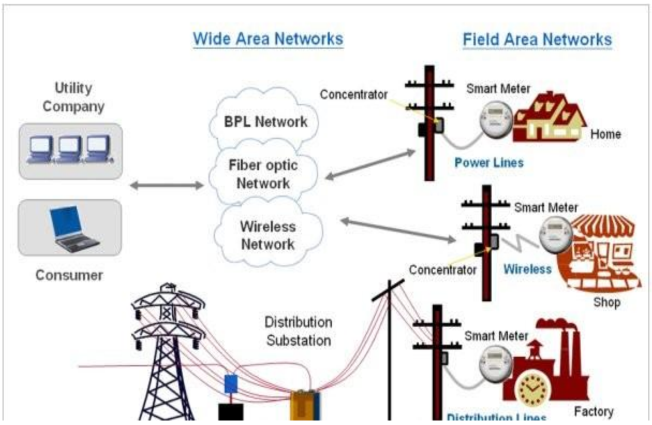

Fig 2 Network Connections from EB to Consumers

❖ *Current Theft Avoidance*

The concept of tracking and avoiding power theft is also introduced here. Since the device is fitted in all the consumer units, it would be easy to note the extra power consumption and to identify the line that uses the power that is being stolen illegally. That is, the microcontroller that is fixed in the consumer's end displays the details of the bill amount depending upon the amount of power used, and at the supply end the EB office also gets these details through Zigbee. So, during power transmission it would be easy to identify the point of electricity theft and take necessary actions to avoid it.

❖ *Replacement Of Manpower*

The power management system consists of Zigbee Digital Power meters installed in each and every consumer unit and an Electricity e-Billing system at the energy provider side. The Zigbee Digital Power Meter (ZPM) is a single phase digital kWh power meter with an embedded Zigbee modem which utilizes the wireless sensor network to send its power usage reading. At the power provider side an e-billing system is used to manage the received zigbee meter reading, compute the billing cost, update the database, and to publish the billing notification to its respective consumer through a wireless medium.

Traditional meter reading for electricity consumption and its respective billing is done by human operators who move from one consumer unit to the other to note down the exact reading. This process requires a huge number of laborers or operators and it takes long working hours to complete the data reading and billing of the entire area. Human operator billing is also prone to reading errors, because at times, the electric power meter is placed in a location where it is not easily accessible. All these problems could be easily avoided as everything in our proposed method is digitized hence decreasing the possibility of errors. And if the consumers had failed to pay their bills, it would be possible to cut the supply of power to that particular consumer directly from the power provider end, since the power consumption details are sent directly to the microcontroller with the help of zigbee. Due to this facility, it also seems unnecessary to send laborers to take down readings in the houses of consumers, thus replacing the need of manpower.

VI. Overall System Module

This block diagram represents the entire module of the system. It consolidates the system for power cut avoidance, management of power theft and the system that replaces manpower. The microcontroller is interfaced with the passive infrared (PIR) sensor and the light dependent resistor (LDR) sensor along with the relay drivers and the signal conditioning circuit. In addition to this, an LCD display is also connected to the microcontroller.

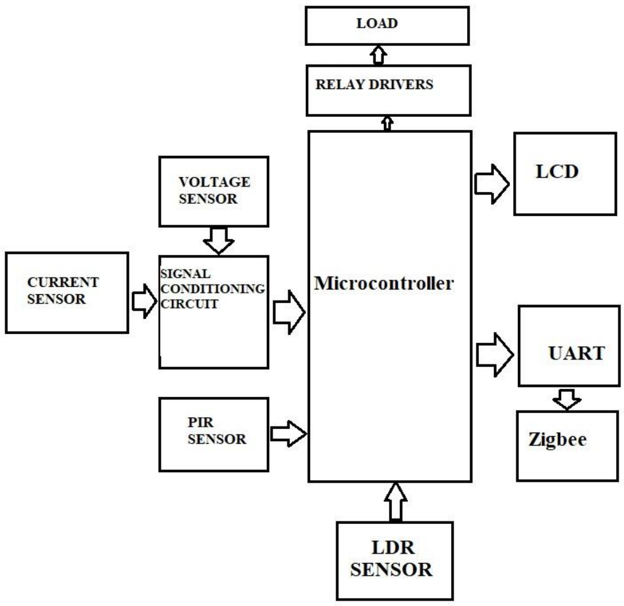

Fig 3 Block Diagram for the proposed system

VII. Hardware Description

a) Power Supply

This is the power supply unit which aids in regulating and supplying current depending upon the requirement of the

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circuit. The ac voltage is stepped down to the desired dc level from 220V rms by connecting it to a transformer.

b) Zigbee Unit

Zigbee is used for transmission between electric boards and customer residences. Zigbee and IEEE 802.15.4 are used to provide network infrastructure in wireless sensor network applications. 802.15.4 defines the physical and MAC layers, and Zigbee defines the network and application layers.

c) LCD Display

The current reading, bill amount and the power to be consumed in peak hours are displayed in the LCD display.

d) ARM Microcontroller(LPC 2148)

The LPC2148 microcontrollers are based on a 32/16 bit ARM7TDMIS CPU with real-time emulation and embedded trace support, that combines the microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB.

e) LDR Sensor

LDR (Light Dependent Resistor) sensor senses the presence of objects (humans) in the residence. This system automatically switches off the power when there is nobody at home.

f) PIR Sensor

PIR (Passive Infrared) sensor is an electronic sensor also known as passive infrared motion detector to measure infrared light radiated from those objects present in its field of view.

VIII. CONCLUSION

This project develops a system for better management and sharing of electricity, ensuring maximum utilization of the available electricity at the peak hours using an embedded microcontroller. Using this system, it is possible to avoid power cuts, reduce the use of inverters, and electricity theft can also be effectively monitored and avoided. Thus, power distribution can be effectively managed at a very low cost and this system can very effectively ensure power availability to various consumers causing them least or no inconvenience at all.

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