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Cluster Based Routing Algorithm for MANET-IoT-WSN Systems

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Abstract - The Internet of Things (IoT) refers to the network of interconnected devices that communicate and exchange data with each other over the internet. The primary goal of the IoT is to enable these devices to collect and share data, leading to improved efficiency, convenience, and decision making. Mobile Ad hoc Network (MANET) is a type of wireless network that is characterized by the absence of any infrastructure. In MANET, mobile devices communicate with each other directly and forming a temporary network without the need for a fixed infrastructure such as routers or access points. Wireless Sensor Networks (WSN) is networks of spatially distributed autonomous sensors that are equipped with sensors, transceivers, and energy sources to monitor physical or environmental conditions. The interaction between the Internet of Things (IoT), Mobile Ad hoc Network (MANET), and sensor networks is an area of growing interest and research. These three technologies can be interconnected to create dynamic, efficient, and scalable systems for various applications. With increased mobility and lowest costs, communication is made possible by this advanced combination. However, obtaining energy efficiency in the networking environment remains a challenge. The proposed MANET-IOT-WSN Clustering Routing Algorithm for achieving energy-efficient utilization is discussed in this paper. The proposed system efficiency is shown through analysis of comparisons using MANET-WSN.The obtained result shows the proposed MANET-IoT-WSN improved performance over the MANET-WSN in terms of energy consumption and packet delivery ratio.

Keywords: *MANET, IOT, Wireless Sensor Network, Clustering Routing Algorithm*

I.Introduction

The internet has facilitated rapid growth in the development of interconnected devices. Internet connectivity serves as a reliable means of establishing interfaces between these devices. The Internet of Things (IoT) plays a crucial role in creating a network that interconnects global infrastructures. A key aspect of IoT is its ability to connect multiple electronic devices through internet connectivity, utilizing communication technologies to facilitate interaction between physical or virtual entities within a specified timeframe.IoT is characterized by its capacity to integrate interconnections among small objects, such as sensors. Wireless Sensor Network (WSN) is particularly instrumental in IoT systems, especially in functions such as data sensing, collection, connectivity, and processing. The evolution of WSN has been instrumental in the development of Mobile Ad-hoc Networks (MANET), which are wireless, self-configuring multi-hop networks that connect numerous nodes through routers.

The combination of MANET and IoT has paved the way for the advancement of intelligent and reliable technologies[2].

The successful integration of MANET-IoT-WSN systems can be attributed to the effective management of energy resources. The IoT relies on multiple wireless sensors, leading to increased energy consumption. However, MANET protocols mitigate this issue by selecting optimal routes within the network, thereby reducing energy usage. Numerous researchers are actively engaged in developing energy-efficient routing protocols, with the primary focus being on maintaining network connectivity and prolonging its lifespan. It is important to note that the application of wireless network protocols in MANET-IoT-WSN networks is not straightforward, as it is influenced by factors such as human interaction with nodes, computational speed, and network node density.

This paper is structured as follows: the introduction is covered in Section 1, the literature review is covered in Section 2, the proposed system are shown in Section 3, the result and conclusion are discussed in Section 4, and the conclusion is covered in Section 5.

Ii. Literature Review

MANET stands for Mobile Ad hoc Network. It is a wireless network type characterized by the absence of infrastructure or centralized administration. MANETs are utilized in a range of situations, such as military operations, disaster recovery, and emergency response, where a fixed infrastructure is not feasible. However, their dynamic and decentralized nature poses challenges in terms of security, reliability, and scalability. Routing protocols such as AODV, DSR, and OLSR are commonly used in MANETs to establish and maintain communication paths between nodes in the absence of a fixed infrastructure. The following section outlines the routing protocols utilized in Mobile Ad Hoc Networks (MANET)[4].

Cluster-based routing protocols are a type of routing protocol used in Mobile Ad hoc Networks (MANETs) to improve the efficiency of data transmission by organizing nodes into clusters. Clustering helps reduce overhead and increase scalability by grouping nodes into clusters. In these clusters, one or more nodes act as cluster heads to facilitate communication within the cluster and between clusters. Here are some well-known cluster-based routing protocols:

LEACH (Low-Energy Adaptive Clustering Hierarchy) is a widely used and influential cluster-based protocol. It employs a randomized rotation of cluster heads to distribute the energy consumption among nodes. Nodes take turns being cluster heads to balance the energy load and extend the network's lifetime.

HEED (Hybrid Energy-Efficient Distributed Clustering): HEED is an improvement over LEACH that considers both residual energy and intra-cluster communication cost when selecting cluster heads. It aims to create more stable clusters and reduce energy consumption.

PEGASIS (Power-Efficient Gathering in Sensor Information Systems) can be adapted for MANETs, although it was originally designed for sensor networks. It organizes nodes in a chain or sequence, and each node transmits data to its neighbors in a hop-by-hop manner. This reduces the need for complex routing tables and decreases energy consumption[5].

SEP (Stable Election Protocol): The SEP is designed to prolong the network lifetime by electing stable cluster heads. It takes into account the remaining energy and the cumulative stability of nodes when selecting cluster heads in order to enhance the stability of the network.

CBRP (Cluster-Based Routing Protocol): CBRP is a proactive cluster-based protocol that establishes clusters and maintains routing information for each cluster. It employs a hierarchical structure with a cluster head for each cluster and facilitates inter-cluster communication through gateway nodes[6].

ACO (Ant Colony Optimization)-based Clustering: ACO is inspired by the foraging behavior of ants. In ACO-based clustering, nodes act as ants, and the process of forming clusters mimics the way ants discover and establish paths. It helps in creating optimal cluster structures based on the energy and connectivity of nodes[10].

TEEN (Threshold-sensitive Energy Efficient Sensor Network protocol): Originally designed for sensor networks, TEEN can be adapted for MANETs. It utilizes a threshold-based mechanism for data transmission and cluster formation, ensuring that only nodes with adequate energy and connectivity become cluster heads.

Cluster-based routing protocols provide a structured approach to managing communication in MANETs, particularly in scenarios where nodes have limited energy and need to optimize their resources. By organizing nodes into clusters and designating cluster heads, these protocols aim to enhance the overall efficiency, scalability, and reliability of communication within the network.

Interaction between MANET with the Internet of Things and Wireless Sensor Network

The interaction between the Internet of Things (IoT), Mobile Ad hoc Networks (MANETs), and sensor networks is an area of growing interest and research. These three technologies can be interconnected to create dynamic, efficient, and scalable systems for various applications. The integration of IoT, MANETs, and sensor networks opens up possibilities for innovative applications across various domains, including smart cities, industrial IoT, environmental monitoring, and healthcare.

Iii. Proposed System

MANET-IOT-WSN Based Clustering Routing Algorithm

Deploying nodes is the first step in the proposed method. Using nodes within a range is the node deployment model's component. The energy levels of the deployed nodes vary, ranging from low to high. The network is completed amongst the deployed nodes first. Each node broadcasts a "Hello" message to its neighboring nodes in order to complete the broadcast for this message. The nodes that respond are regarded as active nodes, and only active nodes engage in transmission. After cluster construction based on the active nodes, the cluster agent selection procedure is carried out. As a cluster agent (CA), a node with a high energy level inside the cluster network is chosen. The proposed system's core, or CA, is responsible for the network's overall transmission [10].

The following are the steps that to put the proposed method:

Step 1: Deploying nodes in the network model

Step 2: Choosing a Cluster Agent (CA) by running Proposed Method

Step 3: After analyzing each node in the network, the node with the highest energy level is chosen to be the CA.

Step 4: The growth of CA starts

Step 5: The CA tracks the energy level of each neighboring node and broadcasts the "Hello" message to them all.

Step 6: The CH selection procedure is then carried out by CA. As the CH, the node with the highest energy level is chosen.

Step 7: The Selected CH starts transmitting data to the network's nearby nodes.

Step 8: The CA is in charge of overseeing the network transmission as a whole. It examines the duty of keeping an eye on the CH energy level.

Move on Step 1: Deploying nodes in the network model

Step 2: Choosing a Cluster Agent (CA) by running Proposed Method

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Iv. Result & Discussion

The work proposed in this research is carried out on the NS-2 simulation environment. For conducting research, the most used tool is Network Simulator - 2. There are fifty nodes in the experimental configuration, ranging in size from 1000 × 1000. The proposed method and MANET-WSN are compared in terms of performance. The energy usage and packet delivery ratio are the performance measures used for comparison. Seconds are used to compute the execution time. To determine the performances, the observation obtained from both algorithms is shown in a graphical way. Table 1 below gives details of the other parameters used for the experimental setting.

Table 1: Simulation Parameter

Parameter	Configuration Value
No of nodes	50
Simulation environment	1500*1500
Range of Radio transfer	500 m
Size of Packet	1024 bit
Send type	Constant
Time of Simulation	500 s
Primary energy value	250-450 Jul

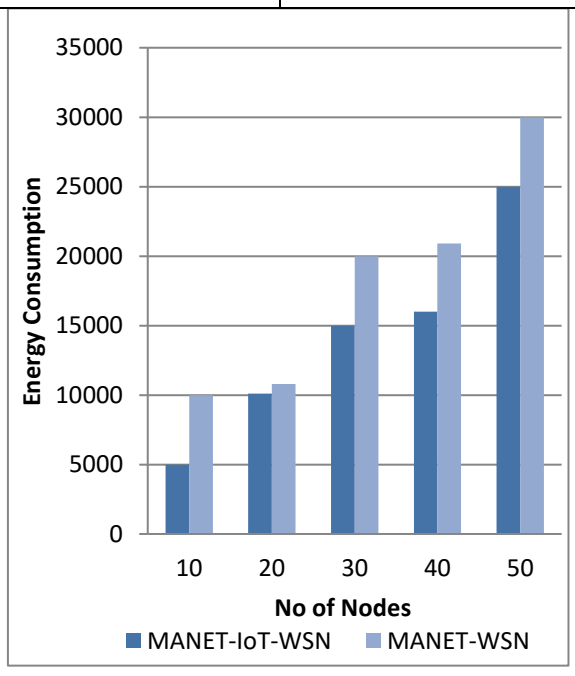

Figure 1: Energy consumption VS number of nodes

Figure 1 depicts the energy consumption achieved by algorithm. The energy consumption is initially calculated with 10 nodes at each stage; the input nodes are increased by 10 and the observations are recorded. The X-axis represents the number of nodes used in the experiments, and the Y-axis represents the energy consumed by each

set of nodes. The proposed Method energy consumed is 5000 sec for 10 nodes, 10100 sec for 20 nodes, 15000 sec for 30 nodes, 16000 sec for 40 nodes, and 25000 sec for 50 nodes. Whereas MANET-WSN energy consumption for 10 nodes is 10000 seconds, 20 nodes consume 10800 seconds, 30 nodes consume 20000 seconds, 40 nodes consume 20900 seconds, and 50 nodes consume 30000 seconds.

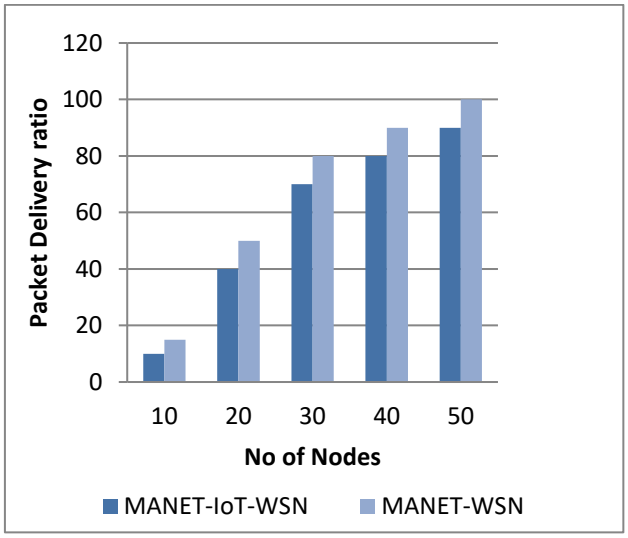

Figure 2: Energy consumption VS number of nodes

The packet delivery ratio (PDR) attained by algorithm is shown in figure 3 above. PDR calculates the proportion of successfully delivered packets to all packets transmitted during the allotted time. At each stage, the PDR is first calculated with 10 nodes; the results are then recorded and the input nodes are increased by a count of 10. The number of nodes entered into the experiments is shown by the X-axis. For 10 nodes, the proposed Method achieved PDR is 10%; for 20 nodes, it is 40%; for 30 nodes, it is 70%; for 40 nodes, it is 80%; and for 50 nodes, it is 90%. This graphical result shows that the PDR attained by the proposed method get better on that of the MANET-WSN.

V. Conclusion

The MANET-IoT-WSN Clustering Routing Algorithm is proposed in this work to get a better data routing path. Improving IoT energy performance with MANET and Wireless Sensor Network is the primary goal of this work. Cluster-based network algorithm is proposed in order to free network transmission from this complex path. Compared to existing method the transmission becomes more stable and effective when CA and CH are coupled. The efficiency of the proposed work is demonstrated by contrasting the energy usage and packet delivery ratios of the proposed MANET-IoT-WSN and MANET-WSN. It is clear from the result that the proposed method performs significantly better than the MANET-WSN. CH's hierarchical and chain selection approach allows fast transmission with a high packet delivery rate.

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