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Vehicle Assisted Device To Device Data Delivery for Smart Grid

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Abstract:

Smart grid (SG) has recently attracted much research attention from both the power and communication fields. SG refers to a modernized and advanced power system that aims to monitor and deliver electric power consumption information in a more efficient and reliable manner by incorporating state-of-the-art communication, computing, and control technologies into the traditional power grid.A smart grid management system in a home/community is necessary to be organized by integrating services, thereby reducing the workload. At home grid can be utilized by manual switching. This conventional manual switching method has to be overcome by an easier method of switching. This can be done using an advanced switching method like a remote control for electrical home appliances. Here we are using a technology known as Internet of things (IoT), in which we can wirelessly operate home appliances by communicating IoT module with the controlling system. At home, consumed units information is sent to the authorized person/community using Zigbee communication thus forming HAN (Home area network). The received information is displayed on LCD and uploaded to the web server using IoT from the receiver to view the information using internet thus it forms a RAP. The main system of the project is ARM1176 microcontroller to which all input outputs are interfaced.

This project uses regulated 3.3V, 500mA power supply. 7805 three terminal voltage regulator is used for voltage regulation. Bridge type full wave rectifier is used to rectify the ac output of secondary of 230/12V step down transformer.

Keywords: ***Raspberry Pi Board (ARM11), ZIGBEE Module, Current sensor [ACS712], IoT Environment, Raspbian OS (Linux) QT Creator.***

1. INTRODUCTION

Smart Energy has been an important conceptual paradigm for future energy use. Because of limited nonrenewable energy resources available on Earth and also high costs of acquiring renewable energies (REs),the ways to use energy more efficient and effective is critical for future social and economic developments [1], [3]. Managing smart grids to deliver smart energy require advanced data analytics for acquiring accurate information and automated decision support and handling events in a timely fashion. Significant progresses have been made for using field data obtained from intelligent devices installed in substations, feeders, and various databases and models across the utility enterprises. Some of the examples can be found in and references therein.

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Typical information sources include market data, lighting data, power system data, geographical data, weather data which can be processed and converted into information and knowledge that can be used for state estimation, situational awareness, fault detection and forewarning, stability assessment, wind or solar forecasting. Information acquisition is a key for timely data sensing, processing, and knowledge extraction. So far, the most talked-about information about power network operations is from data collected from intelligent electronic devices installed in substations and various parts of the transmission and distribution networks. In recent years, smart meters are being installed in homes and other premises in many regions of the world [2].

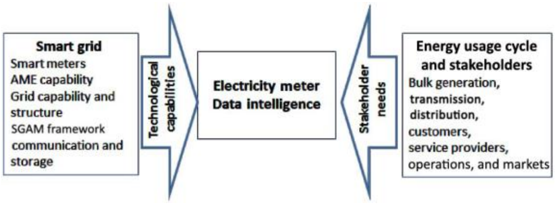

Figure 1: Environment for smart grid data intelligence.

To describe the components of smart meter data intelligence, it is necessary to understand the environment they exist. Fig. 2highlights the main environmental factors being the SG, which provides the infrastructure and the stakeholders who generate the need for, smart metering. Key elements which make up the environment are described below. The environmental factors presented in Fig. 2 provide the "bigger picture" for metering intelligence and positions the components presented in Fig. 1within the smart-metering environment. The energy usage cycle and stakeholder information are based on NIST classification.

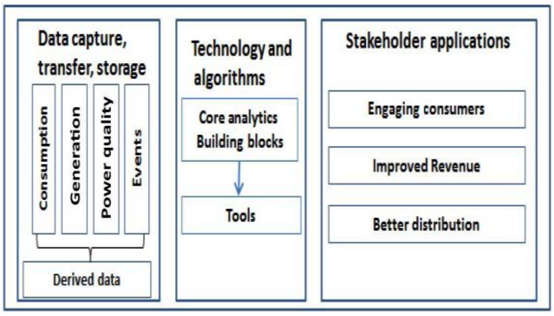

Figure 2: Smart grid data intelligence framework.

The rest of this paper is organized as follows. The architecture is presented in Section II, and detailed hardware and software implementations are described in Section III. Project Implementation methodology in Section IV. Finally, we conclude our work with results in Section V.

II.SYSTEM ARCHITECTURE

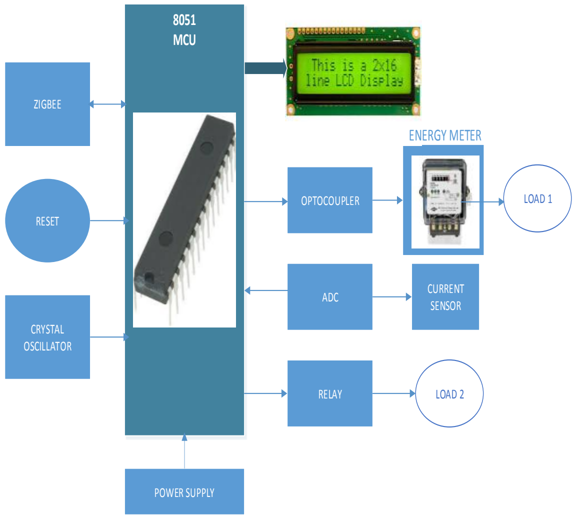

Figure 3: Transmitter section

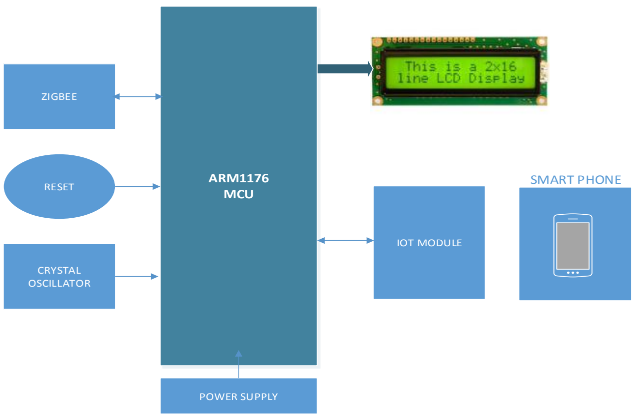

Figure 4: Receiver section

Firstly to identify the worker, each worker will be having different tag. Once the tag is identified, person's data will be sent to the PC through ZIGBEE [5]. In order to check whether the worker has been using the helmet or not, IR sensors are used to check the helmet presence. The surrounding hazardous gases will be detected by the gas sensor present in the helmet. When gas is detected

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voice notification will be given through speaker. By the use of MEMS sensor [2], the head injuries occurrence will be identified. All the data related to sensors will be posted into the PC through ZIGBEE transceiver.

III.HARDWARE IMPLEMENTATION

3.1. Raspberry Pi Board

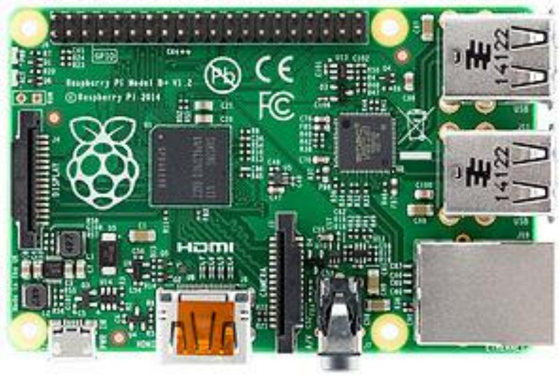

Figure 5: Raspberry Pi3 Board

The compute module is intended for industrial applications, it is a cut down device which simply include the BCM2835, 512MB of SDRAM and a 4GB eMMC flash memory, in a small form factor. This connects to a base board using a repurposed 200 pin DDR2 SODIMM connector [4]. Note the device is NOT SODIMM compatible, it just repurposes the connector. All the BCM2835 features are exposed via the SODIMM connector, including twin camera and LCD ports, whilst the Model A or B/B+ only have one of each.

The compute module is expected to be used by companies wishing to shortcut the development process of new product, meaning only a baseboard needs to be developed, with appropriate peripherals, with the Compute Module providing the CPU, memory and storage along with tested and reliable software.

3.2. ZIGBEE Technology

ZigBee modules feature a UART interface, which allows any microcontroller or microprocessor to immediately use the services of the Zigbee protocol [6]. All a Zigbee hardware designer has to do in this is ensure that the host's serial port logic levels are compatible with the XBee's 2.8- to 3.4-V logic levels. The logic level conversion can be performed using either a standard MAX-232 is directly connected to the XBee UART. Tarang modules are designed with low to medium transmit power and for high reliability wireless networks. The modules require minimal power and provide reliable delivery of data between devices. The interfaces provided with the module help to directly fit into many industrial applications.

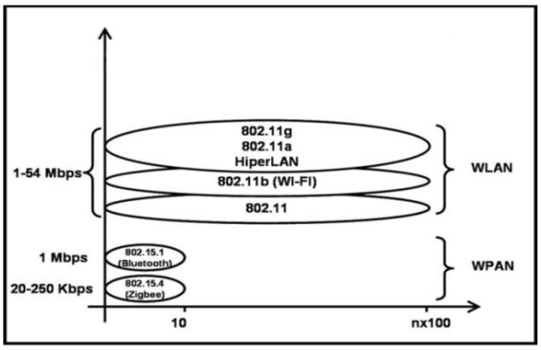

Fig 6. Various Wireless Technologies

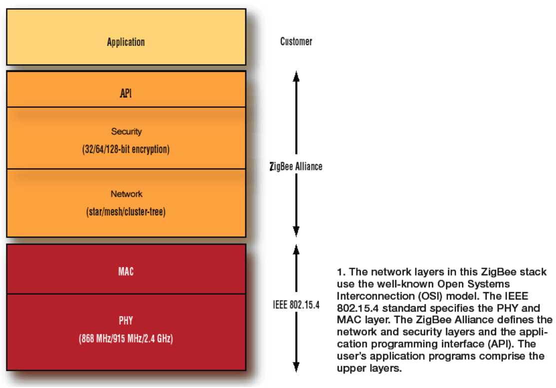

Fig 7. ZIG-BEE Architecture

3.3 IOT Application Gateway

The ARM11 is connected to a router with a wired serial connection. The router runs open source embedded Linux software, providing networking functionality to connect the internet. This essentially provides internet access to the ARM11 board. Router acts as an IoT application gateway and interconnects. A private IPv6 network using a Virtual Private Network (VPN) [7] is used for connecting the IoT application gateway to the server.

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The server collects sensor data forwarded by the application gateway and store in a database for further processing and then to be viewed via a website. Data can be viewed in terms of previous day, week, and month time periods graphically. In the present setup, heterogeneous sensing units are designed and developed indigenously for intelligent home monitoring systems to integrate with IoT networks.

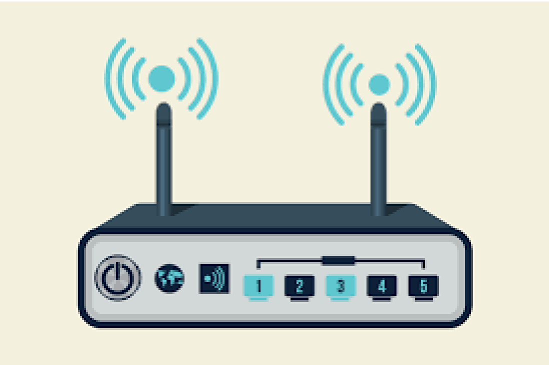

Figure 8: Internet Router

The Linux-Open WRT software provides the networking architecture to participate in many types of networks. These networks are abstracted into devices, which generalizes management and configuration. This abstraction requires device drivers which operate in the kernel space, making development difficult. A TUN/TAP device driver acts as a virtual network device with its output directed to a user space program instead of a physical device. This simplifies the development of a network device, as a user space program is easier to develop

3.4 HALL EFFECT-BASED LINEAR CURRENT SENSOR [ACS712]

The device consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper-stabilized BiCMOS Hall IC, which is programmed for accuracy after packaging. The output of the device has a positive slope (>VIOUT(Q))when an increasing current flows through the primary copper conduction path (from pins 1 and 2, to pins 3 and 4), which is the path used for current sensing. The internal resistance of this conductive path is 1.2 mΩ typical, providing low power loss. The thickness of the copper conductor allows survival of the device at up to 5× over current conditions. The terminals of the conductive path are electrically isolated from the sensor leads(pins 5 through 8). This allows the ACS712 current sensor to be used in applications requiring electrical isolation without the use of opto-isolators or other costly isolation techniques.

The ACS712 is provided in a small, surface mount SOIC8 package. The lead frame is plated with 100% matte tin, which is compatible with standard lead (Pb) free printed circuit board assembly processes. Internally, the device is Pb-free, except for flip-chip high-temperature-based solder balls, currently exempt from RoHS. The device is fully calibrated prior to shipment from the factory.

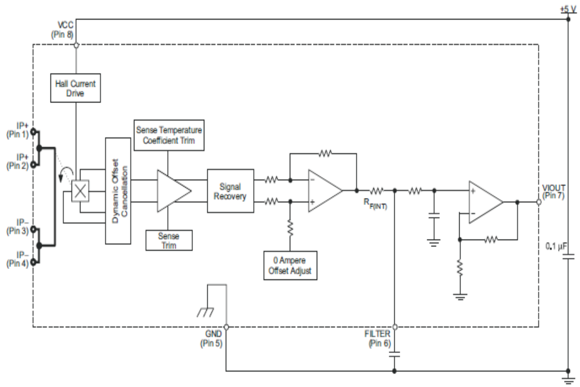

Figure9: Sensor Functional Block Diagram

3.5 OPTOCOUPLER

In electronics, an opto-isolator (or optical isolator, Optocoupler, photo coupler, or photoMOS) is a device that uses a short optical transmission path to transfer a signal between elements of a circuit, typically a transmitter and a receiver, while keeping them electrically isolated — since the signal goes from an electrical signal to an optical signal back to an electrical signal, electrical contact along the path is broken.

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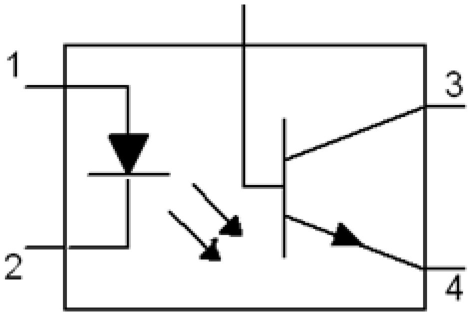

Figure 10: Optocoupler

With a photodiode as the detector, the output current is proportional to the amount of incident light supplied by the emitter. The diode can be used in a photovoltaic mode or a photoconductive mode. In photovoltaic mode, the diode acts like a current source in parallel with a forward-biased diode [6]. The output current and voltage are dependent on the load impedance and light intensity. In photoconductive mode, the diode is connected to a supply voltage, and the magnitude of the current conducted is directly proportional to the intensity of light.

IV IMPLEMENTATION METHODOLY

A smart-Grid system framework has been proposed in the past, but it only looked at consumer characterization and not holistic view of the complete smart-metering process and environment. The proposed framework is expanded and enhanced in this section consisting of two key components. The top part depicts the current smart-metering scenario: the data aspects, stakeholder needs-based applications, and technology tools and algorithms that attempt to support the application needs from the available or derived data. Current technologies and algorithms are shown a score analytics building blocks that are realized using different tools.

V.EXPERIMENTAL RESULTS

The developed system is tested by installing the Smart sensing units and setting up an IOT based system. Interconnecting IPv6 network is performed by connecting and configuring the modified router (IoT application gateway) as discussed in section III. Integrated system was continuously used and updated real-time sensing information to the server over an IOT environment.

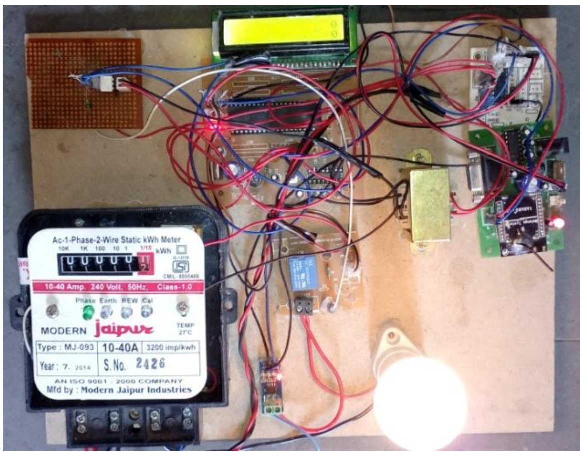

Figure 11: Transmitter section

When the load is connected to the meter the reading will vary according to the current units utilized. The current units measured using current sensor interface to the microcontroller at the transmitter section. The same reading will be send to the receiver section.

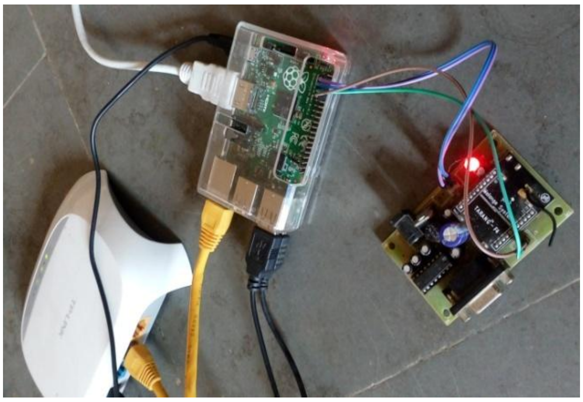

Fig 12: Sensor values shown at the receiver section pc

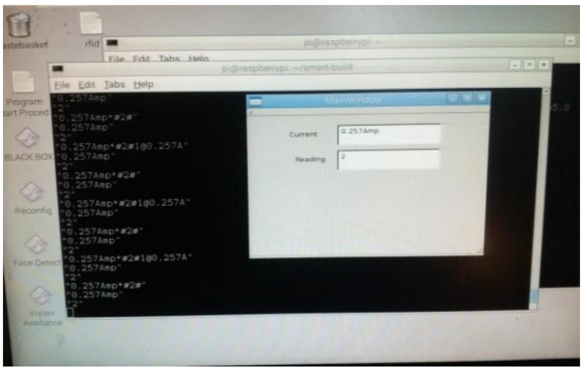

Fig 13. Screen shot of smart grid values

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VI.CONCLUSION

The proposed smart grid system, which incorporates Ethernet module in a ARM11 using Zigbee, has been successfully implemented. The Raspberry PI(ARM11) connection bridge interfaced the ZigBee module to the UART Port. The use of the Zgbee module made the wireless transmission of the meter data possible through the wireless to the receiver and the output can be observed in web. The transmitted data were received at the receiver and were further connected to server through IOT module. So data, specifically the voltage consumption, can be accessed by consumers through the built website.

VII FUTURE WORK

Future work will include a comparative study between the proposed system and other wired system, focusing on energy efficiency, Smart Grid capabilities and installation and Maintenance costs.

Further implementations will be done in order to extend the proposed system to other standards or technologies of lamps, luminaries or lightning communication and control protocols.

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