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IOT AND BIGDATA ANALYTICS APPROACH USING SMART HOME ENERGY MANAGEMENT SYSTEM

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Abstract - The emerging technologies of Internet of Things *(IoT) and Big Data can be utilized to better manage energy consumption in residential, commercial, and industrial sectors.*

This paper presents an Energy Management System (EMS) for smart homes. The data acquisition System on Chip (SoC) module collects energy consumption data from each device of each smart home and transmits the data to a centralized server for further processing and analysis. This information from all residential areas accumulates in the utilitys server as Big Data. The consumers, being aware of their consumption behavior and having a close interaction with the electricity utilities, can

adjust and optimize their power consumption and reduce their electricity bills. IoT also enables seamless remote access control of home devices where the customers get online access to the ON/OFF usage pattern of in home appliances via a personal computer.

***KeyWords*: Big Data Analytics, Energy Management System, HVAC, Internet of Things, MQTT, System on Chip.**

1. INTRODUCTION

Energy efficiently using in smart homes save money. The need for smart energy management for smart homes and for smart cities in general. The large quantity of data collected from different cities for countries present multiple challenges in data storage, organization and analysis. so we use Internet of Technology(IoT) and Big Data. IoT technologies can provide a ubiquitous computing platform to sense, monitor and control the household devices energy consumptions on a larger scale. This data collected using different wireless sensors. Wireless sensors installed in residential units. Similarly, Big Data technology collect and analysis the large amount of data. The data can be monitored and collected ,analysis using predictive analysis and advanced method to perform generate graph and reports. The consumers being aware their power consumption details and the consumers being close interaction between the electricity utilities. The users can adjust and optimize the power consumption and reduce the electricity bills. Additional advantages of IoT also enables remote access and control the devices. The customers get online access to the ON/OFF usage pattern of home devices via personal computers.

Big Data means that large volume of data generated from sensors, temperature sensors and various other software applications and digital devices that continuously generate large amounts of structured, unstructured data. McKinsey Global Institute [20] defined big data as the size of data sets that are a better database system tool than the usual tools for capturing, storing, processing, and analyzing such data [18].The bigdata characterize three types they are: data sources, data analytics,the presentation of the results of the analytics. IoT offers platforms for sensors and device communicate via smart environment and enables information sharing across platforms in a convenient manner. IoT developing intelligent systems, such as smart office, smart retail, smart agriculture,smart water, smart transportation, smart healthcare, and smart energy.

Big data analytics is rapidly emerging as a key IoT initiative to improve decision making. One of the most prominent features of IoT is its analysis of information about "connected things." Big data analytics in IoT requires processing a large amount of data and storing the data in various storage technologies. The IoT and Big Data analytics approach using energy management system main aim is consumers being aware their power consumption details.

The rest of the paper is organized as follows. In section 2 relationship between IoT and Big data analytics. Section 3 proposed system. In section 4 system architecture. Section 5 result and discussion. Finally section 6 concludes the paper.

2. RELATIONSHIP BETWEEN IOT AND BIG DATA ANALYTICS

Big data analytics is rapidly emerging as a key IoT initiative to improve decision making. One of the most prominent features of IoT is its analysis of information about "connected things." Big data analytics in IoT requires processing a large amount of data and storing the data in various storage technologies. The relationship between IoT and Big Data analytics figure shown in below:

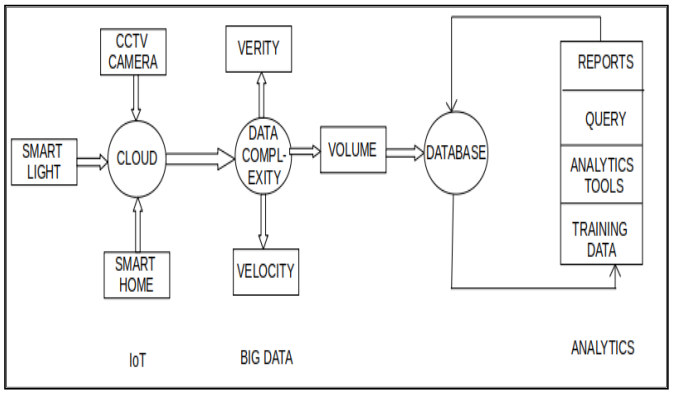

Figure -1: Relationship between IoT and Big- data analytics

The above figure divided in to three steps, The first step is comprises and managing IoT data sources. Connected sensor devices use applications to interact with one another. For example that interaction of devices such as CCTV camera, smart traffic lights and smart home devices, generate large amount of data sources with different formats. This data stored on the cloud. Second step, generate data are called "big data". which are based on their volume, velocity and variety. These huge amount of data stored in big data files in shared distributed fault tolerant databases. The last step applies analytic tools. The analytics tools contain four levels. The analytics tools start from training data, analytic tools, query, report.

3. PROPOSED SYSTEM

- The SoC should gather power consumption information periodically, and send it to a centralized server.
- The server should parse the information and transmit the readings to a central data storage system or database.
- The stored data should be used by analytic engine to process and generate reports, graphs, and charts.
- Clients should be able to view the generated graphs through a personal computer.
- client application interact with server via web.
- Different services provides user such as viewing reports, device status, and remote control of device or bill payment.

4. SYSTEM ARCHITECTURE

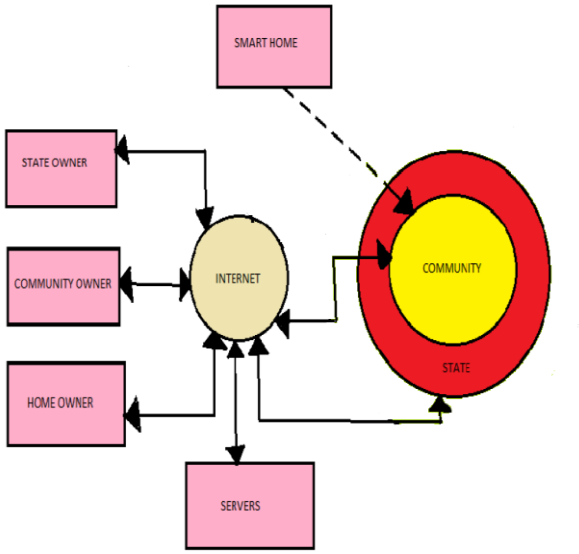

Figure -2: System Architecture

The architecture contain both hardware and software parts:

4.1 HARDWARE ARCHITECTURE

Sensors and actuators: The IoT Power Relay you can easily control the power going to a device with an Arduino, Raspberry Pi or other microcontroller. A solid state relay is controlled by the microcontroller to switch ON/OFF the devices accordingly.A current sensor is used to measure the AC current to calculate. The power consumption. Temperature sensor is used to measure the temperature.

RFID technology and its applications in Internet of Things (IoT) Radio frequency identification system (RFID) is an automatic technology and aids machines or computers to identify objects, record metadata or control individual target through radio waves. RFID is often seen as a prerequisite for the IoT. RFID uses electromagnetic fields to automatically identify and track tags attached to objects. The RFID technology is a means of gathering data about a certain item without the need of touching or seeing the data carrier, through the use of inductive coupling or electromagnetic waves. The data carrier is a microchip attached to an antenna (together called transponder or tag), the latter enabling the chip to transmit information to a reader (or transceiver) within a given range, which can forward the information to a host computer.

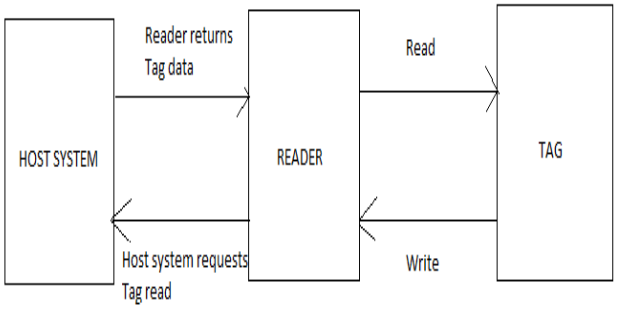

Figure -3: RFID reader

RFID reader device that activates the tag and retrieves the information stored in its internal circuit (IC). An RFID reader sends and receives signals with the help of the reader antenna. An RFID reader, also known as an interrogator, is practically a bridge between the raid host system and the reader antenna.

RFID host system that manages the flow of data between the readers and tags. A RFID host system can also have a more complex structure, where different readers are located across different locations and data flows to the host computer through LANs or the internet. RFID tag that is attached to or embedded in an item that you need to track.

- **High end microcontroller:** A SoC high end microcontroller is used for collect the data periodically from sensor. It is basically used in communications and in controlling or operating many devices. It has 14 digital input/output pins (of which

  6 can be used as PWM outputs), 6 analog inputs,a USB connection, a power jack, a reset button and more. It contains everything needed to support the microcontroller, simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

- **Servers:** In the proposed architecture, the servers act as high end pCs.The server stores the data.

4.2 SOFTWARE ARCHITECTURE

Software architecture consist of three modules. They are,

- **Data acquisition module:** Data acquisition is the processing of measuring electrical or physical signal such as current,temperature. Sensor is the measurement of physical phenomena such as the temperature of the room. A sensor, also called a transducer, converts a physical phenomenon into a measurable electrical signal.

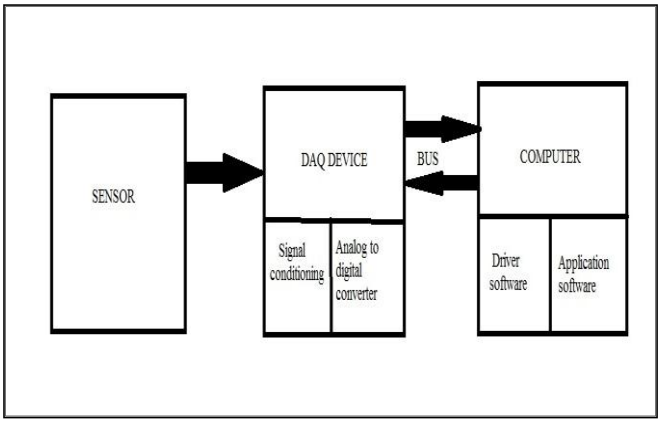

Figure -4: Data acquisition

DAQ hardware acts as the interface between a computer and signals from the

outside world. Signals from sensors or the outside world can be noisy or too dangerous to measure directly. Signal conditioning circuitry manipulates a signal into a form that is suitable for input into an ADC. Analog signals from sensors must be converted into digital before they are manipulated by digital equipment such as a computer. Computer bus is DAQ devices connect to a computer through a slot or port. The computer bus serves as the communication interface between the DAQ device and computer for passing instructions and measured data.

Data acquisition module performs two functions namely monitoring and controlling. The monitoring function continuously read temperature and AC power consumption's. The reading also transmit to middleware module through MQTT protocol. The control function is used to receive the commands from the middleware module to turn ON/OFF the AC Units accordingly.

- **Middleware module:** The middleware module provides several services:

  1. MQTT Server:MQTT server or broker is use to medium for the communication between the edge device (home appliances such as AC-Unit) .The broker side access control was enforced to prevent unauthorized access to certain topics. Some topics are consumption reporting topic and device state change reporting topic is configured as write only. Only those with required privilege can read what is being published. Topics like control command. It is

configured as read only. Unauthorized controlling of device is prevented.

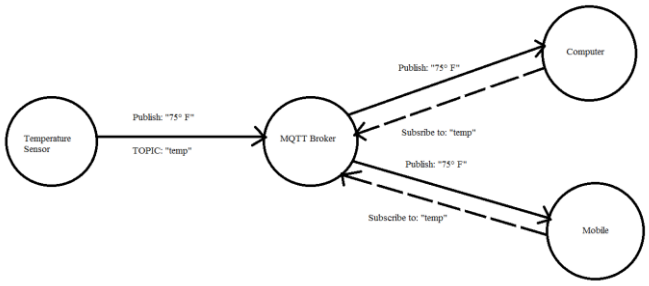

Figure -5: MQTT Broker

a) Publish/Subscribe:

The first concept is the publish and subscribe system.

In a publish and subscribe system, a device can publish a message on a topic, or it can be subscribed to a particular topic to receive messages. In above figure(5) publish is ”75 degree F” and subscribe is ”temp”.

b) MQTT Messages:

Messages are the information that you want to exchange between your devices. Whether its a command or data.

c) MQTT-Topic:

Another important concept are the topics. Topics are the way you register interest for incoming messages or how you specify where you want to publish the message. In above figure(5) topic is ”temp”.

2. Storage Server: A highly scalable storage server is used. Because data warehouse for storing the edge devices sensor data details and user information. It can handle the generated Big Data from residential units as well as scale up to more residential areas that can be added in future. Use a high performance and scalable database and store the information related to users, user-house relations and house-device relations.

3. Analytic Engine Server: The measured data is classified based on temperature and power consumption. This classification is used to generate reports, graphs, and charts that identify the consumption pattern of the houses in a residential area.

4. Webserver: The client application accesses the operational database through different web services implemented using PHP. These services are used to transmit data to and from the database and send it back to the requester. Web services are used by the client application to authenticate monitor and control devices, view registered device status, and view registered devices, monthly bill viewing/paying and viewing graphs appropriate to the level of the user.

- **lient application module:** A cross-platform IDE was used to develop the front end PC user interface.

5. RESULT AND DISCUSSION

In this section the hardware and software components used in the system prototype are described in details as follows:

A) HARDWARE

The hardware consists of a sensor, high-end microcontroller, and relay banks. The sensor collects the device status and reports it to the microcontroller periodically. The microcontroller is a high end single SoC on the edge that collects the information from the sensors and forwards it to the servers for further processing via MQTT broker. To implement remote controlling of devices through client application, the microcontroller reports the status of the device whenever the state of device is changed. To enable the billing utility process, the microcontroller transmits the power consumption of the device to the servers via the MQTT protocol.

B) SOFTWARE

There are two services available for home owner. First is monitoring the power consumption of house devices. Second is a remote control service (ON/OFF) for house device. For the bill tracking services, the user can view the monthly bill and pay the amount in online. The state owner can view the power and temperature related graph.

6. CONCLUSION

The proposed work is set to open new avenues for smart energy management on IoT and Big Data platform. The system design uses data analytics and scalable storage for building a smart EMS to aid different stakeholders with their respective privileges. The system empowers users to remotely monitor and control devices, an online bill generation via a friendly user interface Pc application.

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