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Edge Computing-Based Smart Electric Meter for High-Speed Data Processing

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ABSTRACT

The concept of smart grid is rapidly expanding and the people desire to know more feasible methods. They are methodical in the collection and processing of information. Real time realised data capturing With conventional electric meters there is little that can be done with the average. It uses a lot of data or a frequent frequency of data and needs a central cloud. This may prove to be, inefficient since such traffic will be relayed on proxy servers hence will reduce efficiency. The challenge can be reduced to latency, bandwidth bottleneck and security threat. Among the solutions are In this project, it is proposed to indentify and design an Edge Computing-Based Smart Electric Meter. Assist with the answers to these issues. The proposed system introduces the perimeter Computing to the smart meter can be done itself. This can help the layer to acquire real time information. Locally store information and supporting data in relation to energy use. device itself. Edge computing implies that not so much is supposed to be pinned on. The fastness of the system is assured since they can be stationed far away in another location. Time and bandwidth can be seen as Load-sharing capacity that goes in operation on demand and, therefore, enables the system to remain operational.

KEYWORDS: Intelligent Meter High speed data processing,Communication Low Latency, Smart Grid Real-Time Monitoring

INTRODUCTION

Energy is one of the most important requirements in our day-to daily life. We employ it to make and manage our homes, workplaces, factories etc. With the increased number of humans in the world, there has been a high level of consumption of electricity. This has a tendency to cause problems like power blackouts at the peak time. Our power systems have to be redesigned to be smarter and more potent to allow them to overcome these issues. Here the Internet of Things (IoT) is used. With IoT and digital technology, the cities now have a certain edge in energy management being done by smart cities. These solutions include smart grids, smart meters and energy efficient buildings, which help us reduce and declutter our reliance on traditional sources of energy. The fact that they induce ease of

incorporating the renewable power into the grid as sun and wind also becomes easy. Intelligent energy monitors that are interconnected in the manner of the IoT are deployed in order to facilitate this. Smart meters have the ability to automatically collect and transmit energy data instead of the older variants that were read manually. They show the real power consumption that enables them to point out the issues, including the unauthorized use of power. Not only do smart meters make it faster to bill but also provide the customers with information about their consumption of energy which could be helpful. Such openness makes people decide and save energy. Conventional meters take too long to read, create unnecessary workload, and have the probability of error whereas IoT-based smart meters give out data continuously and transmits in a secure way.

LITERATURE SURVEY

A literature check is an examination of books, papers, and other material that is connected with something.

Research statement/question It is quite significant to conduct literature check in the first stages of research.

each session. Authoring an article review will inform the collection about how our study is relevant.

The question which is going to be defined is what new things it will introduce. The aim of literature search

Pay attention to how much you differentiate in graphic information at the moment.

The assurance, that our satisfied is not a copy of another individual and is an original work.

Identify what you can't find out and issues where there has not yet been a research answer.

Design the simple framework and approach.

To provide information in various forms of writing. it demands intimate scrutiny of the data garnered through the bridging of spaces in existing knowledge.

It brings out the limitations of the idea and views and how one can look into the same.

to analyse other related topics

Smart electric meters are one of the subcomponents of the greater development of smart grids.

The subject has received scrutiny in the past years. Conventional electric meters primarily record the measure ofCfg cent

They just may not be able to handle data in real time but use a lot of it.

They are bandwidth, the requirement of centralized cloud servers to process data, and so on. These problems

Having to respond can be more difficult and lead to delays when lots of energy is involved.

consumption data.

In smart grids, researchers have proposed to use edge computing to circumvent these

The problems arose when the idea of advantage computer science was brought into the picture.

It has a move that is less dependant on cloud-based servers. Devices work with Collection lourcisms high-tech

Results in increased low latency, reduced bandwidth consumption and resiliency demonstrated that edge-enabled systems were a possible alternative.

Real-time monitoring is better performed using hyper convergence enabling real-time monitoring than by using cloud-only solutions.

It offers enough computing power to contact others and fault detection as well as recognition.

EXISTING WORK

Most smart electric meters installed today are little more than data repositories and send the data up to a cloud-based server or at their data center of the utility. Services that are hosted in the cloud include demand forecasting, anomaly detection and billing and usage analysis. Cloud systems because they provide central connectivity and are readily able to handle an increase but it equally has many problems. One of the greatest problems is delay. Things that need time-sensitive actions, like peak demand response and quick component tracking, can be impacted by the lag since all you are doing is sending the information to the cloud and then making the decision. Furthermore, transfer of bulky fluids on an on-going basis clogs the network, consumes band space and reduces efficiency of the systems. The failure of the network to reach the server before or after a transport due to a weak network or in the case of the network down, the information may not reach the server at an opportune time or at all. This makes energy monitoring ineffective This is potentially the worst, as privacy and safety are jeopardized because sensitive energy-related information circulates over the network and is subject to network hacking. In the present day smart meters, local intelligence is missing. Most of the calculations are handled on distant computers, as opposed to the meter. This is the reason they have not been able to perform higher functions in the smart meters including local anomaly detection, online forecasting, and dynamic energy pricing. This reduces them as inappropriate in attaining the quick and trustworthy data processing of smart grids. The disadvantages of the system are latency, network congestion, and links with considerable usage of bandwidth as the system heavily depends on cloud-based computing.

PROPOSED SYSTEM

The new system comprises Edge Computing-Based Smart Electric Meter to support processing and analyses of data on devices level, thereby reducing the shortcomings of the traditional cloud-based smart electric meters. Computational intelligence that has been integrated in the meter permits performing of real-time functions and issues related to energy control, tracking issues of energy anomaly, and load forecasts without any outsourcing to servers. The smart meter/edge contrasts with conventional meters which transfer raw data to cloud at a continuous rate and continuously perform most processing tasks (rather than transferring all information to the cloud). This saves much on latency, network congestion as well

as bandwidth making them faster in resolving decisions and easier to manipulate data. Further, the mechanism is also operative in the cases in which there is unstable network connectivity or a poor connection as local computations are carried out. The smart meter can also be used to dynamically manage tariff, make predictive forecast and detect anomalies right down on the meter. These features are also advantageous to utility providers since they facilitate effective dispersal of power and consumers can know real time information about power consumption to use as a guideline in energy saving measures. The privacy of data and security is a pertinent issue of the system. Sensitive data on users are encrypted locally, access limited, and secure communications channels employed, and thus cannot be accessed by any unauthorized person or a hacker. The design is also highly scalable and dependable, attributes that make it suitable to apply on large infrastructures of smart grids. Lastly, the proposed edge and enabled smart meter can become a reliable and safe, yet speedy and intelligent technology in controlling energy.

METHODOLOGY

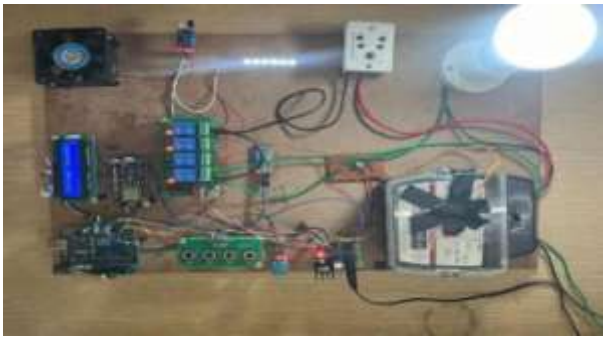
An IoT based smart meter has a few steps which are followed to ensure the developed system is useful and secure, plus reliable. Planning, system design, hardware and software integration, testing and deployment are the major stages. The initial stage is planning and analysis of requirements. In this phase, the objectives of the system are identified, including accurate monitoring of the energy, minimizing power losses or/and facilitating real-time decision-making. The stakeholders such as utility providers, technology developers and the consumers are identified. There is also a feasibility study to determine whether the project is viable technically, financially and practically. The follow-on step is system design This is where the system architecture is designed consisting of sensors, communication device and processing units. Appropriate devices, including current / voltage sensors, Arduino / ESP32 boards and IoT gateways, are chosen. There is also power backup, e.g. through use of batteries or solar panels as long as the meter must have power at all times regardless of the conditions. The hardware integration phase concerns the connection of sensors and microcontrollers, installing data gathering and processing software and interconnecting IoT gateways. Contemporaneously, software integration provides that data is transferred properly between the device and the server or the cloud. This is in form of hardware programs in the meter and data storage and visualization programs. At the end of the integration process testing and validation occurs. Each of the components is also tested in accuracy and their reliability. The whole system is evaluated in the laboratory and in the real world, to ensure its functionality.

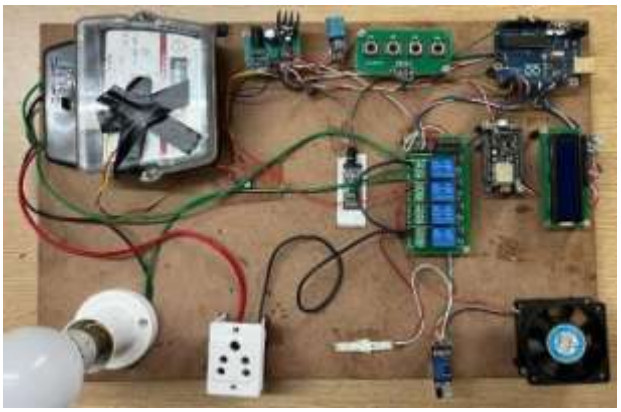
EXPERIMENTAL RESULTS

The proposed Edge Computing-Based Smart Electric Meter was put into testing to understand its functionality with respect to the traditional cloud-based meters. The experiments concentrated mostly

on speed, consumption of bandwidth, reliability, and security. It was observed that the edge-based meter operated at a faster rate compared to cloud system. This is because when calculating most calculations were made locally on the meter and therefore the average response time was about 50 to 100 milliseconds but in cloud-based systems it took 400 to 600 milliseconds. Such quick response is particularly helpful in faster tasks such as real-time anomaly detection and managing peak loads where the latency can have an impact on performance. When compared with network usage, the new system had a significant reduction in the use of bandwidth. Rather than transfer uncrunched data constantly to the cloud, the smart meter only transferred processed and significant data. This saved data by nearly 60-70 percent thereby decreasing network traffic congestion and also making it more efficient in case of poor network connectivity. It also stored the data in the meter even though the internet was not available, thus preventing data loss. This is due to the fact that as the connection was made once again the data was communicated to the central server and no data was lost. The smart meter could also execute analytics within the device, including dynamic tariffs, load forecasting and potential anomalies. This provided the utility providers with a quicker understanding on power distribution as well as enable consumer to get a live picture on their energy consumption.

SNAPSHOTS





CONCLUSION

The advanced automated technology replaces human labour with a complex automatic workout. There is the effect of ensuring that meter accuracy is improved and maintenance costs are reduced. There are two components in this proposed automated system. One is at the office of the Electricity Board and comprises an office and a back end server that connects to the database. The other element is the customer home part that the customer places in the home. This module measures the power consumption of the customer and transfers the data to PC in the EB office. This EB office branch computing unit prepares bills and dispatches them to the customers through PLCC. It also informs the user to the amount of electricity he consumes at home. The offered solution uses an existing power line. It probably appears to be the most practical and flexible approach when compared to the others in terms of cost. Therefore, this method is to a large extent beneficial since precise consumption data can be easily obtained. It has accurate and precise billing completed.

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