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A novel development of wireless mesh protocol data transmission framework for internet based energy conservation

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Abstract. This paper describes the design of wireless mesh network for the development of energy grid to overcome energy crisis problem. In past few decades, IoT and wireless sensor networks provides promising solution for implementation of real time systems in both industries and academics. To improve day today life quality, new era of technology IoT provides efficient way of machine to machine communication with internet by using wireless protocols. The proposed design has an advantage of low cost, high speed and good reliability for the implementation of energy grid.

Key words. Wireless mesh network, energy grid, IoT, wireless protocol.

1. Introduction

The novel paradigm named IoT was introduced by Kevin Ashton in the year 1990. Electronic products like Sensor, chips are used everywhere because of miniaturization and system of chip technology. Wireless sensors play a major role in IoT Communication [1–3]. Over few years with advancement of embedded devices and wireless sensors, the occurrence of IoT applications are productive, comfort, easy to use, Cost effective. IoT has great potential to communicate with unlimited devices over the internet. IoT intelligence is the technological revolution for future real-time applications. Internet of things provides promising solution for integrating sensors microcontroller wireless protocols to connect physical device to the internet. IoT emerges as new platform for consumer electronics continue to achieve performance

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in terms of power and functionality and reduce cost of the system. IoT provides communication for the humans with machine anywhere and anytime.

Wireless mesh networks network is the hybrid network topology for cooperate point to multipoint communication. The performance of Wireless mesh networks in remote monitor and control of IoT applications are excellent. Wireless mesh network is a network used in communications and it consists of radio nodes that are structured in mesh topology. Customers are various electronic devices, embedded systems and several sensors that are used in communication process for interactive with people in a network. The router act as a link among two or more networks mainly for transmitting the data from one network to another. Another electronic device called gateway which acts as a passage through which the network connects to the internet [4].

In wireless mesh network while one node cannot function, the remaining nodes can be still efficient, and it can be utilized to communicate with others either straight or with the help of one or more intermediary nodes. The best quality of the wireless mesh network is simplicity and easiness to add new nodes without re-installing. The application of Wireless mesh networks has been used in the arena of remote monitoring and control system including environmental monitoring, the water meter infrastructure, automatic street light monitoring system, real time indoor carbon dioxide monitoring, data mining, Health care applications, Agriculture. The wireless module technology based physical layer such as Zigbee and radio frequency has been used in the above-mentioned studies. The topology of wireless mesh networks has a great benefit in terms of flexibility and reliability in comparison with other network topologies. The robustness of the network can be significantly enriched by using the self-organizing management approach that is present in the network nodes which finally ensuing in a strong mesh networking technology [5]. In smart ad hoc mesh networking technology, the node is used to observe the adjacent nodes initially and it is used to measure the strength of the signal. After that it chooses the proper neighbor for the synchronization of time and then based on it send the joining request. After that the neighboring node conveys the appeal to the gateway [6]. Later the gateway accepts the invitation and allocates the network resources for the node. The sensor network nodes can be allotted according to the mesh network with two or more communication paths predominantly for improving the consistency of network. Wifi technology based wireless mesh networks are appropriate for the Internet of Things applications because of its stress-free installation and connectivity [7, 8]. Wifi is a wireless communication technology which is based on internet protocol and it is widely used due to quality communication and better data security in contrast to another physical layer technology.

In present scenario, the lack of resources is major problem existing in the world. Of those resource electricity and water are the most needed resource for human in their daily life. Based on increasing demand of electricity, we design IoT based energy grid used for controlling and monitoring the power consumption by the various electrical load. The agenda of the paper is to reduce the use of active power consumption. The technology oriented products are used to help people to reduce usage of electricity as well as use it for their primary need. To change the circumstances

with use of technology. IoT is used to send the data to cloud by machine, hence it reduces human work. Energy consumed automatically updated to the cloud by interfacing sensor to each load.

The objective of the paper to avoid energy wastage, satisfy the energy growing demand and to improve security, reliability of the energy grid we design innovative energy grid. The remainder of this paper is organized as follows. In Section 2, a novel design of energy grid system based on nRF mesh network is described briefly and the outline of the control flow and software design of the system. And in Section 3, the experimental result and prototype of the system is elaborated. Finally, a conclusion is drawn in Section 4.

2. Design of the system

The objective of this paper is to designing wireless mesh network for energy grid, and it communicates to internet. The IoT is the path used for information exchange between objects and Internet. IoT mainly consists of three main streams. First things oriented, in this paper we use sensors such as AC712 sensor, relay load, ATMEGA328, PC. Second internet oriented, we communicate through RF protocols such as NRF2401, ESP8266 http based Wifi. We are designing wireless mesh network for transferring sensor value with another microcontroller. This is the basic work of my research. Wireless mesh network is the promising paradigm for multi hop feature. The main contribution of mesh network is flexibility in terms of self-organizing. Third semantic oriented developing smart applications, we develop energy grid.

2.1. Block diagram

The block diagram explains IoT based energy conservation system. IoT have capability to interconnect billions of sensors for data collection. Block diagram organized as two sections namely Transmitter section, Receiver section. Transmitter section used to sense current value by using Acs712 sensor and send data to the receiver section. By using Acs712 sensor every electrical load electrical consumption measured and sends data to microcontroller.

Microcontroller interfaced with PC, Process and stores the data. After that it sends data to receiver by using NRF2401 protocol. We use low cost RF Sensor for wireless mesh network. Wireless mesh network provides Modular architecture, low cost, decentralized network, larger range, no loss of data, failure proof. In the receiver section data sense retrieved at receiver section PC using NRF receiver. After that receiver Microcontroller send the data to cloud by using http based Wifi protocol.

ATMEGA328 ports have features that make simple, process of control and monitor. ATMEGA328 has inbuilt SPI and I2C communication features with using chip select pin. Three registers in microcontroller namely SPI Control Register, SPI status Register, SPI data register used for communication. The advantage of the whole system is fastest implementation and no loss of data.

2.2. Flow chart design

The firmware was presented based upon block diagram components. Flowchart explains the functionality of whole implementation. Initialize the process by power on the circuit. After that configure the sensors by using serial peripheral Communication. Electrical load interface in the block by using relay. Three types of electrical load are present. In this paper we use resistive load. By using microcontroller, data in the electrical load fetched and coded using memory. Data automatically uploaded to transmitter section of nRF module. nRF receiver section retrieved the data and sends it to core Microcontroller. Eventually machines communicate with internet.

Microcontroller sends the data to cloud by using Wifi module. First configure Wifi module by interfacing both ATMEGA328 microcontroller and nRF transmitter as well as Receiver. After that for transmission of data vice versa. Connect microcontroller transmitter to nRF receiver as well as nRF transmitter to Microcontroller receiver. The cloud stored the Data send by the Microcontroller and responds with reference of data. The Mesh network is depicted in Fig. 1, the corresponding flowchart is shown in Fig. 2.

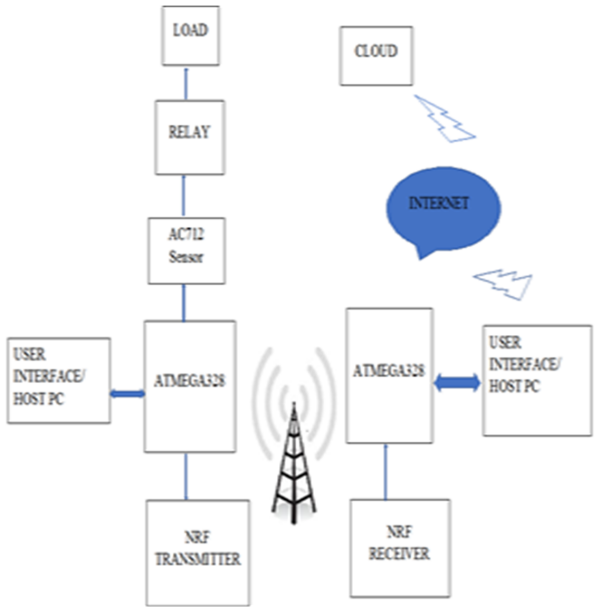

Fig. 1. Scheme of mesh network

3. Experimental results

The hardware and software implementation of energy grid prototype shown below. The aware of current consumption by customer is essential, because of high demand on energy resource. With the strength of IoT technology user can measure

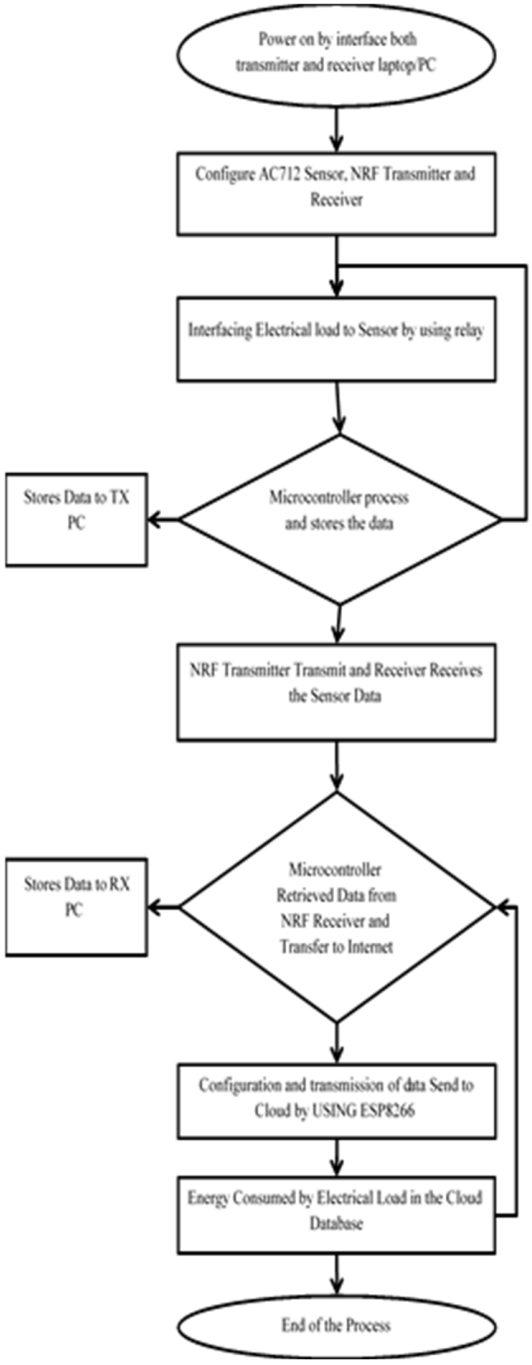

Fig. 2. Flow chart for basic mesh network

their current consumption by each load. We design simple kit of mesh network by using one electrical load.

3.1. Hardware implementation

The hardware prototype for mesh network based energy grid shown below. The developed board is multihop connection and use two protocols namely nRF2401 and ESP8266 used for communication. Energy consumption can read from AC712 sensor. The developed prototype has features such as good efficiency, simple design and low power. The prototype of grid using the mesh network is in Fig. 3.

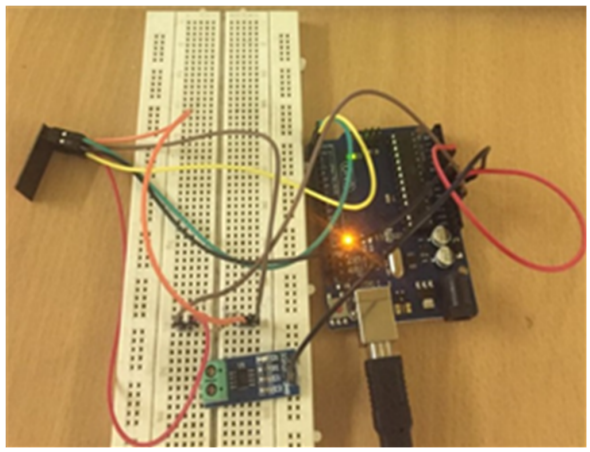

Fig. 3. Prototype of simple energy grid using mesh network

3.2. Visualization of data from cloud

The current consumption by single load for the consumer shown in the figure data from cloud by using things we speak software. The graph shown in Fig. 4 is the web server output current data received by ESP8266.

By using this data user can control and monitor the whole system. Sensor value is retrieved as graphical representation. The user can get data of utilization of energy by their electrical load. So that we concentrate on saving energy.

4. Conclusion

Design and implementation of wireless mesh network, IoT-based energy grid for saving energy is developed. Due to impact of energy crisis in this world, humans must concentrate on energy conservation. IoT technology helps with high potential features for analysis, monitoring and controlling functions for variety of applications. The developed protocol is the basic for my research idea. This paper focus on energy transmission, consumption. In future, we aim at generation of energy by using solar

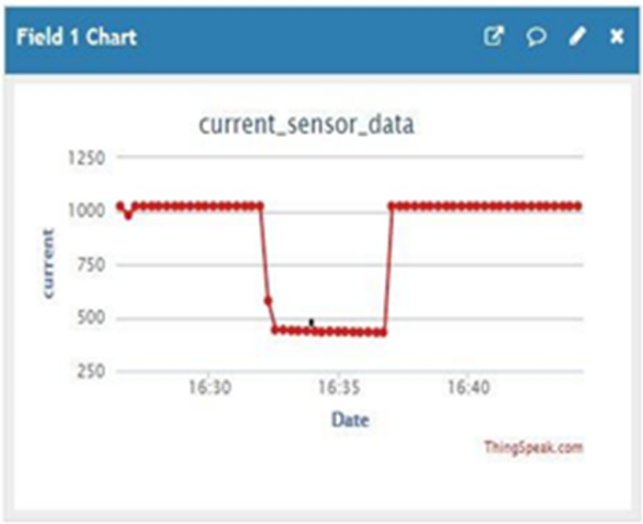

Fig. 4. Screenshot of energy meter current consumption data by electrical load

energy and distribution by using more number of electrical loads. We designed only using single electrical load in this paper. But our proposed work investigation towards energy grid for apartment blocks. Another important area must concentrate on gateway. In IoT technology, it is necessary to provide high end security introduce gateway concepts and focus on energy saving by demand energy management.

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