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A CACHE-Based Energy Efficient Scheme For Data Aggregation In Iot

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Abstract: Internet of things (IoT) has emerged as one of the popular technologies in today's era. IoT came into existence after the usage of various sensors. It is the improved version of the wireless sensor networks. In order to deal with IoT technology we require to connect the internet to the physical things. IoT deals with heavy amount of data and that data is used to analyze the information. So, while sending the data to the base station from sensors it should be first aggregated and then it should be forwarded to the base station. In the context of data aggregation, there are various mechanisms available like cluster based, tree based, and centralized. Since the resources utilized by the sensors are more in terms of battery of the sensors that is the energy should be maximum. Energy is one of the important factors in the wireless sensor networks. So as to increase the efficiency of the sensors nodes we propose a novel approach of cache-based scheme with usage of Leach protocol and this can be implemented in Matlab.

Keywords: Internet of things (IoT), ch (cluster head), sensors, data aggregation mechanism.

1. INTRODUCTION

1.1 Internet of Things

With the advent of IoT, the scope of the internet is going to get enlarge. It is going to interconnect different things that is the physical objects we see around like air conditioners, lights etc. IoT provides advance level of services. Embedded system is built in part of the IoT and they are dedicated to solve particular type of the problems and they are classified into Real time embedded systems and network embedded systems. The main goal of embedded system is that it is going to help in connecting different other things that are around them. IoT is one of the building blocks and that is considered to be used for developing smart homes, smart cities etc. IoT technology is connecting devices, machines & tools to the internet by means of wireless technology. Since IoT deals with lots of data and that should be managed according to the user purpose.

1. 1. 1 IoT and data aggregation

IoT deals with large amounts of data and that data should be aggregated first from sensors and then forwarded to the base station. This process is known as the process of data aggregation [1]. Data Aggregation plays a major role in the field of wireless sensor networks. A sensor is one the

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most important enabling device for building IoT. Basically. we have three types of mechanism namely tree based, cluster based, centralized approach.

1. 1. 2 Characteristics of IoT

Following are the main characteristics of IoT :

a) Scalability: IoT systems should be scalable because we were talking about many things.
b) Efficiency: It should have to serve efficiently for which purpose it has been deployed i.e. requirements of the application etc.
c) Performance: IoT networks is dynamic so there may be chance of increasing device and it should not compromise about the performance.
d) Security: Security should be the first priority along with getting gains from the IoT (internet of things). The design of IoT should be based on security for both the designers and users of the IoT [2].

1. 1. 3 Architecture of IoT

The architecture of IoT is five layered architecture and each layer is dedicated to specific functionalities. As to establish communication between wireless sensor networks and to the internet and for the effective communication each layer has to serve very efficiently.

Perception Layer: The perception layer is also sensing layer because the main aim of this layer is to sense the information from the sensors and transmit as a signal over the network.
Network Layer:. This layer helps in connecting the things around them and it deals all the aspects of network related issues and the Technologies used are Wi-Fi, Bluetooth, Zigbee, 3G, UMB, infrared technology etc

Application Layer: This layer decides or it evaluates the information that has been received is exactly what the application is deployed for and it provides the advance level of the services.

Middleware Layer: This is in between layer of application and business layer. This layer gathers information from the network and stores in the database [3].

Business Layer: To control the overall activities and products, this framework generates business models, flowcharts and graphs. IoT technology performance depends on the importance of implemented technology and the business application's sensitivity in which it is to be used.

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1. 2 Data Aggregation in IoT

IoT is improved version of wireless sensor networks. In IoT energy consumption of sensors is more and that can be reduced through aggregating the data from the sensors and this process is known is Data aggregation. One of the main goal of data aggregation is that it reduces the communication cost[4]. Data aggregation removes redundancy from rough data and reduces communication cost. Following figure shows the data aggregation procedure.

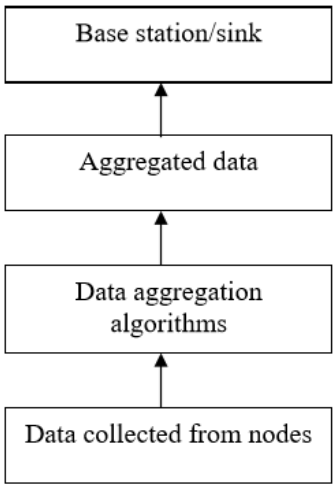

Fig 1: Data aggregation flow

Initially the data from the sensor nodes is collected and it is aggregated with the usage of the various aggregation mechanisms and thus the aggregated data is forwarded to the base station and to the internet for analyzing purpose or for the monitoring purpose. In the following sections we are focusing on different types of data aggregation mechanism.

2. Literature review

This section represents the related work done on data aggregation algorithms in IoT by various authors. H. Rahman, et. al (2016) recommended a hybrid data aggregation approach called QADA [8]. The recommended approach combined the attributes of clusters and tree dependent data aggregation approaches. The proposed approach addressed some of their important limits as well. The achieved outcomes depicted the efficacy of recommended technique by considering different performance parameters. These parameters included energy consumption, network life span and ability to bear more traffic load. The future work would involve the design of a data aggregation approach in view of heterogeneous environment in the test beds state under genuine stipulation.

In the similar context, Hideaki Yoshino, et. al (2018) proposed a flexible control approach for aggregating data in mathematical manner [9]. The proposed approach minimized the latency after noticing time difference in the arrival rate. Flexible control of the aggregation figure based

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on existing traffic was recognized by implementing the evaluation rule of the best aggregation figure to the recommended approach. The simulation was performed to clarify the transitory and typical features of the recommended approach using time varying input. The achieved results depicted that the recommended approach achieved steady and almost theoretical optimal latency even in overloaded traffic scenario.

Similarly, Abrar Alkhamisi, et. al (2016) examined a dispersed approach called CLCP [10]. This approach had been utilized for aggregating data in IoT. The contribution of this protocol for search relied on query was also analyzed. The CLCP approach with no aggregation performed better than other schemes in terms of overhead reduction and throughput increase on the basis of specified testing condition. However, both CLCP schemes consumed remaining energy similarly. In order to check the result of recommended scheme with many cluster corpuses, it is required to perform more study with some practically existing smart meter dataset in nearby future. In addition, an attempt would be made in nearby future for analyzing the impact of many aggregation nodes (ANs) inside a cluster in the wireless sensor network. H. Rahman, et. al (2016) recommended an effectual hybrid data aggregation scheme. This approach was used in the IoT design [11]. The recommended hybrid scheme was positioned between the cluster and tree-based data aggregation approaches to deal with the limits of both approaches. The proposed approach outperformed other existing protocols in terms of different performance metrics. These metrics included energy consumption, network life span and traffic load. The proposed approach significantly reduced the quantity of noticed information transferred from ending tools to the base station. In future, the main focus would be on designing a hybrid data aggregation approach for heterogeneous scenario.

Bo Yin, et. al (2019) investigated the issue related to the construction of an Aggregation Tree (AT). Compounding query using the minimal transferring overhead was the main aim of this approach [12]. It was not possible to directly implement accessible based on Steiner tree for conventional query operators due to the dynamic size of transitional outcomes of compound queries. Initially, the data pruning power and aggregation cost were considered together to formalize the output. A data suite having more reducing energy and minor magnitude had been chosen by maximizing the aggregation gain. This dataset was later transmitted for data aggregation at successive nodes. Afterward, various aggregation operations with maximal aggregation gain were connected together to construct an Aggregation Tree (AT). The wide-ranging assessment revealed that our recommended approach achieved satisfactory results.

Rongxing Lu, et. al (2017) recommended a novel approach for aggregating data in internet of things based on the modified version of fog computing [13]. This approach was named as LPDA. Several methods had been employed in this work to describe the recommended approach. These techniques along with aggregating hybrid data of IoT tools into single device also inserted fake information at the network's border in early stage. Comprehensive security analysis revealed that the proposed approach was completely secure and improved privacy with various privacy methodologies. Moreover, wide-ranging performance evaluations were carried out in this work. The achieved results indicated that the proposed approach was truly lightweight in fog computing-improved internet of things. H. Rahman, et. al (2016) stated that Internet of Things was a relatively a new concept. In contemporary era, tremendous growth in this approach had been noticed [14]. An imperative constituent of this approach was identified as Wireless sensor network. An important role had been played by the

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data aggregation approaches for making improvements in the general efficiency of these networks. Gathering and aggregating data packets efficiently for reducing energy usage, traffic congestion, and increasing network life span and data accuracy was the major purpose of data aggregation approach. Few methodologies which were used to aggregate data in Internet of Things had been compared here for analyzing their performances in terms of different performance parameters.

Cheng Huang, et. al (2018) recommended a new confidentiality maintaining and trustworthy approach for internet of things dependent on fog [15]. The proposed approach addressed confidentiality and consistency concerns related to the aggregation. In particular, proxy re-encoding approach was implemented for removing problems related to confidentiality. At the same time, proxy re-authenticator methods were applied for eliminating the concerns related to trustworthiness. A novel risk framework had been described in this work to characterize the non-deceitful and deceitful intrusions triggered by malicious fog nodes. The tested results revealed that the recommended approach had the ability to avoid both intrusions. Moreover, the effectiveness of recommended approach on the basis of computational and transferring cost had been demonstrated by performance assessments.

Shigeru Imai, et. al (2018) investigated Map Reduce based data aggregation approach for IoT data [16]. Initially, earlier experimental studies based realistic performance model was designed in this work. Afterward, application performance for various operation designs was analyzed. The efficiency of three differ mapping methods had been analyzed in this work The tested results depicted that a truly-cloud based deployment was 53% quicker in contrast to other approaches used for data aggregation. On the other hand, the edge scheme was 46% quicker because of the edge resource closeness to query customers for query reply. The use of hierarchical Map Reduce approaches would be optimized on fog computing in nearby future.

Ji Li, et. al (2020) recommended uniform sampling and Bernoulli sampling based novel algorithm for IoT [17]. Some reasonable evidences were provided in this work to demonstrate the efficacy of the recommended algorithms. These algorithms provided satisfactory outcomes. The achieved outcomes revealed that the implemented approaches outperformed the uncomplicated dispersed approach on the basis of power expenditure.

Xiong Li, et. al (2019) recommended a novel confidentiality protecting approach for MEC supported IoT applications [18]. The recommended model had three constituents. These constituents included multiple components. The encoding of data produced by terminal device was carried out initially. This data was later transferred to the edge server. Afterward, the edge server aggregated the data of the terminal devices. Edge server delivered the aggregated data to the public cloud center. Finally, the public cloud center used its secret key to recover aggregated plaintext data. The proposed approach along with ensuring data privacy of the terminal devices also provided source validation and reliability. The proposed approach had the ability to save almost half of transmission overhead in contrast to traditional model. The proposed approach was highly appropriate for MEC (Mobile Edge Computing) supported IoT applications.

Wenjuan Tang, et. al (2019) recommended a secrecy protecting heath information aggregation approach. The proposed approach gathered health data from various sources in secure manner [19]. The proposed approach also guaranteed reasonable incentives for contributory patients. In particular, signature methods were employed to ensure reasonable incentives for patients. In the meantime, noises were added into the fitness data for getting

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different confidentiality levels. In addition, two aggregation approaches were combined together for securing data and fault tolerance. It was analyzed that the proposed approach had the ability to oppose differential attacks, bear medical hubs breakdowns, and maintain reasonable incentives for patients.

Xiaoyang Li, et. al (2019) recommended a novel wirelessly powered AirComp (WP-AirComp) structure for IoT networks [20]. The non-convex combined optimization issue was imitated into the corresponding external and internal sub-issues for wireless power control for getting a real-time solution. The achieved results revealed that the optimum energy beams pointed to the leading Eigen paths of the WPT conduits. The optimum energy distribution made an attempt to balance the close-loop effectual channels of several sensors. The obtained simulation outcomes depicted that large number of design magnitudes had been obtained after the scheming of WPT. This phenomenon reduced the AirComp fault in considerable manner.

Sunny Sanyal, et. al (2018) proposed a novel data aggregation approach for extremely unsure unprocessed IoT sensor data [21]. The data was gathered through the end to end information sharing. At first, the recommended approach rebuilt the subspace with the help of sample data. Further, it repeatedly discovered the low-level estimation of the leading subspace in the occurrence of more number of doubts at the fog server. Afterward, a more consistent truthful sensor data template was estimated from the extremely doubtful unprocessed IoT sensor data traffic environment using the strong leading subspace. The tested results revealed that the recommended scheme had the ability to estimate a consistent true sensor data matrix during high doubts.

Osama M. Bushnaq, et. al (2018) suggested the use of an unmanned aerial vehicle (UAV) for aggregating areal data from a limited spatial field. The UAV just flew over the field and collected the necessary data [22]. Specifically, the division of ground was done into various sub-fields. The UAV flew over these sub-fields for collecting samples from the essential nodes. However, the projected system faced np-hard combined integer problem. Therefore, a decoupled heuristic scheme had been presented in this work. The achieved results depicted that existing optimum number of sub-fields balanced the exchange between balanced and wandering periods for minimizing the overall time consumed in the gathering of needed samples. Simlilarly, Aishwarya Tripathi, et. al (2018) recommended a protected frivolous approach utilized for aggregating data in cloud assisted IoT devices [23]. The recommended approach adopted two main concepts. The first concept was called ElGamal encoding while the other concept was a signature technique dependent on individuality. The analytic results based on security highlighted the security of recommended approach. This approach prevented the likelihood of inserting of any type of fake data. This approach verified data leakages as well. The effectiveness of the recommended approach in contrast to other existing approaches had been validated through performance analysis.

Sagi Sai Sruthi, et. al (2016) initially discussed the different challenges of Internet of Things such as security and privacy [24]. In this work, a comprehensive review of the available aggregation approaches. These approaches were implemented for aggregating information of wireless sensor networks. Moreover, an integrated scheme had been recommended in internet of things system to carry out similar task. The recommended approach considered some challenges related to information sharing and computation in Internet of Things environment. This

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approach also incorporated security features to design a qualified protected data aggregation scheme.

3. OBJECTIVES

1. To study and analyze various energy efficient protocols for internet of things.
2. Design cache based scheme for the data aggregation in internet of things.
3. Implement proposed scheme and compare with existing in terms of certain parameters.

4. PROBLEM FORMULATION

4.1 LEACH PROTOCOL

4.1.1 Low Energy Adaptive Clustering hierarchy

It falls under the hierarchical networks, Self-organizing, adapting clustering protocol that uses randomization to distribute energy load evenly. Dense network of sensor nodes grouped into clusters. Base station is fixed and away from sensor networks.

The head of each cluster is selected based on the following :

Cluster head is selected from each cluster group based upon the two factors

1)Energy of the cluster head should be maximum

2)Distance between base station and cluster head should be minimum

Energy is one of the important factor while dealing with the sensors, that is the energy consumed by the sensors is more for sending and receiving the data.

Energy of the sensors depends upon the four factors or it can be calculated upon the following factors :

1) No of packets transmitted by the sensors

2) No of packets received by the sensors

3) No of packets modulated

4) No of packets aggregated by the sensor node to the cluster head.

In this scenario the energy consumption of the wireless sensor networks is one of the major concern. So, we are introducing the concept of the cache node in order to decrease the energy consumption of the wireless sensor networks.

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5. PROPOSED METHODOLOGY

In this methodology we are going to introduce a new node that is cache node, due to the introduction of the cache node the most frequent data is stored in the cache node and that is accessed by the base station based upon the distance between the cache node and base station, and that should be less distance. Energy and the distance are the two main factors of the research methodology.

Cache node/gateway node:

Cache node is a node that is placed between the sensor network and base station. Cache node is like flash memory. It stores the most frequent data, so that base station access the data from the cache node instead from the cluster head. The main goal is to improve network lifetime of sensor networks in an energy efficient manner. As to improve energy of sensor network, initially sensors send the sensed information to the cluster head and that cluster head passes the information to the cache node and base station access the information from the cache node which is nearest to the base station. The cache node which is near to the base station is identified by calculating the distance between the cache node and the base station. So that data can be aggregated in efficient manner. By placing the data in the cache node instead of storing in the cluster head the load on the cluster head reduces and thus the network life time of the sensor network get increases.

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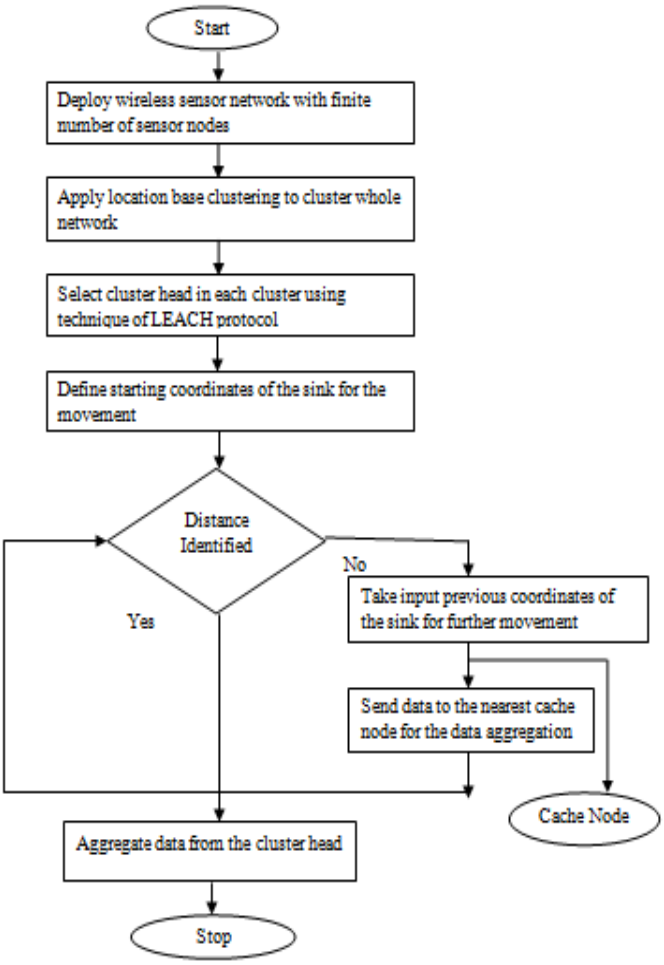

Fig 2. Flow diagram of proposed scheme

5. CONCLUSION

A technology that senses the information from the sensors and then forwards it to the base station/sink is known as IoT. Due to the resources utilized by the sensors, energy consumption of the sensors networks get increased. So, in this paper we introduced a new model of the data aggregation that combines that cluster based mechanism and cache based mechanism. A cache-based protocol is proposed in this paper to deal with the energy-efficient data aggregation in IoT. Due to the implementation of the cache node the energy consumption of the sensor networks gets reduced by sending the frequent data to the cache nodes and to the base station. Furthermore, In future, we would focus on more energy efficient protocols in the field of data aggregation in IoT.

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