Energy Management Scheme is a Scheme for Managing Energy in Green Iot Environments

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Abstract— The Internet of Things (IoT) offers a wide range of applications in fields such as business, military, security, and health care. Most IoT node designs are known to be energy restricted. As a result, one of the most essential issues in IoT research is maintaining an appropriate energy consumption rate. An IoT Energy Management Scheme (EMS) is proposed in this study. Different sorts of energy-constrained nodes are studied in this system. Three strategies are included in the planned EMS. The first technique reduces the amount of data that may be sent through the Internet of Things. The vital energy IoT nodes' work is scheduled in the second strategy. The third technique presents a fault tolerance scenario that can be used to address the energy issues that IoT nodes will inevitably confront. Finally, the NS2 network simulator is utilised to create an elaborate simulation of the IoT in order to test the proposed EMS. The suggested EMS beat the typical IoT system in terms of energy consumption rate, number of failed nodes due to energy loss, throughput, and network longevity, according to the simulation findings.

Keywords: Internet of Things (IoT), Energy Management Scheme (EMS)

I. Introduction

In recent years, the Internet of Things (IoT) has changed the world like the Internet did. The IoT has been considered to be one of the most important research topics. The IoT can be defined as billions of passive and active networked devices communicating with each other [1]–[3]. The communication between IoT devices can be achieved anytime and anywhere using services by any links. The IoT is a heterogeneous environment that incorporates many different nodes such as sensors, RFID tags, RFID readers, and mobile devices. In addition, there are many IoT applications in all aspects of our lives, such as military, security, marketing, and healthcare [4]–[6]. The Internet of Things is more than just a data transmission network; it's also a system with protocols, events, and big data processing. Furthermore, because the Internet of Things was not designed to need human participation, artificial intelligence applications might be applied in this sort of setting. The growth of IoT technology presents possibilities as well as threats.

There are a few Many issues in IoT research themes such as data processing and storage, routing, Multimedia transmission, security, communication, and energy management are being coordinated by the associate editor who is directing the review of this paper Energy-based IoT nodes may be used for a variety of applications, including wireless sensor networks (WSNs), radio-frequency identification (RFID) networks, and mobile ad hoc networks (MANET). Regrettably, the majority of studies attempt to create protocols or strategies to or special networks. Due to the diverse nature of the IoT ecosystem, this cannot be used. As a result, determining a single approach to reduce energy use is challenging (if not impossible). The varying software and hardware requirements, as well as the functions each energy-based node, help explain this. As a result, an IoT Energy Management Scheme (EMS) is presented in this work. There are three basic tactics in this system. The first option entails using strategies to limit the quantity of data sent or received by energy-based nodes. The second technique includes a work methodology for reducing the amount of energy used by each IoT node. To compensate, the third option includes a failure tolerance scenario for energy-based node failures

A. *Keywords*

- Development of a methodology to conserve energy in IoT energy-based nodes
- Design of a fault tolerance scenario for IoT energy-based nodes;
- Use of data reduction techniques in the IoT environment;
- Building a simulation testbed for the IoT ecosystem;
- Presenting and debating the simulation findings

II. The Proposed Energy Management Scheme (EMS)

The proposed EMS is specifically designed for the IoT environment. The main purpose of EMS is to consider the power problem at nodes based on different power in the IoT environment. To achieve this goal, the proposed EMS design must consider a number of alternative solutions and ideas. This is because IoT power-based nodes differ in their nature and specificity. The concept of EMS is based on the use of three basic strategies. These strategies are: reducing data transfer in the IoT environment, setting up power-based node processes, and providing error tolerance. The concept of EMS is based on the division of power-based nodes into classes according to their types so that each class has a specific type of node (i.e., sensors, RFID, and cellular). EMS strategies can be used in each class. One or more strategies may work in one class depending on its specificity and environment. The sections below discuss each EMS strategy in addition to the standard EMS algorithm that describes how the proposed EMS works.

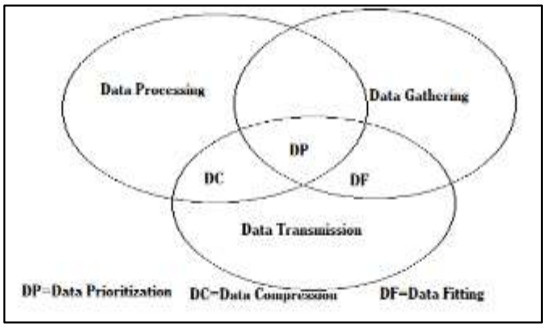

Fig. 1:

A. Strategy 1: Determination of Data

In the IoT environment, there are many relationships that integrate power issues with data. Data is considered one of the main forces consuming nodes. This is because there are many types of data processing, such as data collection, processing, and transfer, which contribute to the level of power used in IoT nodes. Reducing the amount of data in the IoT environment will have a positive impact on energy consumption. The implementation of the data reduction process varies from one power-based node category to another. Each class has its own tasks and data to deal with. For example, the sensory sector has the ability to collect, process, and transmit its data, but the RFID phase in particular has the ability to transmit only its own data. In order to address this issue in the data reduction model, each class must be identified or the identification of each node should include its class. In addition, the variability in the use of data reduction methods is due to the variability of IoT power-based nodes. Therefore, the data reduction process in EMS includes data prioritization, data compression, and data entry. The data collection process can be used for a class with data transfer and collection skills. The data prioritization process can be applied to classes that specialize in data collection, processing, and transfer. The data compression process is used by a class capable of data transfer and processing capabilities

1) Prioritization of Data

It is important to note that, in the case of IoT network congestion problems, IoT data should be prioritized. The data prioritization method used in EMS is based on line-based theory. Data is prioritized in classes 'n'. Each data class will be processed in a separate line. If data is prioritized in more than two classes, the size of the data, whose service may be delayed (or ignored), will increase; which, in turn, results in a reduction in the data that will be stored, thereby reducing the amount of data that will be transmitted over the IoT network. For simplicity, a two-line model (i.e., n = 2) is used to prioritize data [44]. This model can be extended to more than two lines, as in [35].

Therefore, IoT data is divided into two classes; that is, C1 and C2. The most important IoT data is allocated to C1.

The work to be done depends on the pre-defined conditions required for different types of applications. The most important IoT data was given to C2. C1 data is included in the first line, with the highest quality of service (QoS) that makes this category of data the best in the service. Second-line C2 IoT data service has low value. Next-generation rabbits should be reviewed and aligned with this priority model. In a two-line model, a line data system is used. The formula $P_{ij} = \lambda_i + \mu_j$ is used, where Pij is likely to change from i (birth status) to j (death status). The model represents C1 and C2 with the corresponding lines Q1 and Q2, respectively. Over time, the data separator can distribute IoT data between two lines. There are seven steps used to summarize how the proposed two line model works. In Step 1, during the duration of the EMS server, IoT data is categorized individually according to its importance. The choice of divider has a first chance low charge bandwidth while using data, the service controller should assign QoS to the next IoT data in the same line. In Step 3, partially processed data should be transferred from Q1 to Q2. In Step 4, data processing in Q1 continues, even if Q2 is empty, as long as QoS is available in Q1. In Step 5, as soon as Q1 is empty, the service controller begins processing the data in Q2. While the data is being serviced in Q2, and when a new piece of data arrives in Q1, the service controller should jump to Q1 and start the service process. An additional explanation of the two-line model and its change of shape is given in [44].

2) Installing Data

A second way to reduce EMS data is data entry. As mentioned above, this process is used by power-based nodes as sensors that can collect and transmit information. In data measurement, the data can be scaled down and sent to the destination. The extraction process depends on finding the relationship between IoT data, so this link can be sent with other parameters that help the destination to extract the original data. To explain how to compile data in a simple way, the sensor state can be taken as an example. Suppose each sensor collects its data and organizes it into a pair (a, b). The data aggregation method can now be applied to pairs of collected data. The data entry method has many strategies. In the proposed EMS, a small square method is used to measure data. In this area, there are two methods, direct and indirect. By line, the interval between each data object, collected by IoT sensors, should be the same. Common intervals between data are considered to be a special situation in the IoT environment. For simplicity, the line method is used in the proposed EMS.

3) Data Compression

A third way to reduce IoT data size is compression. Data compression is used to reduce power consumption levels by reducing the number of bytes to be transferred from power-based nodes to other nodes in the IoT environment. There are many ways to compress, especially for data sensors. The use of theses methods in the IoT environment is still under investigation. It is very difficult to integrate one method with another and use it in an IoT environment. To address this challenge, an existing and proven pressure method has been selected to demonstrate its effect on reducing energy consumption without considering the preferences. Additionally, it is not a requirement that the data compression method be used only for power-based nodes, but can be used from other nodes as long as it contributes to reducing power consumption. For example, data compression can be applied to sensors as well as sinks and servers. In addition, it is true that the main load on the IoT system is the data collected by the sensors, but also do not forget that the data of other nodes such as cell phones and RFIDs may represent a risk to their power consumption levels. In addition, the strategy to be used is not based on the use of data congestion only once; it is possible to re-compress the compressed data collected if necessary. In addition, because there are nodes derived from different energies in the IoT environment, they only work

B. Strategy 2: Planning

A second strategy to reduce energy consumption is planning. Setting in IoT means that each power-based node can achieve its function but without a predetermined or predetermined time. The proposed planning approach to EMS should consider seven issues. The problem is to start the current power level in each area based on IoT power. The second story is a source of power. The third issue is alternative modes (spacing in the covered area). The fourth issue is heterogeneous energy-based nodes in the IoT system that lead to diversity of their functions. The fifth story is the value of each node. The sixth story is usually a work in progress. The seventh edition is the location of each node. These problems determine the relative weight of each node. These problems can be changed over time. Therefore, the editing algorithm should work in a flexible manner.

Nodes based on IoT capabilities should be divided into clusters for administrative purposes. Each group has a head that controls its locations. Management here means assigning tasks to each location in addition to the suspension, redistribution, or suspension of these functions. The head of the set should consider seven parameters to determine the power of each node based on power.

The current power level has an initial value because it determines whether the planning method should be used or not. The power source parameter has a secondary value. The parameter for other node methods has a third value. The heterogeneity parameter has a fourth significance. The node value parameter has a value of five. Frequency of activities has a value of six. The place can be saved first. The proposed navigation system provides the head of the cluster with a clear route to the right area to intervene if there is a capacity to rescue all the affected nodes. These key structures are grouped into three groups. The first group includes the first parameter defined by sending an alarm that reports power problems to EMS. The second group includes the second and third parameters related to finding alternatives, so there is no need to use a planning model if another is available, as discussed in paragraph 3.3. The third group consists of the fourth, fifth, sixth, and seventh parameters related to the use of the proposed planning model. The node area can be used as an input parameter to define its value.

The proposed planning model begins by receiving an alarm from a power-based node with a severe power outage. The message is sent in a node to the head of the collection (sink). The head of the collection should determine the level of energy and first determine whether the available energy is significant. Next, the header sends a message to the EMS server asking for an alternative to that node. The answer is that it is negative, the head of the collection should determine the type of device: the device can collect, process, and send data as sensors; or a device that can only send data, such as RFID.

In the case of sensors, for example, the header should use an algorithm for aligning the sensor, but in the case of another class of nodes, it should use the appropriate scheduling model for that class. For simplicity, sensors and RFIDs are taken as examples.

The sensory schedule model is based on sensory changes between the three regions. The first state is fully functional, which means that each sensor achieves its function in normal mode. The second mode is less active, which means that the sensor is active and most functions are assigned to it but do nothing, so the level of energy consumption is less than the fully functional state. The third condition is sleep state, which means the sensor is not ready to do anything and no task is assigned to it. Algorithm 1 and algorithm 2 define WSN and RFID node scheduling models, respectively. The main idea of algorithms is to periodically evaluate node power levels and to reduce the height of power-based nodes depending on critical parameters. In addition, algorithm 1 is modified for use in the MANET environment.

III. Simulation and Test:

The proposed EMS should be tested to prove its claim. This section describes how the proposed EMS is tested. It consists of two main clauses. The first sub-section shows the natural imitation of the IoT, describing its components, parameters, and conditions. The second section introduces performance metrics and simulation results through their discussion.

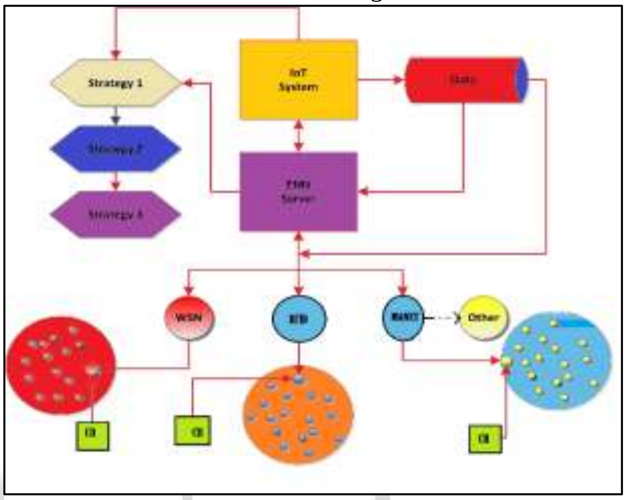

Fig. 2: EMS General View.

IV. Construction of an IoT Environment:

IoT's local simulation infrastructure includes five different types of networks: satellite, high altitude (HAP), WSN, RFID, and MANET. These networks have been selected to reflect the true nature of the IoT environment. Satellite networks and HAP are used as secondary recovery tools as an alternative to the Internet. The simulation concept described in [51] is used for the construction of a simulation space where each network is defined beyond the normal view of the simulation model. Additionally, five network simulation parameters are specified in [51]. The main differences in simulation parameters are the number of nodes and locations including WSN, RFID, MANET, and HAP.

V. Discussion of the Results

In the section below, the simulated effects of the proposed EMS are illustrated and discussed. The performance metrics used to evaluate EMS are as follows: the average power consumption of IoT power-based nodes, the number of node failures due to power loss, output, and overall network life. Metrics are measured in relation to the traditional IoT system. The traditional system description mentioned does not apply EMS techniques. Power consumption is an important performance metric to be measured in the proposed EMS due to the importance of determining its effect on the IoT system. Low power consumption is associated with better EMS performance, and vice versa. In the proposed simulation model, WSN, RFID, and MANET are considered the main IoT systems. This is because most of these networks are power based. The positive effect of EMS 1 and 2 strategies on RFID power consumption levels is significant. Regarding MANET's energy efficiency levels. The number of nodes failed due to power loss is a very important parameter due to its effect on many issues in the IoT system such as router performance and nodes. Measurement of performance metrics in the system to determine the impact of EMS across the IoT system. This parameter is measured after using EMS 1 strategy, strategy 2, and strategy 3 that the number of failed nodes in the traditional WSN, RFID, and MANET system is greater than that in the EMS proposed for these networks. This demonstrates EMS power storage capacity for as long as possible without interrupting any IoT function.

In terms of output performance metrics, it is used to determine the number of bytes sent and received successfully over time. It is considered one of the most important performance metrics to determine the effectiveness of EMS in power management. This is because high power consumption means that there is a high probability of node failure that will affect the data transfer rate, and vice versa. The output results of the output function are shown in

The transfer rate in the case of the proposed EMS is higher than in the traditional system. This is explained by the efficiency of the proposed EMS to save power for each IoT node; this provides stability throughout the IoT system leading to a reduction in the number of lost packets. Conversely, in the traditional IoT system, failure nodes may be increased over a period of time which may result in significant bottlenecks, leading to congestion which, in turn, has a negative impact on transmission rate.

The network's long-term performance metrics are also an important parameter because of its direct relationship with energy consumption levels that may decrease or extend network life. To ensure that the proposed EMS extends the life of the network, the percentage of time that the IoT system operates without problems is measured in EMS and compared with that of the traditional system. The results prove that the IoT network, with the proposed EMS, has a longer lifespan than conventional power control methods. This is due to the large number of failure nodes found in the traditional system. A large number of fail nodes means a low number of bytes passed, resulting in a lower output that specifies a decrease in network life time. On the other hand, the maximum IoT lifetime from EMS means that a low number of failure nodes are compensated, thus reducing their negative effect.

VI. CONCLUSION:

An Energy Management Scheme for IoT systems was introduced in this study. The EMS's main premise is built on the use of three separate tactics. The first technique limited the amount of data that could be sent through the IoT system. To preserve node energy, the second technique changed the status of each energy-based node in the IoT system based on a set of factors such as energy level relevance. The third technique addressed the issue of fault tolerance by locating replacement nodes for those that had failed owing to energy loss. Finally, the EMS was put to the test in a simulated environment built with the NS2 simulator.

According to the simulation results, the suggested EMS outperforms standard IoT in the following ways: The number of failure nodes and the energy consumption rate for WSN both fell by 32.66 percent and 19.75 percent, respectively. The rate of energy consumption and the number of RFID failure nodes both fell by 65.909% and 87.422%, respectively. The number of failure nodes and the rate of energy consumption for MANET both fell by 60.844 percent and 81.481 percent, respectively. By 53.137 percent, the throughput has grown. Finally, the lifetime of an IoT network has been improved by 26.408 percent. As a result, in IoT setups, the EMS is recommended for controlling energy consumption rates.

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