Dynamic Multi Source Energy Saving Policy In IoT

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Abstract - *A smart city exploits sustainable information and communication technologies to improve the quality and the performance of urban services for citizens and government, while reducing resources consumption. Intelligent energy control in buildings is an important aspect in this where, The IoT can provide a solution. Current building designs are not energy-efficient enough due to many reasons. One of them is the centralized control and fixed running policies (e.g. HVAC system) without considering the occupants' actual usage and adjusting the energy consumption accordingly. In this paper, we discuss our multidisciplinary idea on a dynamic multisource energy saving policy on which we introduce mobile location service into the energy policy control by using the now popular GPS-embedded smart phones. Every occupant in the building who has a smart phone is able to monitor their usage and adjust their own energy policy in real time. This changes the centralized control inside the building into a distributed control paradigm. It allows the occupants with different roles to participate in the energy consumption reduction efforts. Latest information technologies such as mobile smart device-based location service, distributed control, and cloud computing are used in this process. The major idea and experimental system is expected to be applied to not only green buildings but also vast number of the conventional buildings to reduce the energy consumption without sacrificing the human comfort and convenience.*

***Key Words*: Internet of Things; Smart Energy; Energy Efficiency; Intelligent Buildings; Location-based Networked Control.**

1. INTRODUCTION

Smart energy in buildings is an important research area of Internet of Things (IoT). Buildings as important parts of the smart grids, their energy efficiency is vital for the environment and global sustainability. According to a general survey [1], in United States, buildings are responsible for around 38% of the total carbon dioxide emissions; 71% of the total electrical energy consumption; 39% of the total energy usage; 12% of water consumption; 40% of non-industrial waste. In the meantime, cost of traditional fossil fuels is rising and its negative impacts on the planet's climate and ecological balance make it important for us to explore new clean-energy sources and improve the energy efficiency in the consumer-side smart grids of various buildings.

In the new configuration for the Internet of Things (IoT), a revision on the traditional concept of the internet is essential. In the traditional version, the internet is an infrastructure which provides the terminals for end users, while within the Internet of Things it provides the interconnection of smart objects within a ubiquitous computing environment [2]. The internet infrastructure will play a vital role as the global platform to enable the communication capability of physical objects. The novelty will be enabled by embedding electronics into objects, making them smart while being integrated into the worldwide physical infrastructure.

Generally, in syntactic category everything in the world is considered as an object, but in the IoT paradigm everything in the world is considered as a smart object, and allows them to communicate each other through the internet technologies either by physically or by virtually. IoT allows people and things to be connected anytime, anyplace, with anything. Let us consider a situation where we face this at most of the time. We often forget to switch off the electrical appliances such as light in the rooms and plugging off the charger without switching it off .It may be a little to one but when considering as the whole there definitely shows the tremendous difference. This difference result shows how electricity gets wasted. And Besides the resource from which the electricity is produced is also getting depleted. So we have no other way than using the resource efficiently. We measured the power consumption in products.

The IoT domain encloses a wide range of standardized or unstandardized technologies, software platforms and diverse applications. Therefore, a single reference architecture cannot be used as a layout for all possible concrete implementations. Though a reference model can be considered for IoT, most likely several reference architectures will coexist [3]. Here, we define the architecture as a framework in which the things, the people and the cloud services are combined to facilitate application tasks. Therefore, the reference model for the IoT can schematically be depicted as in Fig. 1.

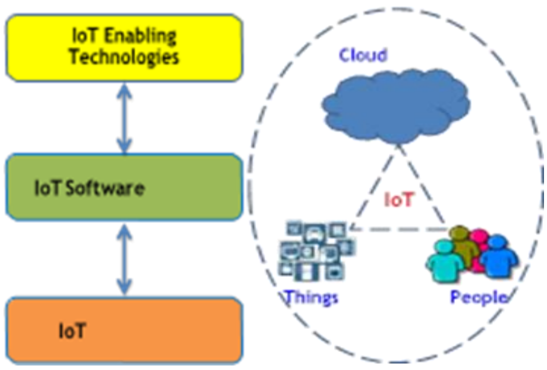

Fig.1. The IoT architecture model

In this paper, we basically focus on following points that we can make use of in reducing the energy consumption:

1. Use distributed and dynamic energy monitoring and policy controls instead of the conventional centralized control (like HVAC) to adjust the energy consumption;

2. Involve occupants' awareness and online active participation into the energy-saving policy decision and implementation process.

To achieve these goals, in our multi-disciplinary idea, we use the latest information technologies such as mobile smart phone with location service, distributed control, and cloud computing to actively involve the occupants in the energy saving process. Energy-saving policies from multiple sources such as individuals and organizations are considered in an integrated policy framework in deciding the final energy saving strategies. We aim to create an energy-efficiency test bed that can be easily migrated to all kinds of buildings and achieve energy savings on a large scale.

2. PROBLEM STATEMENT

Green buildings are not energy efficient, in green office building the energy used are monitored, evaluated and analyzed, although they are green by design due to the centralized and static building controls, these buildings are not energy efficient. There occurs more number of scenarios where the electricity power gets wasted. Some of them are, consider a home where family members are, while they leave home in hurry they forget to switch off motor, until then they return both electricity and water gets wasted, sometimes they unplugs their mobile phones from charger just without switching off the power supply. This is an attempt to save energy, although we are unable to save power wasting by means of copper loss, we can save electricity by avoiding unwanted usage. Due to the advent of new technologies, devices, and communication means like social networking sites, the amount of data produced by mankind is growing rapidly every year. The amount of data produced by us from the beginning of time till 2003 was 5 billion gigabytes. If you pile up the data in the form of disks it may fill an entire football field. The same amount was created in every two days in 2011, and in every ten minutes in 2013. This rate is still growing enormously. Though all this information produced is meaningful and can be useful when processed, it is being neglected.

3. EXISTING SYSTEM

The existing system has drawbacks. The given below provides solutions for the problems faced in the organization.

Develop Green Building Concept: Improve energy efficiency by integrating old and new equipment in the building to achieve significant energy savings.

Build Intelligent Gateway Solution: automatically controlled framework that provides low-power, high-performance computing for connecting legacy and new systems while enabling seamless and secure data flow between edge devices and the cloud. Due to the centralized and static building controls, the actual running of green buildings may not be energy efficient even though they may be —green by design.

IoT Applications in Smart Cities

The IoT potentialities offer many possible applications. Some of these applications are shown in Fig. 2. Only some of them are currently completely deployed and in the future, there will be more intelligent applications for smarter cities, enterprises and factories.

Smart city applications are developed not only to improve the management of urban flows but also to allow a real time response to challenges. Especially in this century, many emerging technological, economical and environmental changes have generated interest in smart cities. These changes include climate change [4], economic restructuring [5] , ageing populations, and pressures on public finances [2] . A smart city can be considered as the general application category in which other domains such a smart home, smart grid, smart automotive and traffic management are included.

A smart home can be considered as a subcategory of smart cities. In this subcategory a residence' appliances, lighting, heating and air conditioning systems, video and audio streaming devices and security systems are capable of communicating with each other or through a central control unit in order to bring comfort, security and energy efficiency for home owners.

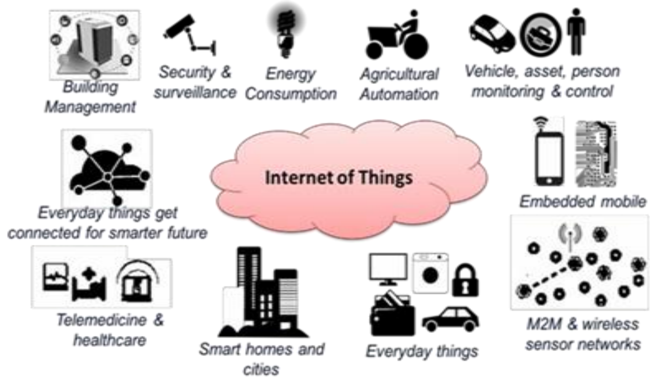

Fig. 2 Internet of Things application domains

The research works on smart cities has attracted a lot of attentions in the last decade [6]. From market's point of view, the smart home is expanding rapidly and is expected to reach more than 100 billion dollars by 2022. In this application personal and family security is a key adoption motivation for the major consumers. In [7] a survey shows that 90% of people agree that security is one the most important reasons to purchase or a smart home system. The next motivation is costs saving as the exciting reason for the consumers to use smart home. In [8] it has been predicted that a typical family home may contain more than 500 smart devices by 2022, while currently for the most consumers, smart home is not an essential demand.

In European countries, since EU Parliament published a directive in 2002 to use the methodologies for increasing the energy efficiency in buildings [9], a lot of international research projects have established to use energy management system to reduce buildings' energy consumption. Some of these projects are: SEEMPubS (Smart Energy Efficient Middleware for Public Spaces) [10], DIMMER (District Information Modeling and Management for Energy Reduction) [11] , AIM (A novel architecture for modeling, virtualizing and managing the energy consumption of household appliances) [12] , IntUBE (Intelligent Use of Buildings' Energy Information) [13] and DEHEMS (Digital Environment Home Energy Management System) [14] . Among them SEEMPubS is one of the EU founded projects in which the main attention has given to development of an energy system for public and historical buildings.

Europe's historic buildings have visitors from all around the world every day. However, providing energy- efficient buildings without significant construction works can be a struggle. SEEMPUBS project had developed an ICT-based energy management control system coping with avoiding possible damages caused by important building interventions due to energy management hardware installation [10] , [15] . In there project a new computer-based system, controls lighting, heaters, air conditioners and other environmental units in large buildings. The SEEMPUBS technology provides a central control system at software level which is connected wirelessly to energy structures placed in different parts of a building or even a number of buildings. Beyond the hardware, the most significant results have been on elaboration of an energy-efficient model for existing buildings and public spaces. This model can be applied to many different historic buildings to avoid construction work, disruption and possible damage, even with deploying new emerging technologies. As a user application, the Heating, Ventilation and Air Conditioning (HVAC) control applications include products, systems and services that target control strategies to save energy [16]. HVAC systems use IoT software and hardware infrastructures to achieve their objectives. An explanation of the applied energy control solution into an IoT home energy management system will be presented in reviewing of each of IoT's components in the following .

Another subcategory application for IoT in a smart city is where the automotive industry offers smart cars. From headlights to engine all systems in between request a range of innovative technologies in modern cars [17]. IoT will provide web-connected vehicles to implement telemetry, predictive maintenance, car-to-car and car-to-user connections. It is mostly desired to replace wire with wireless communications in a smart car while maintaining a safe and comfortable driving [18].

Smart Location-Based Automated

In this project, the smart location-based auto-mated energy control IoT frame work .is present.

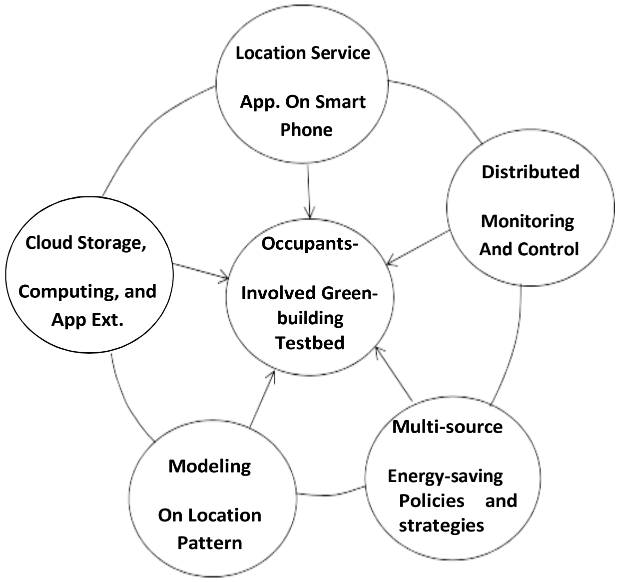

Fig. 3 Structure of Design with Components and Their Interaction.

Overall Structure

There are multiple design components and aspects which interact with each other and form a complete framework of our idea to fulfill the goals. We envision an occupant-oriented and involved networked system and depict it .The key design components include: mobile devices-based distributed energy monitoring and remote control, location application on smart phone, multisource energy-saving policies and strategies, cloud-computing platform-based data storage and application, and energy data modelling and strategy formation. We discuss these below.

Smart Mobile IoT Devices as Remote Controls

In the last several years, smart mobile devices have become very popular. Smartphone's generally have multiple networking interfaces such as 3G,4G, WiFi, WiMAX, Bluetooth, and have multiple sensors including GPS sensors. Because of various connectivity provisions and global accessibility to the Internet, they are suitable for use in any system that needs humans' online participation or interaction. The "Internet of Things" [20] trend makes the cost even lower and the sensors are connected to the Internet at all time.

Smartphone's are ideal for monitoring, controlling, and managing the energy control systems remotely from anywhere at any time. After appropriate authentication and authorization, the occupants are allowed to modify and change their energy-saving policies online by interacting with the policy servers of their office and residential buildings. Such design allows dynamic changes to the energy-saving policies and offers better flexibility to the occupants. It can be a good complement to the general policy decision process based on the modeling results. Such an "app" can be easily developed for the smartphone based on the web technology.

Multi-source Energy-saving Policies Hierarchy

In a real environment, various parts of an organization, such as campus, building, department, and labs may be in charge of different components of a building. Each of these may have their own policies and requirements that need to be taken care of in controlling the energy consumption. Even in a single home building, locations of multiple family members and their preferences need to be taken into account. Therefore, in our location based automatic control scheme, we add policies coming from these levels of control hierarchy.

Fig. 4 shows an example of the policy hierarchy. As shown, there may be a tree-like structure for the building control plane in which there are policy servers enforcing the energy-saving policies covering different levels. This also applies to the residential buildings in which the tree structure may be relatively simple. The mobile users can be connected to the Internet through smartphone, tablet, or even laptop with WiFi connections. In the example shown in Fig. 4, the mobile smartphone holder leaves the home building and travels towards his office building. The movement and location changes will trigger the policy servers to adjust the energy-saving policies for both buildings accordingly. The action steps are denoted as "1 2 3" in the figure.

They need to be able to deliver every single watt of power to every single customer at any given moment of the day. If they fall short, the whole system could crash. When you turn on a light or start your dishwasher, you're probably not thinking about how many other people are making demands on the system at the same moment. But your electric utility would like you to. Because if you don't that could mean they need to build another power plant to increase their capacity. And power plants are very expensive. So they charge a fee for demand, which in states like New York and California, can amount to as much as 40 percent of the entire electric bill or more. This is done both to incentivize limit-setting .Eg. Offering a modular, flexible design, Samsung SDI's Energy Storage System (ESS) technology can be easily tailored to meet a diverse set of customer demands and provide a turnkey solution for every player along the electricity value chain. The lithium ion cells used in Samsung SDI's ESS were developed to meet the demanding requirements of global top automotive brands' electric vehicles. Thus, Samsung SDI ESS provides long life span, safety and the highest dynamic charge acceptance, promising a low total cost of ownership and reliability.

Under the world's class quality assurance measures, Samsung SDI manufactures modules, trays, and rack systems to meet all spectrums of consumer requirements. Computation-intense modeling and analysis jobs are mostly done in the cloud. The communication layer provides configurability, reliability, and security for the network communication between the cloud and the client is the reason to overhead and develop the cloud application and accelerate the application development and deployment process. It also becomes much easier to integrate other services using the same platform (such as authentication services, email services, and user interfaces) to the application on demand and make the development of a cloud application a less-complicated task. The top layer is the application layer. We are researching and developing a user friendly prototype web-based user interface and application for preferences need to be considered.

Therefore, in our location based automatic control scheme, we add policies coming from these levels of control hierarchy. There may be a tree-like structure for the building control plane in which there are policy servers enforcing the energy-saving policies covering different levels. This also applies to the residential buildings in which the tree structure may be relatively simple. The mobile users can be connected to the Internet through smart phone, tablet, or even laptop with WiFi connections. For example, the smart phone holder leaves the home building and travels toward his/her building. The movement and location changes will trigger the policy servers to adjust the energy-saving policies for both buildings accordingly. we have studied with several policy-based control schemes. We apply similar ideas to the building and community environments. In particular, each control region can be defined as which is managed by a realm manager (also a policy server in our building testbed). Energy control policies may span multiple realms and sometime conflicts may have to be resolved. energy saving and comfort. An "App" on the device can automatically enforce these desired policies.

With the help of the location-aware mobile devices, these dynamic adjustment policies could also enable the cooperation and interaction among different buildings. For example, when the location detection daemon on the user's smart phone detects that the user has moved out of a threshold distance range from his/her home building and is moving into a threshold distance range of his/her office building, then a message is sent to a centralized server to trigger the policy control process. The office building room owned by the user will start preheating /cooling to prepare a user-customized or optimized working environment, while the message also triggers the home building to transit into an energy-saving mode.

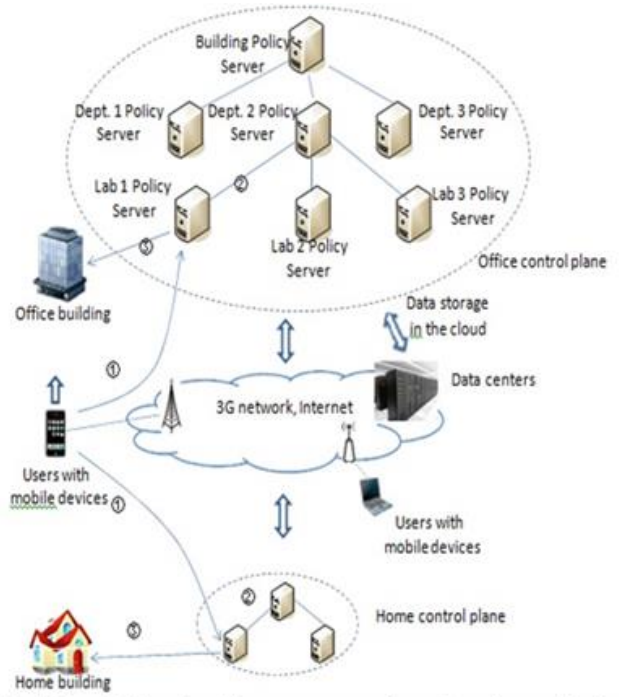

Fig. 4. Example dynamic multi-source energy-saving policy adjustment by the mobile devices

Cloud Computing and Storage

Cloud computing has become very promising in the last few years. We have two basic kinds of jobs which need the cloud-computing platform: (1) The cloud-based data storage, and (2) the cloud-based modeling and analysis computation. We have a preliminary design of how to integrate the system into the cloud computing platform. As shown in Fig. 5, the cloud provides the basic data storage and retrieval service for the logged building energy consumption data. Computation-intense modeling and analysis jobs are mostly done in the cloud. The communication layer provides configurability, reliability, and security for the network communication between the cloud and the client. The middle layer in Fig. 5 is for cloud application development by using the open API provided by the cloud providers such as Google App Engine. The reason we incorporate this layer in this design is that it can alleviate the overhead to develop the cloud application and accelerate our application development and deployment process. It also becomes much easier to integrate other services using the same platform (such as authentication services, email services and user interfaces) to the application on demand and make the development of a cloud application a less complicated task. The top layer is the application layer. We are researching and studding a user-friendly prototype web-based user interface and application for the building environment, which can be easily configured and managed by the remote client.

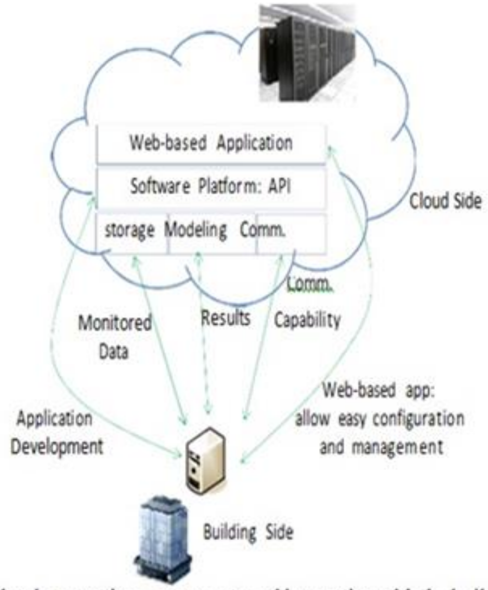

Fig. 5. Cloud computing components and interaction with the building side servers

IoT Model Description

In this IoT model (prototype) system, we focused a simple scenario involving a user associated to two groups of electrical appliances: those in his/her home apartment and those in his/her office room. It is a simplified scenario of what is shown in Fig. 4. The goal is to provide users the ability to dynamically adjust and control their devices across two buildings. The basic function is to enable the server to detect the user's location changes and trigger the energy policy changes by turning on/off the electrical appliances in both buildings associated to the user. By doing this, we essentially enable users to control and implement their own energy policies in real time, and enable their energy consumption to be proportional to their actual usage.

Note that in this simple prototype, we only refer the case involving only one user with control devices in two buildings (the user's office building and home building). In other words, we refer this small-scale proof-of-concept system and compare the energy saving with the case that is without the new design. After proving the effectiveness, then it can be generalized it into a larger scale. In the future work, One can plan to test the case with multiple users controlling their devices simultaneously by which one could show results with a larger scale energy saving.

Hardware and networking structure

In the prototype system, the hardware systems includes the "Kill-A-WattTM" electrical meters [21], WeMoTM control devices [22], servers in each building which act as both web daemon server and in-building controller, WiFi routers, and smart devices with location sensors (Global Sat GPS module).

The networking structure of the prototype system of the home building side is shown in Fig. 6. The basic function is that a smart mobile device with a location sensor keeps sending its location data back to the web servers inside the home building and the office building. The web daemon servers behind the firewall and NAT (Network Address Translation) are accessed from outside by port mapping technology. It also calculates the distance between it and the mobile devices to decide if the distance passes a specific threshold to trigger energy policy changes in either of the buildings. If it does, then it initiates the controller to send instructions to turn on/off specific devices in its territory according to the energy policies.

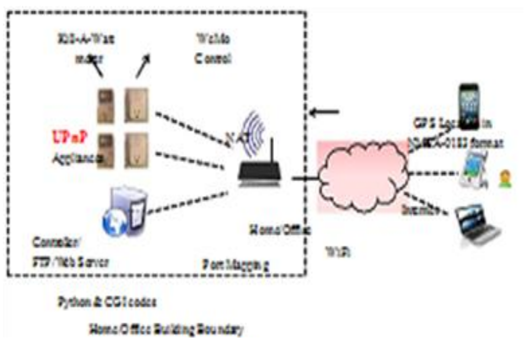

Fig. 6. Prototype system networking structure

Software

The software part includes the software for GPS location data recording and sending to the web server in NMEA (National Marine Electronics Association) 0183 compliant format, and the WiFi router's configuration and management software which provides a port mapping service for web access from outside of the NAT. The web server is programmed with CGI (Common Gateway Interface) scripts to execute Python codes controlling the WeMo devices through UPnP (Universal Plug and Play) protocol. Besides the location based automated control, these software parts working together with the hardware also enable the devices in both buildings to be controllable from Internet in real time through smart devices.

4. Proposed System

This paper has results in saving energy in buildings, and has the experimental result that can be seen directly. It Deals with saving energy in buildings. Energy is the important aspect in current environment. There exist several methods to save energy; here also energy is saved by using Internet Of Things. Saving energy means decreasing the amount of energy used while achieving a similar outcome of end use. Using less energy has lots of benefits – you can save money and help the environment. Generating energy requires precious natural resources, for instance coal, oil or gas. Therefore, using less energy helps us to preserve these resources and make them last longer in the future. Saving energy in homes can be done in several methods. There exist many scenarios where the power gets wasted to a greater extend. The wastage of electricity includes scenarios such as, when the user is in hurry then he will not consider about the switched on fans, lights, etc., this proposal is made to take care of electricity in these areas. The proposed system is designed to consider the kind of scenarios and to control power losses in buildings. When this user's move out from their houses and a certain distance apart, the GPS system provided with the smart phones will automatically generate message and that ask the user either to switch on or off the lights.

For this purpose this concept uses arduino kit, that is positioned in the home location. The generated message will reach the home placed arduino kit and the respective electronic gadget will get switched off. This is connected to only some gadget like fans, lights and these are not suitable for connecting with gadgets like refrigerator, washing machines. The gadgets that are meant to switch off during the absence of the user will be connected to this kit that is to be switched off during the user's absence.

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board. The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

Proposed method synthesizes the previous separate contributions into a complete IoT framework design. It includes research and work in the whole process of identifying the key problems, finding methods to solve them, and developing prototype system to prove the effectiveness of the proposed method. Then build a novel experimental prototype IoT system, which demonstrates the real-time location-based automated energy policy control across multiple buildings. It is the basic step in changing from the current centralized control and static energy consumption modes to distributed and dynamic energy control in the consumer-side smart grids containing various common buildings.. The central idea is developed to generalize the smart phone and location-based energy control idea and include policies of multiple levels of organizations. It aggregates the energy saving of individual users and allows distributed and dynamic energy control, which is the key for energy proportionality.

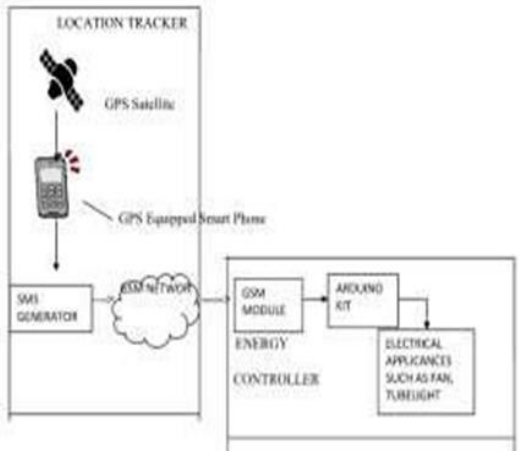

Fig. 7 Architecture diagram

5. CONCLUSION

Here we proposed a framework, for the efficient usage of electricity in buildings by using the concept of IOT. By means of IOT we connect our smart phones and our home location for the effective saving of energy. By using this proposal a large amount of electricity can be saved and can make our home as a energy efficient building. This concept is not suitable for preventing copper losses but can prevent energy wastage to a greater extend in buildings. This concept will be more useful in today busy world and will be suitable. This paper mainly concentrates on saving energy in specified areas. In that area too, only from specified gadgets that are not in necessary during the user is not available in that area. This paper also has the disadvantage that it will not support the mechanism of saving energy in the area of copper losses. This can be enhanced in future to support wastage of energy by copper loss. This concept mainly deals in saving energy and making our world to evolve efficiently. By this way of saving energy will help our future generation. So this can be enhanced to make our world to evolve efficiently. So our future enhancement is to save energy in the area of copper losses also. Thereby, a large amount of electricity will be saved in upcoming future.

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