International Journal of Advance and Applied Research
www.ijaar.co.in
ISSN – 2347-7075 Impact Factor – 8.141
Peer Reviewed Bi-Monthly
Vol. 6 No. 23 March - April - 2025

Enhancing the Reliability and Efficiency in WSNs

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DOI - 10.5281/zenodo.15244340

Abstract:

The emergence of the Internet of Things (IoT) and Wireless Sensor Networks (WSN) has accelerated the process of collecting and combining data, making it a central focus of technological progress and influencing the interconnected nature of modern digital ecosystems. This research synopsis explores the crucial role of data aggregation in enhancing the efficiency and durability of these networks, highlighting its importance in response to changing challenges.

Data aggregation in the context of IoT and WSN has two main benefits: it helps conserve energy resources by using them efficiently, and it reduces the heavy burden of transmitting large amounts of data. With the growing prevalence of IoT applications and the expanding use of WSNs in various sectors such as environmental monitoring, healthcare, and industrial automation, the effective implementation of data aggregation becomes crucial. It not only guarantees the dependability and accuracy of gathered data but also improves the overall effectiveness of these complex networks. This research synopsis aims to offer a thorough overview of the present status of data aggregation in WSN and IoT within the framework of dynamic digital transformation. The exploration covers a wide range of research papers that discuss various topics, including energy-efficient routing schemes, fault tolerance mechanisms, security considerations, optimization methodologies, and data compression techniques.

This research has multiple objectives. Firstly, the objective is to perform a comprehensive survey of the existing data aggregation protocols, with the aim of providing insights into the current cutting-edge practices in this field. Secondly, the goal is to develop and assess scalable data aggregation methods that can effectively handle data in extensive IoT and WSN setups. Furthermore, to investigate the advancement of resilient data security and privacy mechanisms, ensuring the protection of sensitive information in IoT applications. The objective is to examine and apply data aggregation protocols that are conscious of Quality of Service (QoS), designed to meet specific demands for latency and reliability in various application fields. Finally, in order to develop flexible data aggregation solutions that can be adjusted to meet the specific requirements of different IoT and WSN applications, enabling smooth integration across different domains.

This research summary functions as a guiding principle, condensing insights from notable contributions in the field. Through the analysis of emerging patterns, challenges, and possibilities, the goal is to inspire and inform future research endeavors. Researchers and practitioners will discover valuable insights to guide their decisions in creating, implementing, and improving data aggregation protocols in the ever-changing fields of WSN and IoT.

Introduction:

The Internet of Things (IoT) has become a significant force in today's technological landscape, enabling devices and sensors to communicate, exchange data, and contribute to the growing digital ecosystem. At the same time, Wireless Sensor Networks (WSN) have established

themselves as a specialized field. They do this by using sensor nodes that work together to collect and analyze a wide range of data from their surroundings[1].

In more interconnected world, the effective handling of data becomes of utmost significance. Data aggregation is a crucial component in both IoT and WSNs. It involves the complex coordination of collecting, processing, and transmitting data. The role of this entity is diverse, encompassing objectives that go beyond simple data management. The primary objective of data aggregation is twofold: to efficiently preserve the limited resource of energy in networks with restricted resources, and to reduce the significant burden caused by data transmission[2], [3].

The successful functioning of IoT applications and WSNs relies on the strategic and efficient execution of data aggregation. It acts as the fundamental basis for constructing these networks, guaranteeing that the gathered data is not only dependable and precise but also handled with meticulousness and caution. Moreover, data aggregation plays a crucial role in enhancing the efficiency of these networks, allowing them to operate smoothly and efficiently[4], [5].

With the increasing prevalence and variety of IoT applications, and the growing importance of WSN in fields like environmental monitoring, healthcare, and industrial automation, the role of data aggregation is becoming increasingly crucial. This process is not just a minor detail; it is the crucial element that supports the long-term viability and improvement of these complex and interconnected ecosystems. The meticulous organization of data through aggregation guarantees that these networks maintain efficiency, reliability, and adaptability to the changing requirements of the digital era[6], [7].

Currently, in a time characterized by remarkable digital change and interconnectivity, WSN and the IoT are leading the way in technological advancement. These networks consist of numerous sensor nodes that work together to collect and analyze data from their surrounding environments. Data aggregation plays a crucial role in this complex ecosystem by coordinating the gathering, conversion, and transmission of sensor data. The primary goal of data aggregation in WSNs and IoT is to strike a careful balance between preserving valuable energy resources, reducing the burdensome load of data transmission, and guaranteeing the high quality of the collected data[8], [9].

With the ongoing evolution and expansion of networks, the importance of data aggregation is increasingly evident. The constantly changing and limited resources of WSN and IoT environments have sparked the quest for inventive protocols, techniques, and strategies to tackle the complex challenges that emerge. As a result, a significant amount of literature has emerged, providing various viewpoints and solutions to the complex challenges presented by data aggregation in these networks[10]–[12].

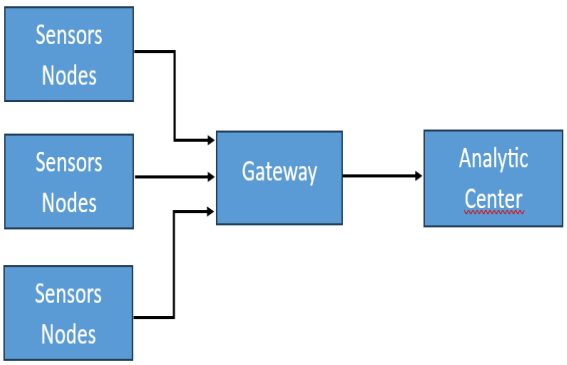

Fig 1: The System model.

Problem Statement:

The IoT and WSN have become crucial technologies, enabling the connection of devices and the effortless sharing of data across various applications. The process of data aggregation is crucial for the functionality and effectiveness of these networks. It involves the collection, processing, and transmission of sensor data.

The ever-changing and limited resources of the IoT and WSN present numerous difficulties for the process of data aggregation. These challenges encompass energy preservation, network expansion capability, and ensuring the quality of the collected data. Although there has been significant research focused on data aggregation, there is an urgent requirement to tackle various crucial challenges in this field.

Objectives:

1. To conduct a comprehensive survey of existing data aggregation protocols for WSN and IoT applications to understand the state of the art.
2. To design and evaluate scalable data aggregation techniques that can efficiently manage data in large-scale IoT and WSN deployments.
3. To explore the development of robust data security and privacy mechanisms for aggregated data to protect sensitive information in IoT applications.
4. To investigate and implement Quality of Service (QoS)-aware data aggregation protocols that meet specific latency and reliability requirements in various application domains.
5. To create versatile data aggregation solutions that can adapt to the unique requirements of diverse IoT and WSN applications, facilitating cross-domain integration.

Results Evaluation:

1. The expected results of this research are of great importance and cover a wide range of contributions to the fields of IoT and WSN. These encompass the creation of novel data aggregation protocols that improve network performance and the prolongation of network lifetimes through energy-efficient methods. The research will yield scalable solutions that can effectively handle data in large-scale deployments, tackle data security and privacy challenges, and meet QoS (Quality of Service) requirements. Furthermore, it will provide flexible methods for collecting and combining data from different domains, as well as adaptive approaches for managing changing network structures. The study aims to enhance the process of collecting and combining data for real-time IoT applications, with a focus on conserving energy. Ultimately, the study will lead to the development of a thorough framework for ensuring the security of the collected data.
2. These results have the potential to greatly improve the current level of data aggregation, promoting efficiency, security, and adaptability within the interconnected ecosystems of IoT and WSNs.

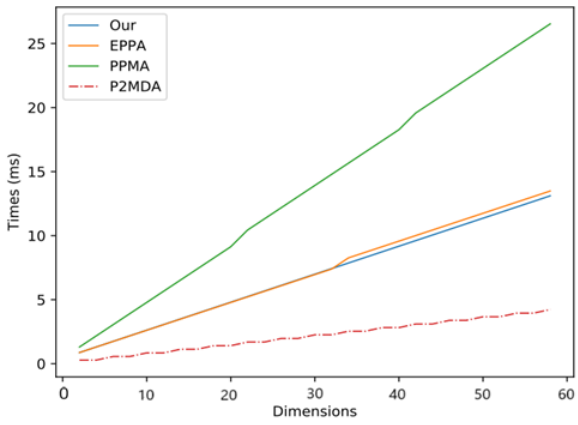

Fig 2: Comparison of computation costs comparison at sensor nodes.

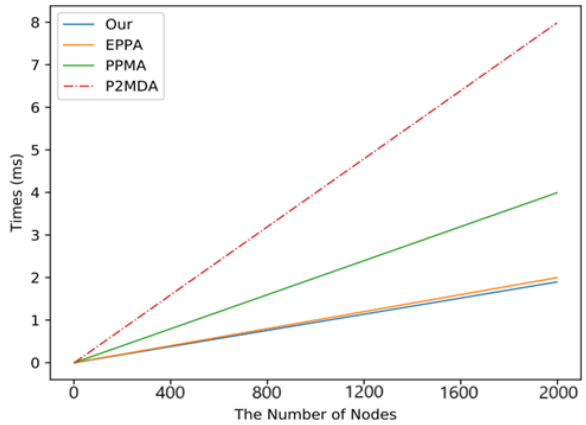

Fig 3: Comparison of computation costs at the gateway

Conclusion:

This research has a wide and complex focus, involving a thorough investigation of data aggregation in WSN and the IoT. This entails the creation of novel methods for gathering data, particularly emphasizing energy efficiency and scalability. The research will focus on addressing the urgent requirement for data security and privacy during the aggregation process, as well as considering Quality of Service (QoS) factors. This will cater to the strict demands of different application domains, particularly real-time IoT applications. Additionally, the study will examine the integration of different domains, the ability to adjust to changing network structures, and the improvement of processing real-time data. The project will result in the development of a thorough data security framework that guarantees the safeguarding of data at all stages of its existence within the IoT and WSN.

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