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Venkatasubramanian S (venkatasubramaniansphd@gmail.com)
Saranathan College of Engineering
Suhasini A
Annamalai University
Vennila C
Saranathan College of Engineering

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AN EFFICIENT ROUTE OPTIMIZATION USING TICKET-ID BASED ROUTING MANAGEMENT SYSTEM (T-ID BRM)

[1] S. Venkatasubramanian [2] Dr. A. Suhasini [3] Dr.C.Vennila

[1] Associate Professor,Saranathan college of Engineering,Trichy, India
drvenketcsephd@gmail.com

[2] Professor in the Department CSE, Annamalai University, India
suha_babu@yahoo.com

[3] Professor in department of ECE at Saranathan college of Engineering Trichy
vennila-ece@saranathan.ac.in

Abstract

MANET – Mobile Ad Hoc Network is the connection of several remote mobile nodes. These networks are dynamic and independent to move anywhere. It does not contain any central controller, and hence it is stated as a structure less network. MANET is one of the most emerging technologies getting popular in recent days. It's significant features, and real-time issues grab the research community's attention towards it. The unstable data transmission will leverage the overall network performance, and designing an energy-efficient routing protocol is challenging. The main reason for this problem is the lack of a stable multipath routing system and resource constraints. Various research works have launched several efficient routing mechanisms, but the need for advancement still exists. In this paper, we propose a Ticket –ID Based Routing management system for enabling reliable routing for the entire network. The proposed system work under the TID principle, which executes according to the node properties and routing maintenance system. This system works under the supervision of TID-Routing manger. The TID routing manager is responsible for managing the ticketing pool and allocating unique ticket-ID based on the collected node factors such as energy, node location, speed, etc. The proposed routing system facilitates the shortest path for reliable communication. An experimental work using NS- simulator is done with the proposed method. The proposed work's efficiency is determined using a comparison work between T-ID BRM with TABRP, OGFSO, and PDMR. The observation states that the proposed Ticket-ID system achieves 94% better than other existing methods.

Keywords: MANET, Network, Routing Protocol, Shortest Path, Bandwidth, and Ticketing System.

1. Introduction

MANET the advancement of wireless networks and the backbone of communications. In recent years the technology impact has more significant influence in every field. These features and on-demand services raise the demand for flexibility and reliability in the working environment. It gives birth to mobile computing. Mobile computing is the most prominent way for communication. Especially MANET, it is a self-configured network without any central controller or infrastructure. MANET can travel at a rapid speed in any direction in an excellent way. The dynamic multihop wireless ad hoc communication network enables ceaseless internetwork between one another without any preexisting infrastructure.

In MANET's primary concern is energy usage, power limitation, bandwidth limitation, and range limitation. The nodes forward the packets from source to destination through a linked connection. But the major challenge is finding the shortest path. In MANET, communication protocols play an essential role, enabling the network by connecting the nodes. For an effective and reliable packet delivery, the MANET network should maintain the QoS metrics.

In MANET, each node consumes more energy, and at a stage, a particular node's energy level gets depleted. It results in node failure [1]. Based on this, several routing protocols are evolved, such as destination-sequenced distance vector (DSDV), dynamic source routing (DSR), location-aided routing (LAR, and the ad-hoc on-demand distance vector (AODV). But these are developed for single-path routing. Multipath routing mechanism such as least standard multiple-based routing (LCMR), Fibonacci multipath load balancing (FMLB) routing, Multicast ad-hoc on-demand distance vector (MAODV), and location prediction-based routing (LPBR) [2-8], etc.overcomes the drawbacks of single-path routings. Even though several works evolved in improving the MANET performance, still the routing issues exist. It highlights the importance of effective path maintenance mechanisms. Multicast routing is a popular technology mostly in establishing collaborative communications and video conferencing [9]. Multicast routing minimizes the time, delay, and bandwidth consumptions. Generally, the MANET routing protocols are three types: reactive protocols, proactive protocols, and hybrid protocols**.**

The reactive protocols maintain memory section routing tables, and these memories no need for frequent updates. The reactive protocol enables the route with a short time and low latency. The proactive protocol allows control packet exchanges between the nodes, and their details are updated frequently in the routing tables. The proactive routing process is more effective as it contains accurate and updated routing information. The combination of both reactive and proactive routing protocols is known as the hybrid protocol.

Therefore, in this paper, we propose a Ticket –ID Based Routing management system (T-ID BRM) for enabling efficient routing in MANET. The TID routing principle with the TID routing manager works effectively in improving the network energy and shortest path for overall communications. The proposed work's significant contributions are listed below;

- Initially, a network is deployed.
- Integrating Ticketing system with Ticket routing manager
- Applying T-ID BRM protocol for obtaining nodes and network information exactly
- The shortest path is decided based on the node's location, energy level, and neighbor table information.
- The routing maintenance system is introduced.
- Finally, the data communication between the nodes and network performance is analyzed.

This paper is organized as follows; section 1 consists of the introduction. Section 2 has various related work regarding MANET. Section 3 contains the proposed system with architecture and working methodologies. Section 4 contains the result and discussions. Finally, section 5 contains the conclusion part.

2. Related Work

S. J. Sultanuddin et al. [10] proposed TABRP (Token Agent-Based Routing protocol)for MANET. In this work, the author introduced a token-based system with a token agent. The entire mechanism functioned under the supervision of this token agent. The reason for introducing this token is collecting the node's activity information and updates to the token agent. TABR establishes the shortest path based on the collected data. TABR is suitable for typical applications and multimedia applications.

Rajasthani et al. [11] introduced an energy-aware optimized link state routing (EA-OLSR) protocol using clustering with the OGFSO algorithm. This proposed work addressed the energy consumption issues in MANET. Initially, a cluster is formed from the deployed network, and a limited energy consumption-based multipath routing system is enabled. Next, an opposition genetic-based fish swarm optimization algorithm is implemented. This mechanism improves the energy level and network lifetime.

Premanand et al. [12] discussed the network's unstable nodes' data accuracy issue. To overcome this, the author proposed Enhanced Data Accuracy based Path Discovery (EAPD) technique. This approach selects the path with maximum data accuracy for node communication and rejects the minimum data accuracy paths. The backing route selection algorithm controls the intrusion during the communication period. From the observation, it results that this approach minimizes the packet drop rate and energy consumptions.

Arindrajit Pal et al. [13] proposed a prediction-based multipath routing protocol. The author initiated this work in identifying the stable neighbors in the MANET. For this, the author discovered a regular multipath route. It achieves a minimum delivery ratio comparing to other existing works.

R. Shanthy et al. [14] discussed the inefficient routing challenges in MANET. The author incorporated the traditional zone routing protocol (ZRP) and enhanced it with a sleep scheduling mechanism. The concept is every node in the network is grouped into zones and select a zone leader among them. The Zonal leader is responsible for choosing the multipath from source to destination. This approach results in better throughput and packet delivery ratio.

Rajendra Prasad et al. [15] disclosed that an energy-efficient routing protocol would maximize network performance. Designing an efficient routing protocol for MANET is a challenging task. The author proposed an energy-aware on-demand routing protocol. The performance proves superior in the aspect of energy consumptions.

Anand et al. [16] proposed an energy-efficient channel aware ad-hoc on-demand multipath distance vector routing protocol. This EECA – AOMDV fulfills MANET's major three requirements, such as energy effectiveness, unwavering quality, and dragging out system lifetime. This approach minimizes the maximum time spends during path choosing.

OladayoOlufemiOlakanmi et al. [17] proposed a mobility and energy prediction model for enabling an efficient routing system in the mobile wireless sensor network. It provides high accuracy about the node's mobility and residual energy, which results in optimal route paths. This predictive model is more effective in obtaining the sink nodes securely.

Dipika Sarkar et al. [18] addressed the drawback of selecting the optimal path in MANET. For this, the author proposed Enhanced-Ant-AODV for effective path selection. This approach combines the Ad-hoc On-Demand Distance Vector (AODV) protocol with Ant Colony Optimization (ACO) for enhancing the networks QoS (Quality of services). According to which pheromone path value obtained using end to end path reliability, nodes residual energy, congestions, and hops. The pheromone path value selects the acceptable route for data delivery.

Lenin Guaya-Delgado et al. [19] discussed the selfish nodes in the network which does not cooperate on task execution. Thus requires a better path with the volunteer nodes to cooperate. For this, the authors developed a novel dynamic reputation-based source routing protocol for MANET. A better path is chosen based on the assigned node's reputation value. Compared to the selfish nodes in the network,cooperative nodes result in a minimum packet loss ratio during transmission.

Several works discussed the routing protocol for MANET. Three mechanisms, such as TABRP, EA-OLSR, and PDMRare taken for comparison. Let's examine those algorithms in detail.

TABRP

(token agent-based route planning protocol):

As the name itself specifies, the token agent plan the routing path. The token agent is also known as the token manager, is the major component of this model. The other features of this model are the token pool and token generation system. Initially, once the network is formed, the token manager assigns a token ID to every node. The broadcast Route Request (RReq) message process states the active and sleeping node in the network. All the node activities are under the supervision of the token manager. Every node details such as energy, node location, speed, etc. are updated regularly to the token manager. Based on the provided details, and the token manager plans an efficient routing path.

OGFSO

(Opposition genetic-based fish swarm optimization protocol):

This mechanism also includes energy-aware optimized link state routing (EA-OLSR) protocol. The EA-OLSR protocol concentrated on power consumption during packet transmissions. The proposed work provides reliable routing for the clustering nodes. Initially, on the cluster network, various nodes presented are represented as cluster members. Among which cluster head is selected based on the energy level of the nodes (cluster member). A cluster formed using the K-medoid clustering model. The overall combination provides a greater lifetime with minimum energy consumptions.

PDMR

PDMR refers to the prediction-based multipath routing protocol. This approach consists of two stages in the initial stage, finding of stable neighbor node and the path. In the second stage, the ERNN (Elman Recurrent Neural Network) model predicts future behaviors of neighboring nodes. The ERNN model consists of four layers: the input layer, recurrent layer, hidden layer, and output layer. These layers update the network parameters and predict the original output value. Based on the expected value, the proposed system enables several parallel paths for communications. This mechanism minimizes the major MANET's drawback link fault.

3. PROPOSED SYSTEM

Multipath routing facilitates multiple routes between the source and destination node. It maximizes successful packet delivery in case the failure occurs in a particular path. Multipath routing consists of three components, such as route discovery, route maintenance, and traffic allocation. Multipath routing achieves load balancing by spreading the traffic among the multiple routes. Multipath routes are easy to discover and enable packet reordering. The major drawback of multipath routing protocol is complexity and overhead. In traffic allocation, the choice of allocation quality is more important. We propose, Ticket –ID Based Routing management system (T-ID BRM). In this mechanism, The TID protocol enhances the multicast routing system, especially in handling the traffic and bandwidth allocation throughout the network. Even though several works are initiating enhanced routing, some details about the sleeping node, whether its presence will affect the network performance or not, are not clearly stated in the existing works. The salient features of our proposed system are;

- The proposed system balances the bandwidth allocation according to the application type, which ensures reliable bandwidth throughout the network.
- It is suitable for large scale mobile ad hoc networks.
- There is no routing priority, which means no nodes acquisitive behavior.
- It works under a single protocol; there is no way for confusion during routing
- The ticketing system chooses the path at limited time and energy consumption.
- Minimum energy consumption maximizes the network lifetime.
- Execution under optimal results on low end-to-end delay

The below section clearly states the proposed architecture

3.1 Proposed Architecture:

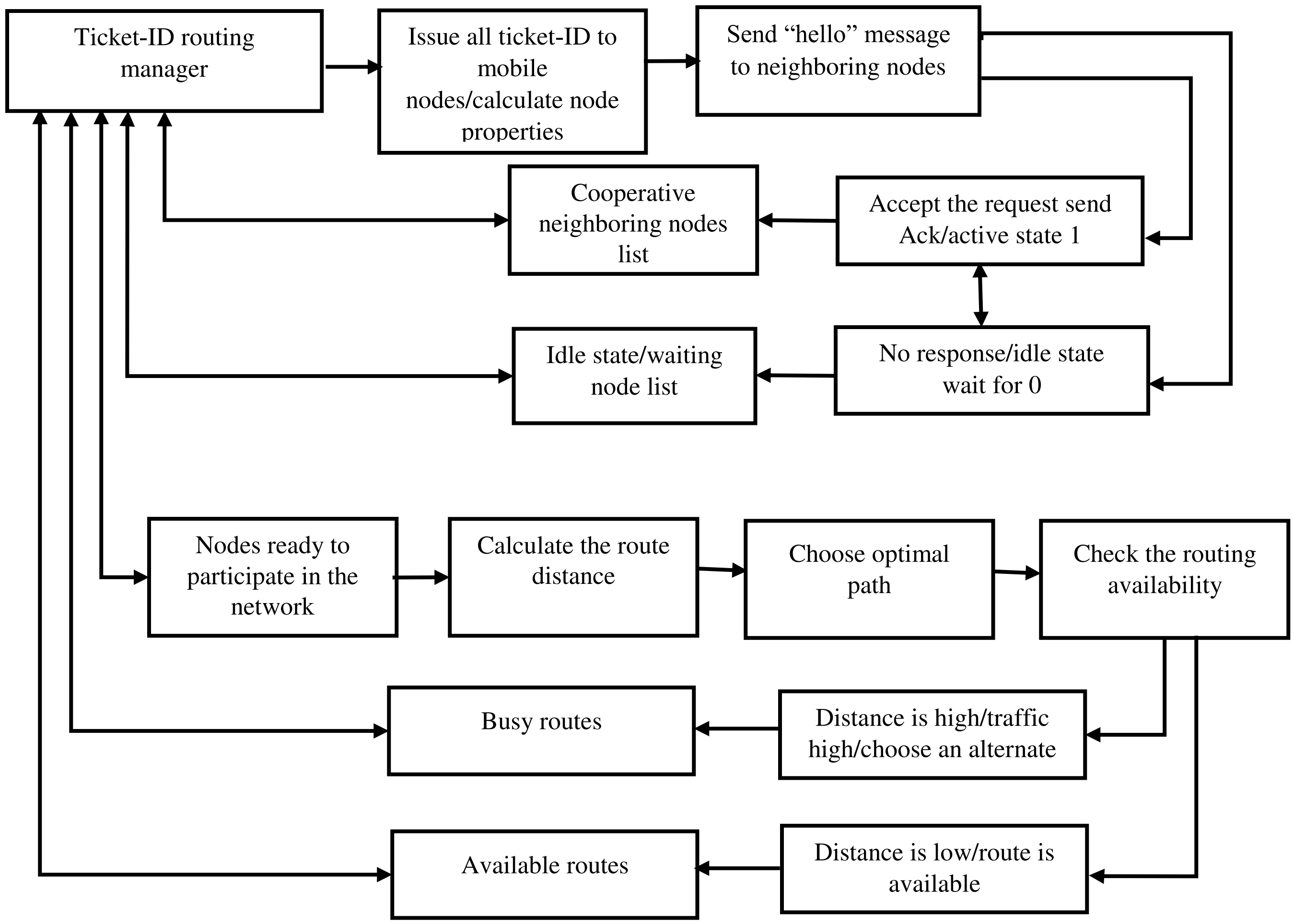

Figure 1: TICKET-ID BASED ROUTING MANAGEMENT SYSTEM (T-ID BRM) Architecture

The proposed architecture's significant components are network model, ticket-ID routing manager, ticketing pool, and route planning. Initially, the proposed system deployed a network with a set of nodes. The T-ID BRM is the heart of the proposed model. In which the ticket routing manager is responsible for overall network performance. Once the network, all the nodes are registered. The ticket ID manager disputes a unique ticket ID from the ticket pool to all the nodes. This unique ticket-ID observes each node's activities, which and used for future purposes. The next step in this mechanism is to identify the active nodes and idle or sleeping nodes in the network. The active nodes are only eligible for packet transmission. The idle nodes qualify on occasion at the time of changing its state from inactive to active. The ticket-ID manager keenly monitors this observation. The Ticket-ID based routing protocol determined nodes active or idle form, and a clear explanation given in the below section TID system. The TID collected details are categorized and updated into a cooperative node list and inactive node list. The active nodes are coming under the cooperative list, and the idle node is coming under the idle node list. Based on this information, the ticket-ID manager organizes the ready nodes to participate in the network.

Based on the information provided by the TID routing protocol, the neighboring nodes are selected, and the shortest path is chosen. The nodes distance is calculated based on the node distance information provided to make the decision. Another condition is the node energy level; it is also precisely determined based on the provided information. Then the route availability is checked whether it is available or busy. It can be calculated based on task size and distance, such as for larger tasks with the length the traffic is high, and that route is busy. So automatically, the minimum task with length will be avail with available routes for faster execution.

3.2 TID – Ticket ID Based System (Core Concept):

Ticket-ID Based Routing Protocol

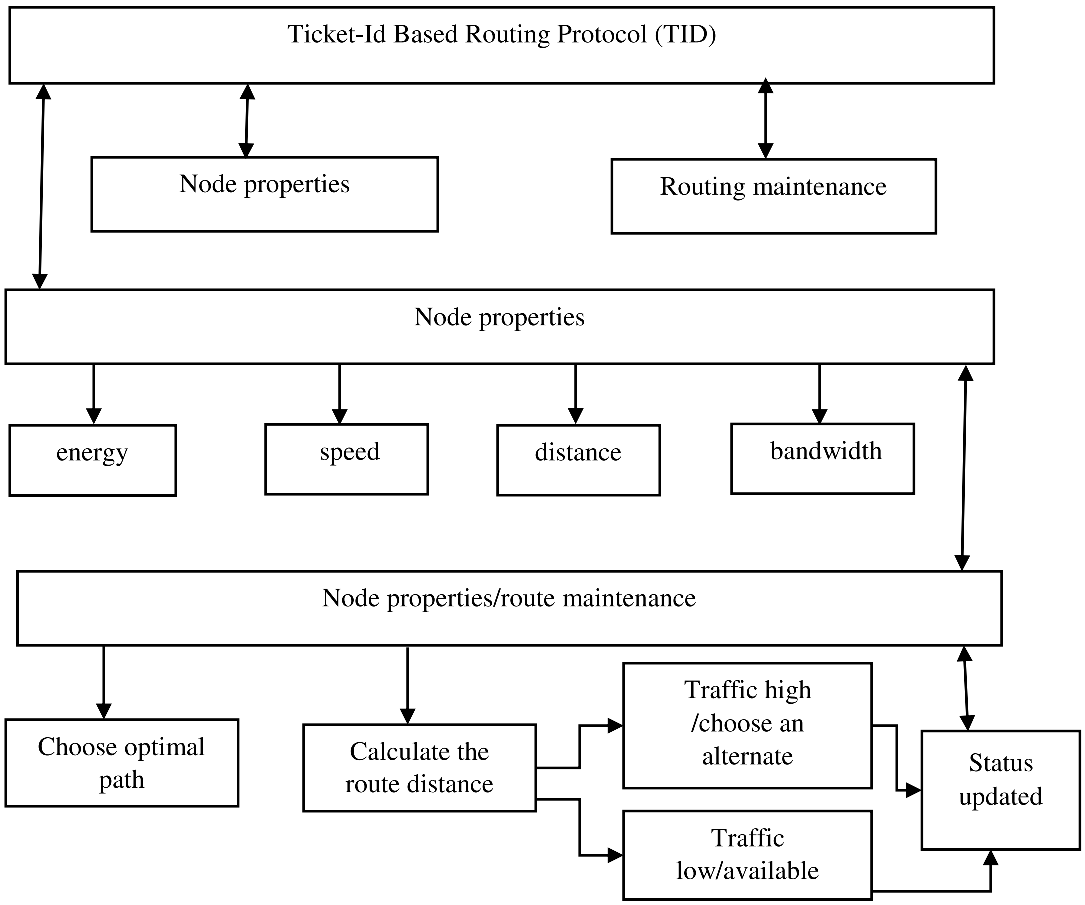

Fig 2: Ticket-ID Based Routing Protocol structure

In our research, the core of the proposed concept is ticket-ID based routing protocol(TID). The ticket-ID manager work based on the information provided by the TID. The TID protocol has two major components, such as Node property-based and routing maintenance, as shown in figure2. Once the network, the ticket-ID manager labels each node with a unique ticket ID. Based on the ticket ID, the active neighboring nodes are identified and updated. Those identified nodes send a "hello" message to the neighboring node. The neighboring node which receives the message will acknowledge, thus proves that these two nodes are active. These nodes are then coming under the active node with value 1 and updated in the cooperative node list. The node that does not respond is awarded 0 value, stating it is idle state updated in the idle node list. This status can change on future occasions the idle node can acknowledge the hello message and comes under an active node with value 1. This process occurs vice versa, and the status is updated regularly on the node's listing tables. Additionally, based on the unique ticket-ID, the mobile node's properties like distance, speed, location, and energy are calculated and updated in the listing table.

In MANET, routing protocols are essential for executing network performances. Here the TID protocol decides the routing plan and updates to the ticket-ID manager. The routing path is established between the source to destination via neighboring nodes as interfaces for packet transmission. As mentioned in figure 2, the route management system is responsible for discovering a newer efficient route to reach the destination. Then the ticket-ID manager allocates the appropriate path according to the application type. The transmission process is processed with sender node broadcasting Route Request (RReq) message to the ticket-ID manager. Then the ticket-ID manager discovers the available path, and details are updated in the routable table, as shown in Table 1.

Ticket-ID	Source address	Destination address	packet Type

Table1: RReq Format

3.3 Network Model:

In this work, the network model is a dynamic multicast model. Multicast routing is the method of building the shortest path between the sender to receiver in transmitting data. Here a Mobile Ad-Hoc Network is structured with an undirected weighted graph $G(N,E)$. In the network, the mobile nodes are represented as $N = \{n_1, n_2, \ldots, n_M\}$. The network connection may be unidirectional or bidirectional links with a set of edges such as $E = \{e_1, e_2, \ldots e_N\}$. The multicast source is denoted as $S = \{s_1, s_2, \ldots, s_i\}$ the multicast destination is marked as $D = \{d_1, d_2, \ldots, d_j\}$ and the intermediate nodes as $I = \{i_1, i_2, \ldots, i_k\}$. The transmission begins from the source and ends at the destination; here the intermediate nodesact as routers. These nodes are a dynamic model which free to move anywhere within the transmission range R. Each node has a unique ticket-ID provided by the ticket-ID manager and the tickets $T = \{T_1, T_2, \ldots, T_n\}$ set. The characteristics of the network model are;

- Mobile nodes are independent of idle or move anywhere.
- Nodes are free to join or leave, with no particular entering or leaving conditions.
- The ticket-ID manager supervises the nodes joining or leaving.
- The network form by TID protocol which never fails
- The active nodes as the source and destination nodes
- There is no control over network transmission, such as direction.
- In this work, communication through bi-directional links.
- Reliable communication using MAC layer protocolIEEE 802.11

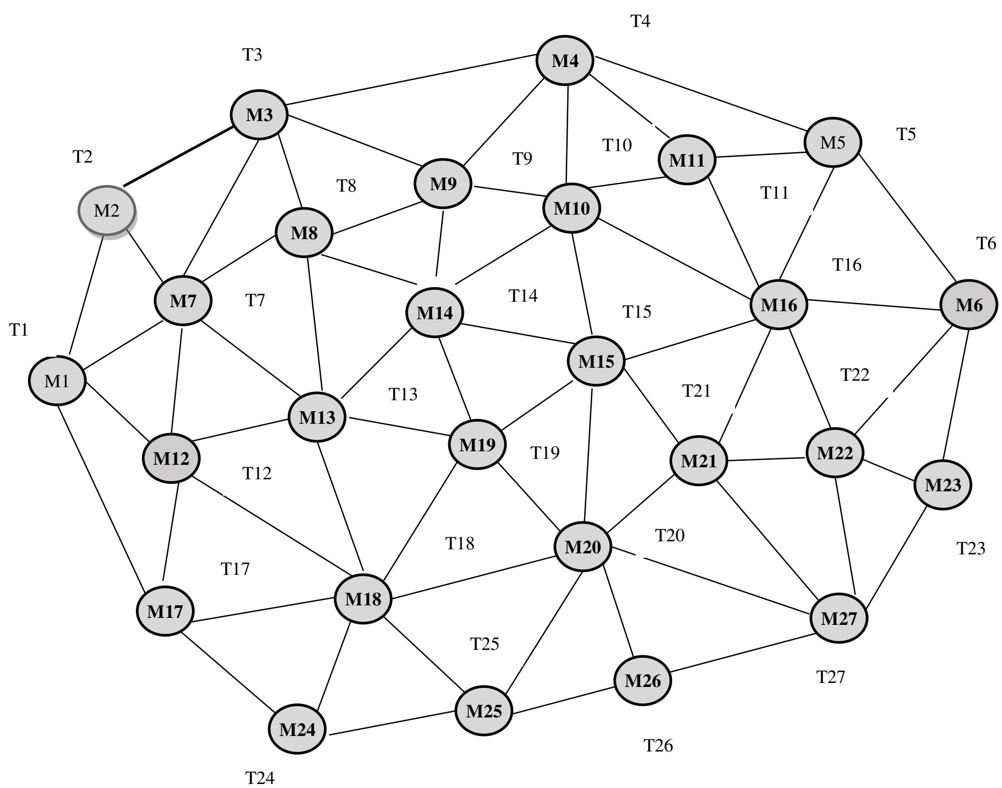

Figure 3: Deployed network model

The above figure3 is the initial network model deployed in our proposed system. These nodes are deployed dynamically in which M1….Mn represents nodes and the T1…….Tn represents ticket-ID. Based on the ticket-ID, the node properties such as nodes speed, location, energy, distance, bandwidth are collected and updated by TID to the ticket-ID manager.

3.4 TID Implementation:

Initially, the token ID is provided based on that ID collects each node's speed, position, location, energy, and distance. On the deployed network, ticket ID's calculates the node properties as mentioned in the below algorithm.

Algorithm for Ticket-ID for nodes properties

1) *Input: token-id (TID)*
2) *Output: nodes speed, position, location, energy, distance,*
3) *Begin*
4) *{*
5) *Set of mobile nodes randomly deployed with dynamic manner* $M_{i,j}$;
6) *Issue the token-id to all mobile node* $M1_{(1,1)} \rightarrow t_{id1}; M2_{(2,2)} \rightarrow t_{id2},; M3_{(3,3)} \rightarrow t_{id3},; Mn_{(n,n)} \rightarrow t_{idn},;,,;$
    i) *Calculate the node properties MN(p)*
    ii) *Mobile node distance* $M_{i,j},(d)$
    iii) *Mobile node speed* $M_{i,j},(s)$
    iv) *Mobile node energy* $M_{i,j},(e)$
    v) *Mobile node bandwidth,* $M_{i,j},(bw)$
7) $M_{i,j},(d) = \sqrt{\left(a_{i1} - a_{j1}\right)^2 + (b_{i2} - b_{j2})^2}$

   The above expression calculates the node's distances in which a and b are the coordinate positions.

8) $M_{i,j},(s)$=$M_{i,j}(sequance\ no), set\_d_{st}(x_{path}, y_{path}, n_{speed})$
Where the *x* and *y* are the position path and n determines the nodes speed
9) $M_{i,j},(e)$=$\left(\frac{E_{ix}-R_{ix}}{c_t}\right)$
$Where E_{ix} \rightarrow intial\ energy;$
$R_{ix} \rightarrow Residual\ Energy;$
$c_t \rightarrow communication\ cost$
10) $M_{i,j},(bw) = \left(\frac{N_{pkt}(tx) * S_{pkt}}{T_t}\right)$
The total consumed bandwidth calculated by the packet transmitted with packet size and total time taken.
Where $N_{pkt}(tx) \rightarrow the\ number\ of\ packets\ transmitted;\ S_{pkt} \rightarrow size\ of\ packet; T_t \rightarrow total\ time\ \ taken\ to\ transmit$
11) $MN(p) \rightarrow\ M_{i,j},(d), M_{i,j},(e), M_{i,j},(s), M_{i,j},(bw)$;
$MN(p)$is the path based on the node distance, energy, speed, and bandwidth
12) *MN(p)are checked to collect the token and send the "hello" broadcast message to all mobile neighboring nodes: //*
    i) $M_1 \rightarrow M_2(request); M_2 \rightarrow M_3, M_4(request) M_3 \rightarrow M5, M6(request) \ldots M_n;$
13) *Check the nodes state active or idle.*
14) *Case: (i) Active node response*
    a) $M_1 \rightarrow M_2(accept); M_2 \rightarrow M_3, M_4(accept) M_3 \rightarrow M5, M6(idle\ (wait))$
    b) *// the M1and M2 is active state so they ready to participate the network*
15) *Case: (ii) idle node*
    i) $M_3 \rightarrow M5, M6(idle\ (wait))$ *M3 is idle state mode wait for some time otherwise the node will be waiting list. The idle node status will be updated to the ticket-id manger*
16) *Case (iii)*
    (i) Collect the status of the active nodes
    $TID = \sum_{i=0}^{n} \frac{Issue\ \ ticket-id}{total\ number\ of\ nodes} (T_{mgr})$*// update ticket-id history*
    $TID = \sum_{i=0}^{n} \frac{Received\ ticket-id}{total\ number\ of\ nodes} (T_{mgr})$ *// update ticket-id history*

    (ii) Collect the idle node status
    (iii) All status is Updated to the ticket-id manager
17) $MN(p) \rightarrow TID$ *Finally, nodes are ready to participate the network communication with the admin of ticket-id manger*

The node state is categorized into active node, then case iii is processed, such as collecting the active node status and update its ticket-id history. In case the response is idle, then it is organized under idle node status with its ticket-id. Finally, the node with the active state is ready to participate in the network communication and updated to the ticket – id manager.

3.5 TID Based Routing:

In this section, the routing is planned for which TID updates the node's properties. The total number of routing paths are initialized. Then the route distance is calculated by the nodes coordinate position such as a,b. The routing path is selected under three conditions good, average, and poor. The good state determines all the node's properties are efficient, thus chooses an efficient available path with no traffic. If the condition is average, the node's properties are average; then, there is a possibility of high traffic, which means the route is busy then choose another available path. If the condition is poor, then the node properties are poor; wait until the node's status updates. The algorithm for TID routing protocol;

Algorithm for TID based routing

1) *Input: TID nodes properties* $MN(p)$
2) *Output: routing performance TID→ R(p);*
3) *Begin*

4) {
5) Node properties initiated $MN(p)$
6) Initialize the 'n' number of routing process $TID \rightarrow R_1, R_2, R_3, \dots R_n$;
7) Calculate the route distance $R(p) = r(d)\sqrt{(\Delta a)^2 + (\Delta b)^2}$// calculate the route distance distance $\sqrt{\left(a_{i1} - a_{j1}\right)^2 + (b_{i2} - b_{j2})^2}$ with a, b coordinate position;
8) While ()
9) {
10) TID→ MN(p) condition is good // the node properties are good; no traffic to choose the efficient path

Route status (available);

11) TID→ MN(p) condition is average // the node properties are average; the route is low traffic some path is busy, some path is low traffic choose the alternate path;

Route status (available, busy); otherwise

12) TID→ MN(p)condition is poor // the node properties are low;route is high traffic all routes are full traffic

Route status (full); otherwise

13) }
14) end

3.6 Proposed Execution:

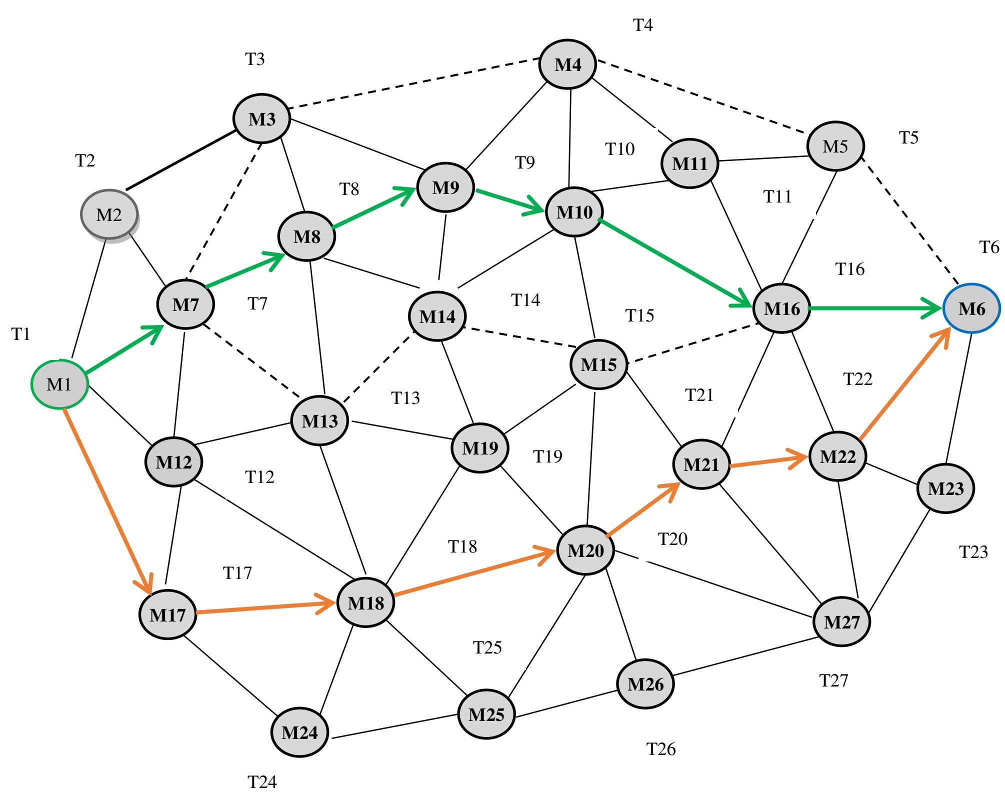

Figure 4: Data packet execution using the proposed model

The above figure 4 illustrates the simple packet data transmission based on the proposed model. As mentioned above, the network model deployed, and TID protocol provides each node with a unique ticket-ID. Here on the nodes structure, M denotes the nodes, and T indicates the ticket-ID. The source node is M1, and the destination node is M6. For these two nodes, the provided tickets are T1 and T6, respectively. The proposed protocol uses the ticket-ID and updates the node's parameters to the ticket-ID manager. The ticket-ID manager chooses the effective shortest path from M1 to M27. There two-path chosen, such as M1-M7-M8-M9-M10-M16-M6 and M1-M17-M18-M20-M21-M22-M6. Among these, the shortest path taken for transmission is M1-M7-M8-M9-M10-M16-M6. At every stage, the updated node's energy level is sent to the ticket-ID manager. The available alternative paths are M1-M7-M3-M4-M5-M6 and M1-M7-M13-M14-M15-M16-M6.

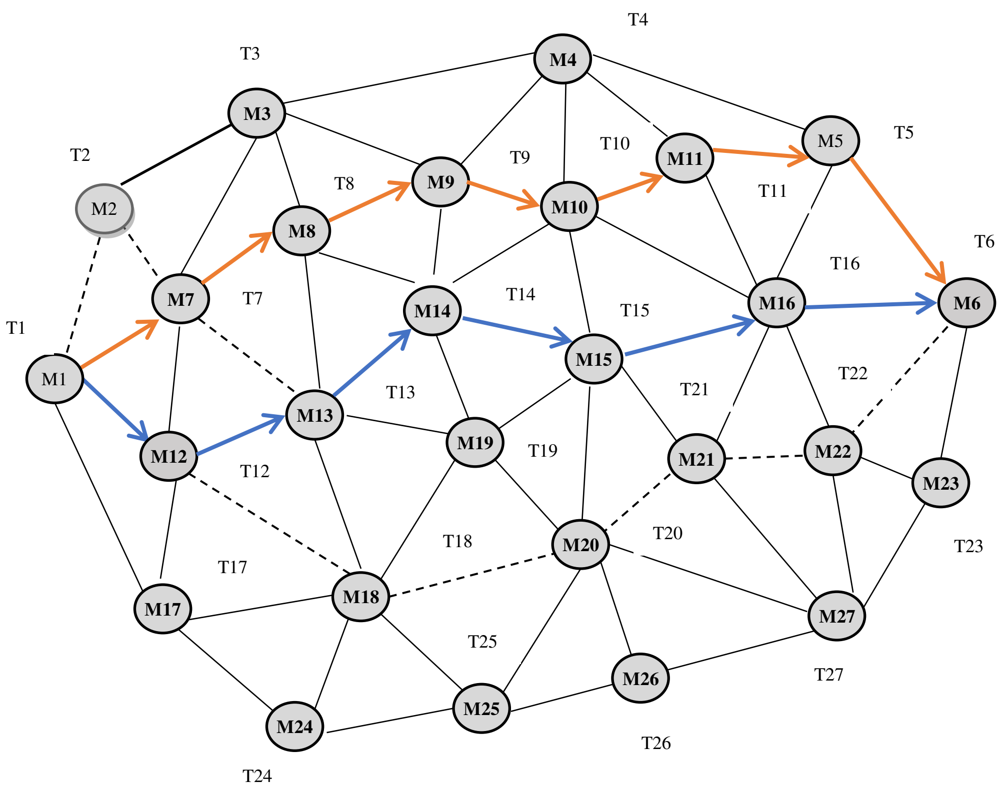

Figure 5: Another Data Transmission

The proposed work is developed based on multipath routing. Hence another set of the route is established, such as M1-M7-M8-M9-M10-M5-M6 and M12-M13-M14-M15-M16-M6. In which the shortest path taken for transmission is M1-M7-M8-M9-M10-M5-M6. The processing procedure is the same, as mentioned in figure 4. The next available paths are M1-M12-M18-M20-M21-M22-M6 and M1-M2-M7-M13-M14-M15-M16-M6. As mentioned in the algorithm (3.4), the nodes factor calculation determines the neighbor node selection. The algorithm(3.5) defines the available route selection decisions.

4. RESULTS AND DISCUSSIONS

4.1. Simulation Environment and Parameters

The proposed T-ID BRM is executed in the network Simulator-2. In the simulation environment, the network is built with 120 nodes between 1700 × 1700 m^2. This network is a dynamic one created using a Random way mobility modelin which the nodes are free to move anywhere. Here IEEE standard of 802.11 Mac protocol is taken as the link-layer protocol. The network traffic is generated using a multicast constant bit ratio. In this experiment, both 802.11b and IEEE 802.11e WLAN heterogeneous traffic is considered. The node mobility range is between 10-35/ms.The TCP or UDP network topology is used for establishing the data connection. The packet size is 2000 bytes, with the data rate at 24 Mbps. The other simulation parameters are described in the below table.

Simulation Parameter	Value
Simulator	NS-2
Simulation time	200 s
Number of nodes	120
Simulation area	1700 × 1700 m^2
Mac Protocol	IEEE 802.11
Data rate	24 Mbps
Radio range	100m
Mobility model	Random waypoint model
Antenna	Omnidirectional antenna
Node speed	10-35 m/s
Packet size	512 bytes
Traffic type	Multicast constant bit ratio

Table 2: Simulation parameters

4.3. Simulation results

Several mechanisms are evolved in determining the efficiency of the routing mechanism in MANET. The proposed system efficiency is declared by a comparison work between the TABRP, OGFSO, and PDMR. The evaluation metrics taken for comparison are packet delivery ratio, average end-to-end delay, routing overhead, and average energy consumptions. The obtained observation is plotted in the graph for better decisions. Let's discuss each algorithm's performance according to the evaluation metric in detail.

4.3.1 Packet Delivery Ratio:

Packet Delivery Ration (PDR) is one of the vital evaluation metrics in determining the network performances. If PDR increases automatically, the network performances also increase. It states the total number of packets successfully transmitted to the destination. The ratio is calculated by the number of packages delivered in total to the total number of packages sent between the sender to receiver. It can be expressed as below;

$$PDR = \frac{Total\ number\ of\ the\ data\ packets\ received}{the\ total\ number\ of\ data\ packets\ send} * 100$$

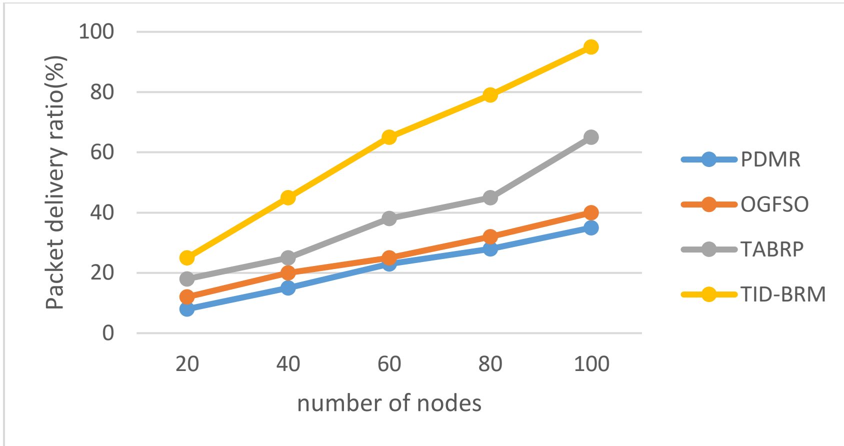

Figure 6: PDR vs Number of nodes

The above figure demonstrates the performance observation between the proposed TID-BRM with PDMR, OGFSO, and TABRP on packet delivery ratio. The X-axis states the packet delivery ratio obtained by each algorithm, and Y-axis states the total number of nodes taken part. At each stage, the number of nodes increases gradually with 20 nodes. On comparison, PDMR uses the maximum number of communications with 80 nodes only with five parallel paths. It has the possibility of the link failure, which means path 1 fails, then path2, etc it delays the packet delivery. But in TID-BRM it is designed without any link failure; at the same, the alternative paths are discovered only for calculating which one is the shortest path and in case of exception. The OGFSO clustering mechanism is discovered with cluster head and cluster members, but our ticketing system enhances with minimum time consumption in successfully delivering the packets. The ticket ID acknowledges the successful packet delivery, but it's not confirmed in OGFSO. In TABRP, there is no final decision regarding the sleeping or idle nodes happens if it joins the network. The proposed TID-BRM achieves with 20 nodes PDR is 25%, 40 nodes the PDR is 45%, on 60 nodes the PDR is 65%, on 80 nodes the PDR is 78%, and with 100 nodes the PDR is about 95%. On comparison, the proposed overall packet delivery ratio is 61.8 %, whereas with PDMR is 21.8%, OGFSO with 25.8%, and TABRP is 38.2%. The result shows that the proposed TID-BRM achieves the maximum number of successful packet transmission on all the stages.

4.3.2 Average End to End Delay:

In transmission, the packets are sent from source to destination. End-to-End delay refers to the total time spent on communication from source to destination. The RTT round trip time, which states the time to go and come back to the host. Minimum end-to-end delay results in reliable transmission with higher efficiency. It is calculated by the difference between the received time and sent time with the total number of packets sent. This evaluation metrics is essential to achieve network QoS (Quality of Services). It can be expressed as follows;

$$Average\ End\ to\ End\ Delay = \frac{Recieved\ Time - Send\ Time}{Total\ number\ of\ data\ packets\ send} (in \text{ a sec})$$

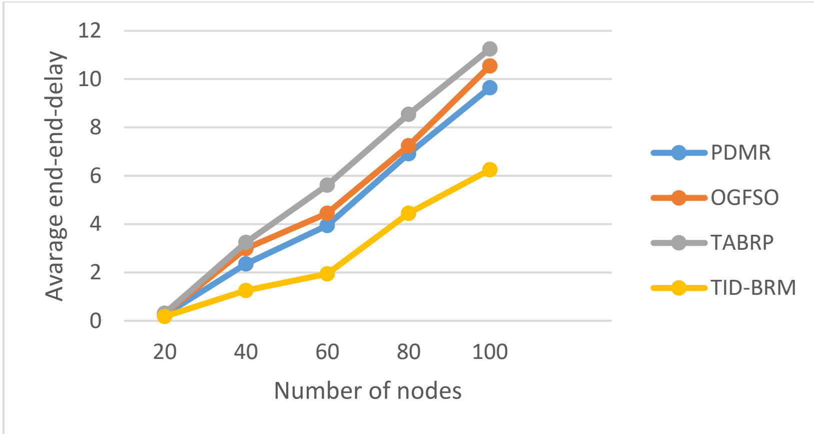

Figure 7: Average End-to-End Delay vs Number of Nodes

The above figure 7 illustrates the average end- to- end delay achieved by proposed TID-BRM, PDMR, OGFSO, TABRP. The graphical representation classifies the obtained performances. The X-axis states the average end to end delay obtained by each algorithm, and Y-axis states the total number of nodes. At each stage, the number of nodes increases gradually with 20 nodes. The average end to end delay is measured in the aspect of seconds. The proposed TID-BRM has a 0.178-sec delay with 20 nodes, 1.25-sec delay with 40 nodes, 1.95-sec delay with 60 nodes, 4.46-sec delay with 80 nodes, and 6.25-sec delay with 100 nodes. As mentioned in PDR, even though each mechanism has some drawbacks and achieves with minimum delay. But on the comparison, our proposed TID-BRM has an overall average end to end delay with 2.8 sec whereas PDRM has a 4.6-sec delay, OGFSO has a 5.1-sec delay, and TABRP has a 5.7-sec delay. These values and the graphical representation state on the comparison, the proposed TID-BRM has a very minimum delay than others.

4.3.3 Routing Overhead:

The Routing Overhead describes the searching of a broadcast link between the sender and receiver. In MANET, link breakage causes severe damages in the network performance. Routing overhead is an interruption that occurred on the selected path for packet transmission. The link faults or reroutes that leverage the network performance. The routing overhead is calculated by the total number of packets sent for maintenance and route discovery. It can be expressed as follows;

$$\begin{aligned} Routing\ overhead &= Total\ number\ of\ routing\ control\ packet \\ &= Total\ number\ of\ REQUEST\ and\ REPLY packet \end{aligned}$$

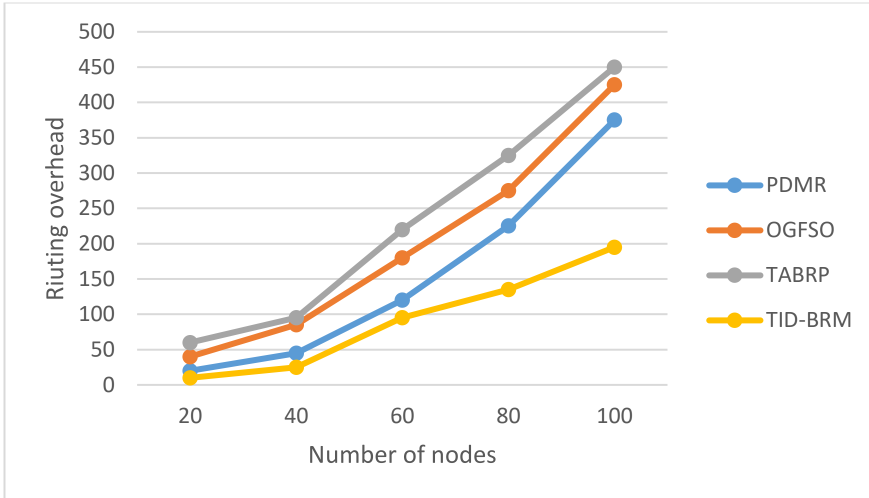

Figure 8: Routing Overhead vs Number of nodes

The above figure 8 illustrates the routing overhead occurs on each algorithm, such as TID-BRM, PDMR, OGFSO, and TABRP. The X-axis states the routing overhead obtained by each algorithm, and Y-axis states the total number of nodes taken part. At each stage, the number of nodes increases gradually with 20 nodes. The plotted graphical representation clearly describes each algorithm's level of performance. The routing overhead occurs in proposed TID-BRM 20 nodes with10 routes, 40 nodes with 25 routes, 60 nodes with 95 routes, 80 nodes with 135 routes, and 100 nodes with 195 routes, respectively.The average routing overhead attained by TID-BRM is 92 routes, whereas TABRP with 157 routes, OGFSO with 201 routes, and PDMR with 230 routes. This result is because compared to others, our proposed TID-BRM has a precise routing mechanism in which the TID manager controls the overall routing process. The TID manager not participating in the transmission; hence the energy level is high, and results with minimum routing overhead; this concept was not disclosed in other mechanisms. The proposed system achieved routing ahead is very low compared to other algorithms, as shown in the graph.

4.3.4 Average Energy Consumption:

In a network, energy consumption is the primary factor. The node's energy level determines the transmitting efficiency. The minimum energy is obtained by designing an energy-efficient protocol. In transmission, the energy consumption is identified through four terms: transmit, receive, idle, and sleep. It can be calculated by the total energy consumed with the number of nodes and initial energy. It can be expressed as follows;

$$Average\ Energy\ Consumptions = \frac{Total\ Energy\ Consumption}{Number\ of\ nodes * Intial\ Energy} (in \text{ joules})$$

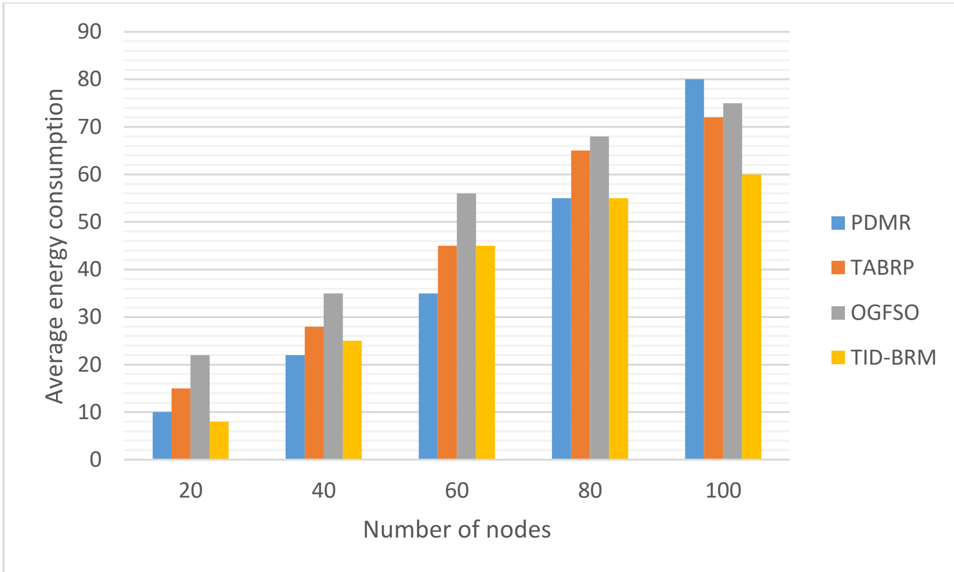

Figure 9: Average Energy Consumption vs Number of Nodes

Figure 9 illustrates the average energy consumed by the TID-BRM, PDMR, TABRP, and OGFSO algorithms. The X-axis states the average energy consumed by each algorithm, and Y-axis states the total number of nodes taken part. At each stage, the number of nodes increases gradually with 20 nodes. The average energy consumption is calculated in the aspect of Joules. The colored bar diagram gives the exact energy consumed with each algorithm. The high PDR, minimum end to end delay, and routing overhead result in minimum energy consumption. In which the proposed TID-BRM achieves packet transmission with 20 nodes on 8 joules, 40 nodes on 25 joules, 60 nodes on 45 joules, 80 nodes on 55 joules, and 100 nodes on 60 joules. The overall average energy consumption attained by TID-BRM is 38.6 joules, whereas PDMR consumed 51.2 joules, OGFSO consumes 45 joules, and TABRP consumes 40.4 joules. This performance shows deficient energy consumed at each stage in comparison to others.

Conclusion:

A new Ticket-ID Based Routing Management System (T-ID BRM) is proposed in this paper. In this work, the multipath routing protocol is enhanced with our TID protocol. The proposed system addressed the multipath routing protocol complexities and overhead issues. The ticket-ID mechanism overcomes these issues and balances the traffic effectively. The ticket-ID manager plays a vital role in the mechanisms, and overall performance occurs under its supervision. The TID examines the nodes factor, and based on the obtained value; the neighbor nodes are selected for transmission. Another component, route maintenance, delivers the optimal routing path, which is described in the algorithms. The performance of the proposed protocol is evaluated through comparison work. The comparison work is carried between TID-BRM with PDMR, OGFSO, TABRP. The evaluation metrics considered are packet delivery ratio, average end to end delay, routing overhead, and average energy consumption. The obtained performance values are graphically represented. From the result, it is proved that the proposed TD-BRM is far better than the other mechanisms.

In the future, this ticketing system can be enhanced in the aspect of security metrics.

Conflict of interest:

There is no conflict of interest.

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Availability of data and material:

There is no availability of data and material.

Code Availability:

There is no code availability.

Author's contribution:

There is no author's contribution.

Reference:

1) Karimi A, Afsharfarnia A, Zarafshan F, Al-Haddad SAR (2014) A novel clustering algorithm for mobile ad hoc networks based on determination of virtual links' weight to increase network stability. Sci World J 2014:1–12
2) Perkins CE, Bhagwat P (1994) Highly dynamic destination-sequenced distance-vector routing (DSDV) for mobile computers. SIGCOMM ComputCommun Rev 24(4):234–244
3) Johnson DB, Maltz DA, Broch J et al (2001) DSR: the dynamic source routing protocol for multihop wireless ad hoc networks. Ad Hoc Netw 5:139–172
4) Ko Y-B, Vaidya NH (2000) Location-aided routing (LAR) in mobile ad hoc networks. WirelNetw 6(4):307–321
5) Perkins C, Belding-Royer E, Das S (2003) Ad hoc on-demand distance vector (AODV) routing. In: Technical report
6) Bhattacharya A, Sinha K (2017) An efficient protocol for loadbalanced multipath routing in mobile ad hoc networks. Ad Hoc Netw 63:104–114
7) Naseem M, Kumar C (2017) Queue-based multiple path load balancing routing protocol for MANETs. Int J CommunSyst 30(6):e3141
8) Ganjali Y, Keshavarzian A (2004) Load balancing in ad hoc networks: single-path routing vs. multipath routing. In: INFOCOM 2004. Twenty-third annual joint conference of the IEEE computer and communications societies, vol 2, pp 1120–1125. IEEE, New York.
9) S.-T.Chou, H.-T.Chern, C.-M. Shiao, and Z.-J. Lee, "Cross-layer design of AODV protocol for multihop flow in ad hoc network," Ad-Hoc and SensorWireless Networks, vol. 17, no. 3-4, pp. 233–252, 2013.
10) S. J. Sultanuddin, Md. Ali Hussain, "Token system-based efficient route optimization in mobile ad hoc network for vehicular ad hoc network in smart city", http://wileyonlinelibrary.com/journal/ett, November 2019, https://doi.org/10.1002/ett.3853
11) M. Rajashanthi1, K. Valarmathi "Energy-efficient multipath routing in networking aid of clustering with OGFSO algorithm", Springer-Verlag GmbH Germany, part of Springer Nature 2020, https://doi.org/10.1007/s00500-020-04710-4
12) R. P. Premanand& A. Rajaram "Enhanced data accuracy based PATH discovery using backing route selection algorithm in MANET", Springer Science+Business Media, LLC, part of Springer Nature 2019, https://doi.org/10.1007/s12083-019-00824-1
13) Arindrajit Pal, Paramartha Dutta, AmlanChakrabarti&Jyoti Prakash Singh, "An efficient load balanced stable multipath routing for mobile ad-hoc network", Springer-Verlag GmbH Germany, part of Springer Nature 2020, https://doi.org/10.1007/s00542-019-04723-6
14) R. Shanthy, T. Padma "A zone routing protocol incorporated with sleep scheduling for MANETs", Springer-Verlag GmbH Germany, part of Springer Nature 2020, https://doi.org/10.1007/s12652-020-01798-2

15) Rajendra Prasad, P Shiva Shankar, “Efficient Performance Analysis of Energy Aware on Demand Routing Protocol in Mobile Ad-Hoc Network”, Engineering Reports published by John Wiley & Sons, Ltd.April 2019, https://doi.org/10.1002/eng2.12116
16) Anand M, Sasikala T, Anbarasan M, “Energy efficient channel aware multipath routing protocol for mobile ad-hoc network”, 2018 John Wiley & Sons, Ltd, https://doi.org/10.1002/cpe.4940
17) OladayoOlufemiOlakanmi, KehindeOluwasesanOdeyemi& Ashraf Abbas, “Mobility and energy prediction models: Approach toward effective route management in mobile wireless sensor networks”, Engineering Reports published by John Wiley & Sons, Ltd.2020, https://doi.org/10.1002/eng2.12095
18) Dipika Sarkar, Swagata Choudhury, Abhishek Majumder, “Enhanced-Ant-AODV for Optimal Route Selection in Mobile Ad-Hoc Network”, Journal of King Saud University - Computer and Information Sciences, august 2018, DOI: https://doi.org/10.1016/j.jksuci.2018.08.013
19) Lenin Guaya-Delgado, EstevePallarès-Segarra , Ahmad Mohamad Mezher and Jordi Forné, “A novel dynamic reputation-based source routing protocol for mobile ad hoc networks”, EURASIP Journal on Wireless Communications and Networking (2019) 2019:77 https://doi.org/10.1186/s13638-019-1375-7

Figures

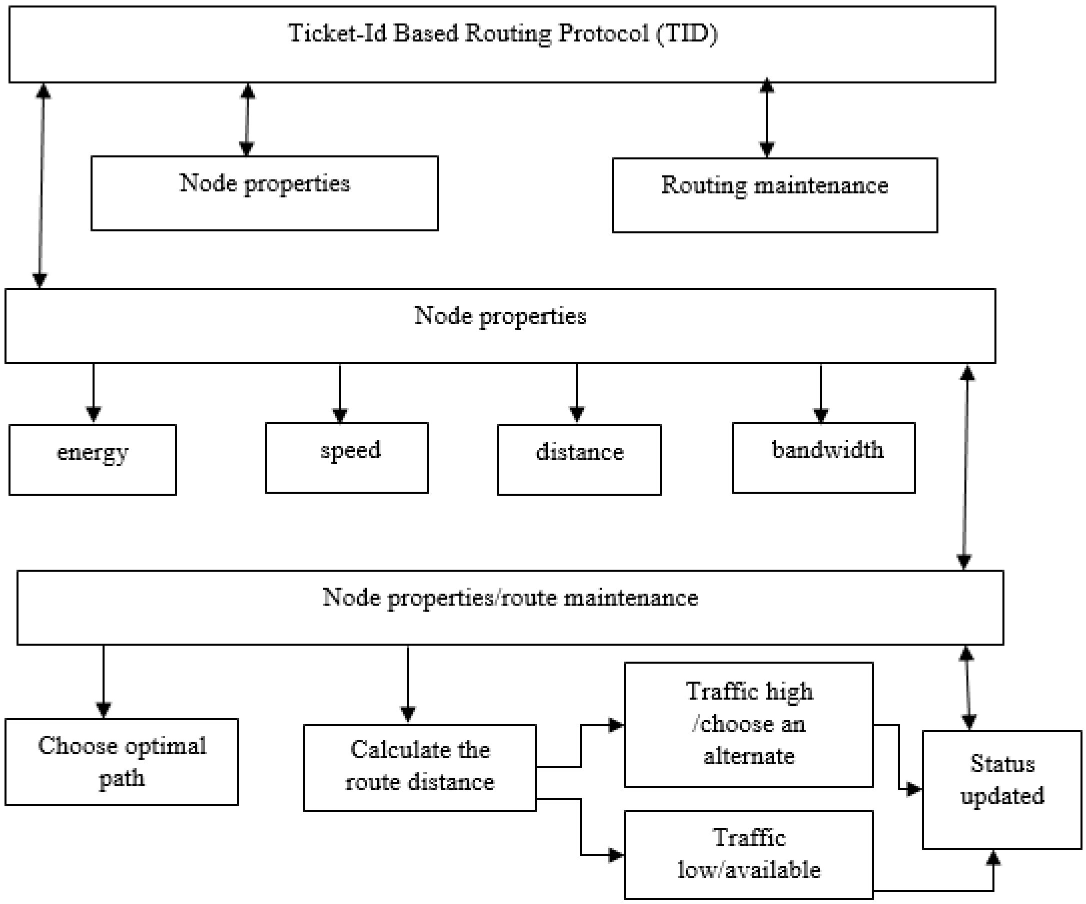

Figure 1

TICKET-ID BASED ROUTING MANAGEMENT SYSTEM (T-ID BRM) Architecture

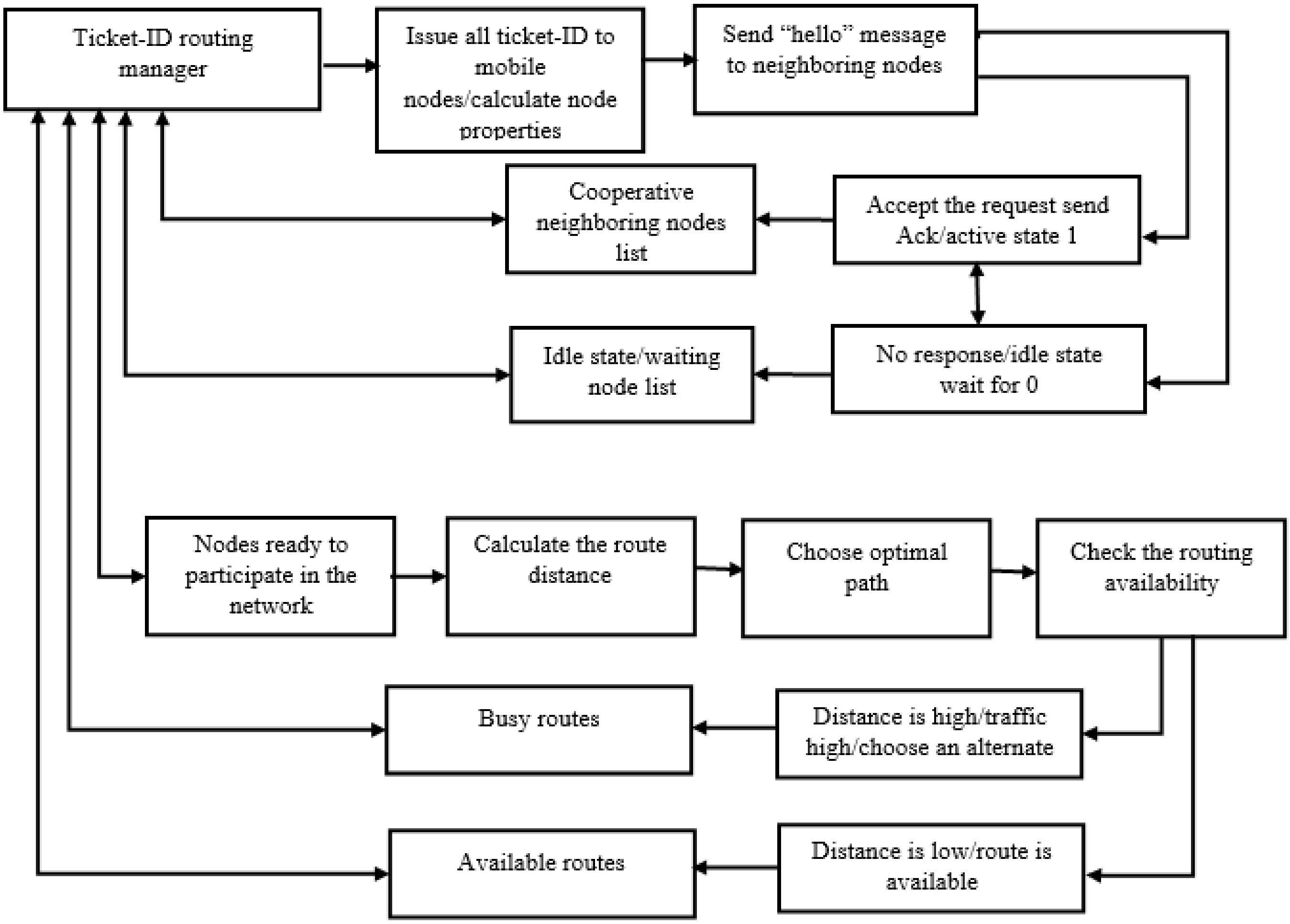

Figure 2

Ticket-ID Based Routing Protocol structure

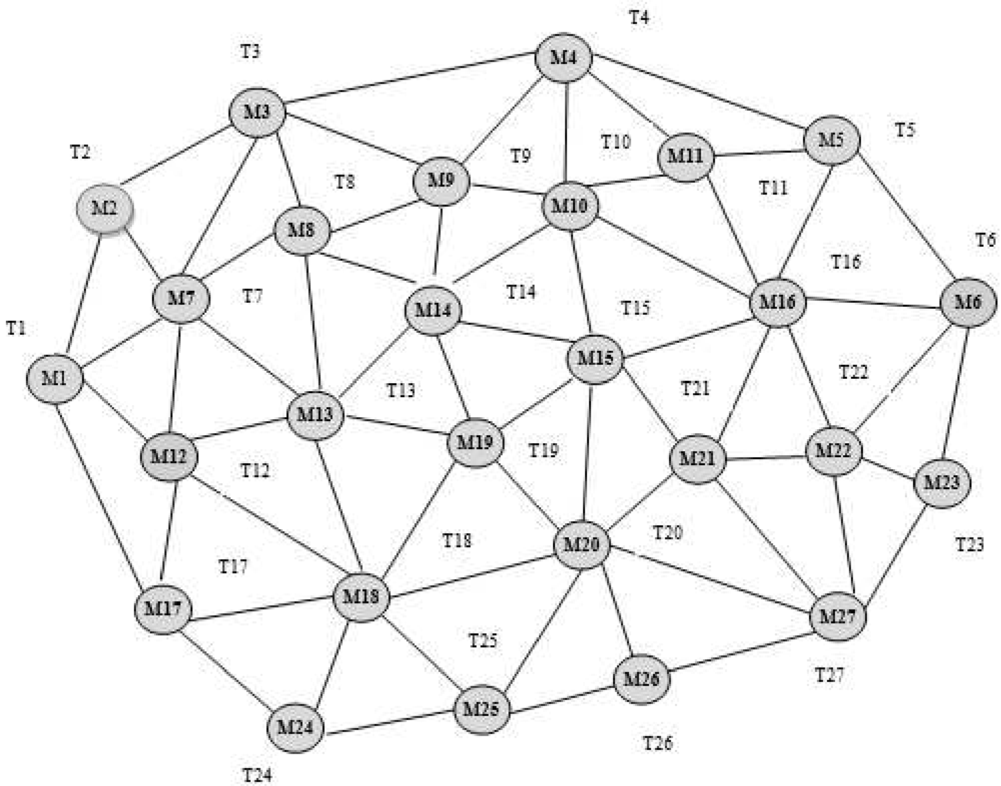

Figure 3

Deployed network model

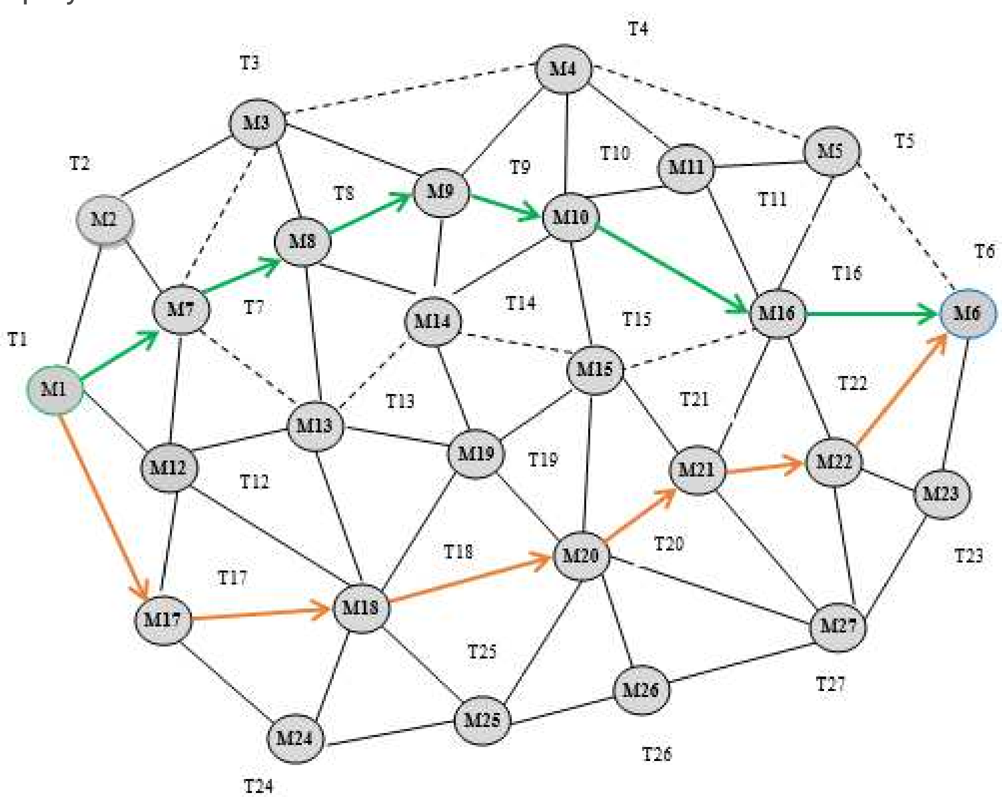

Figure 4

Data packet execution using the proposed model

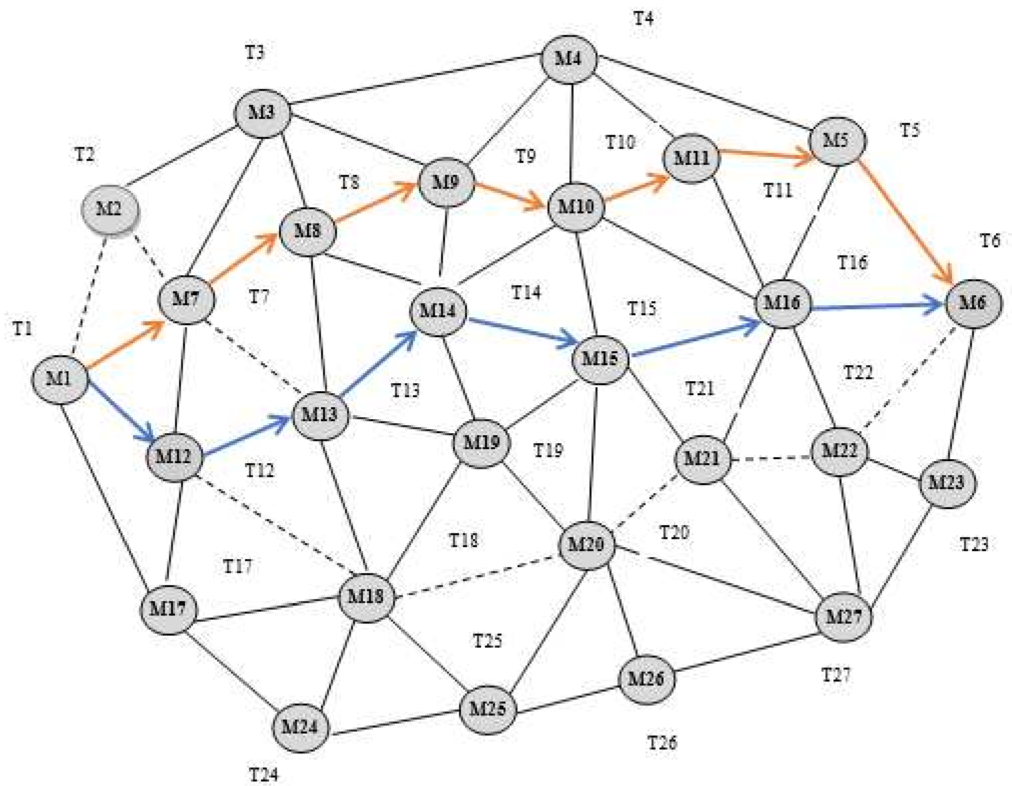

Figure 5

Another Data Transmission

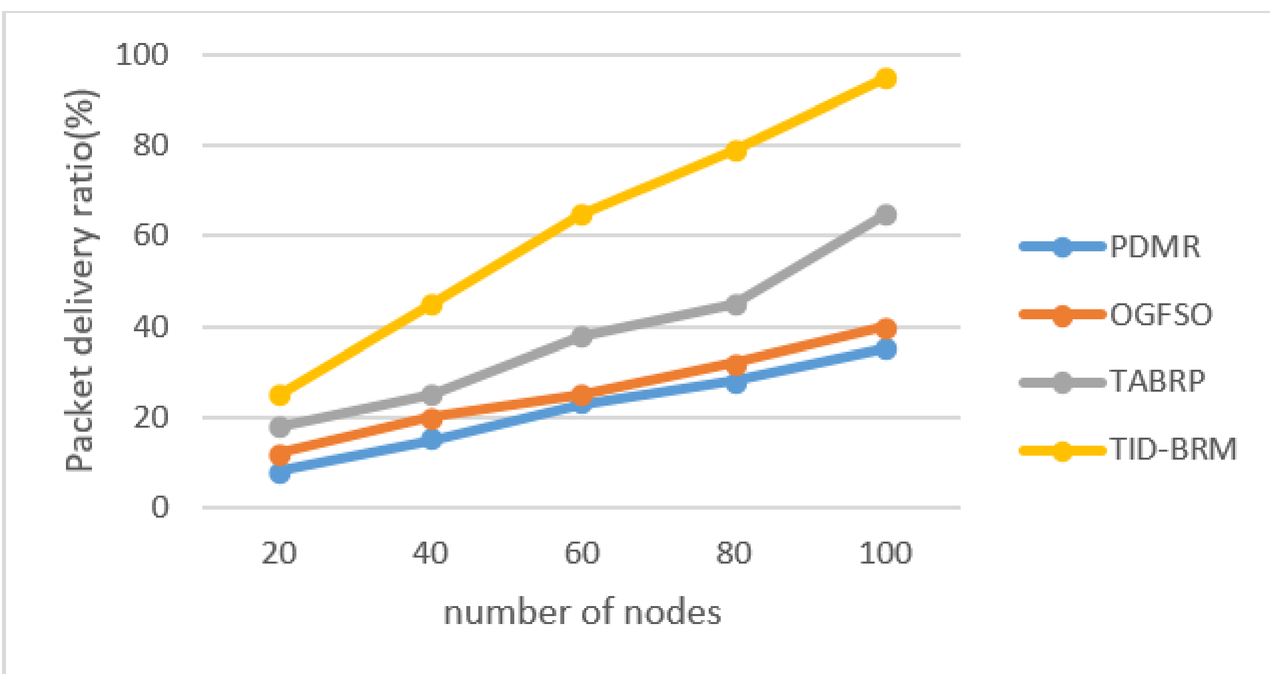

Figure 6

PDR vs Number of nodes

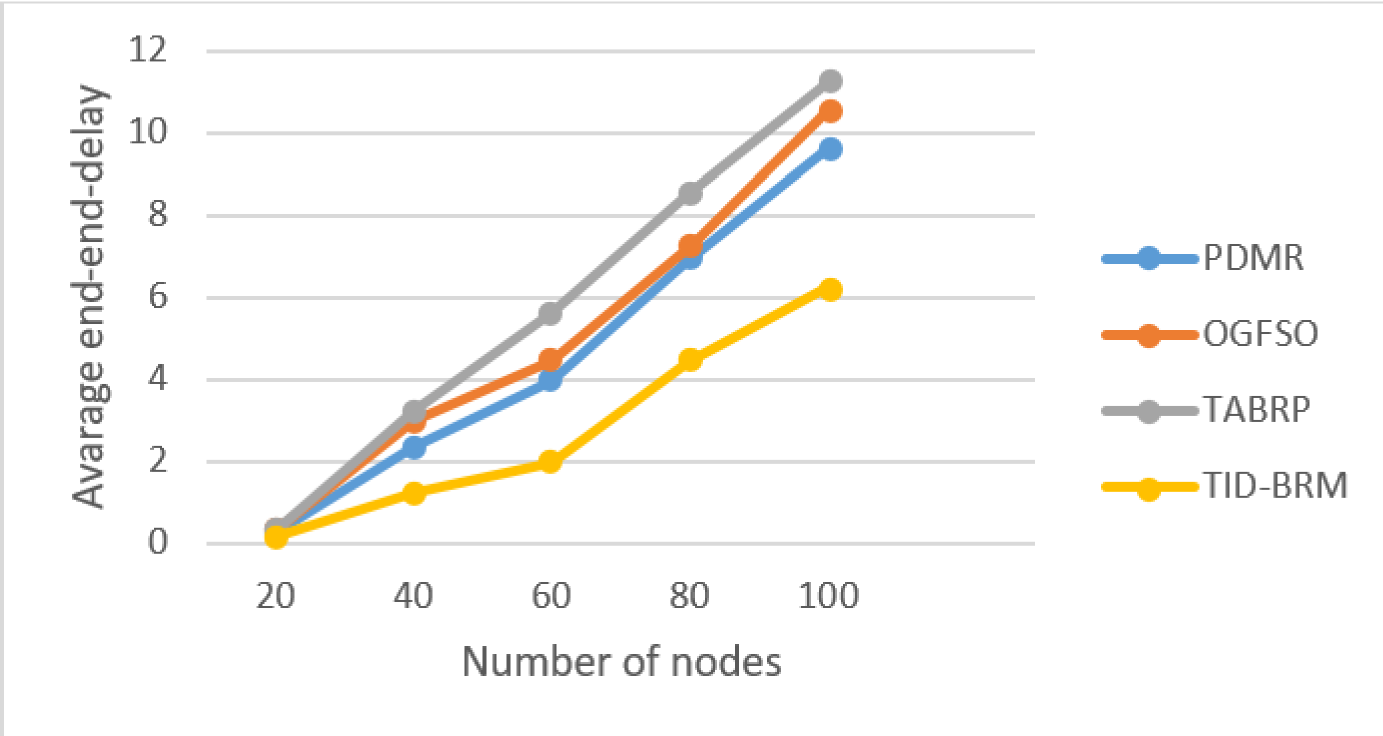

Figure 7

Average End-to-End Delay vs Number of Nodes

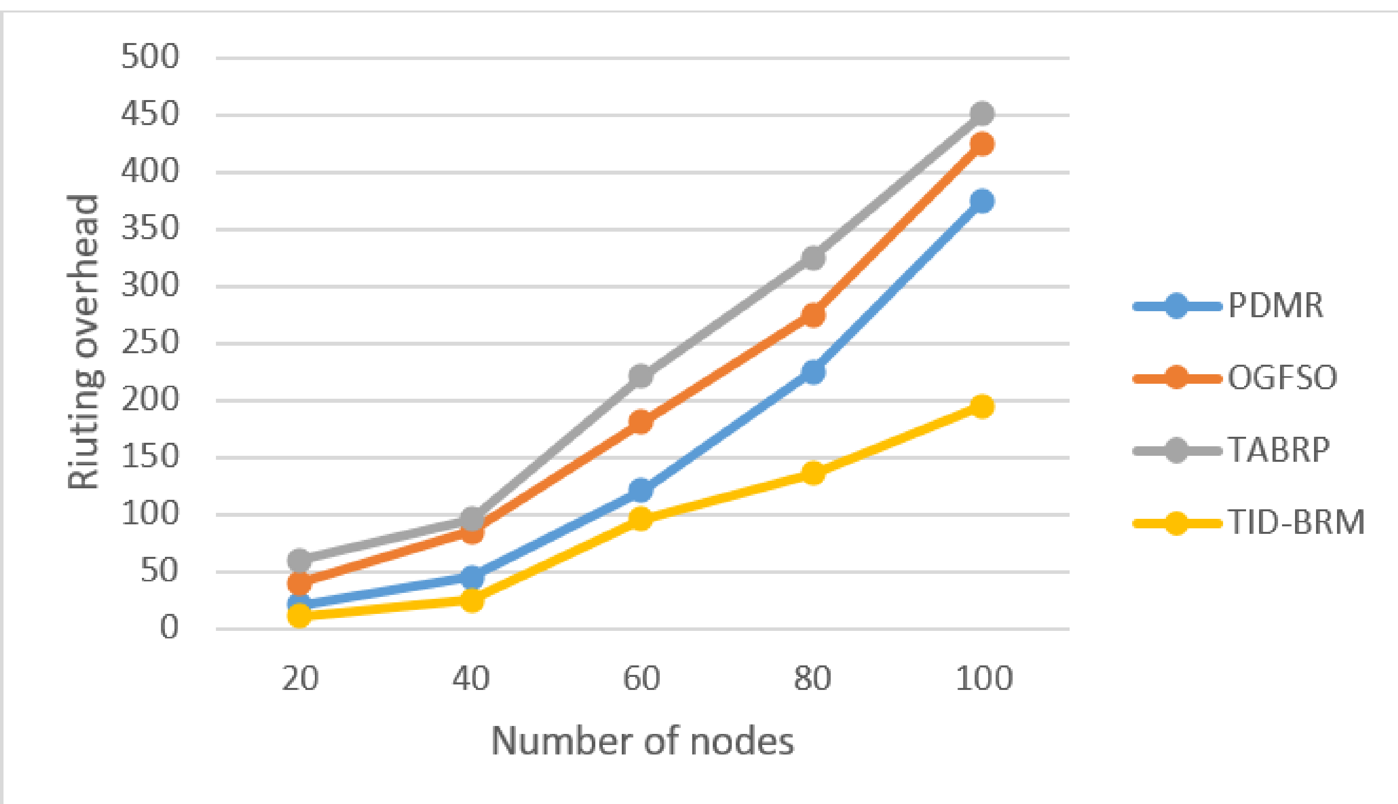

Figure 8

Routing Overhead vs Number of nodes

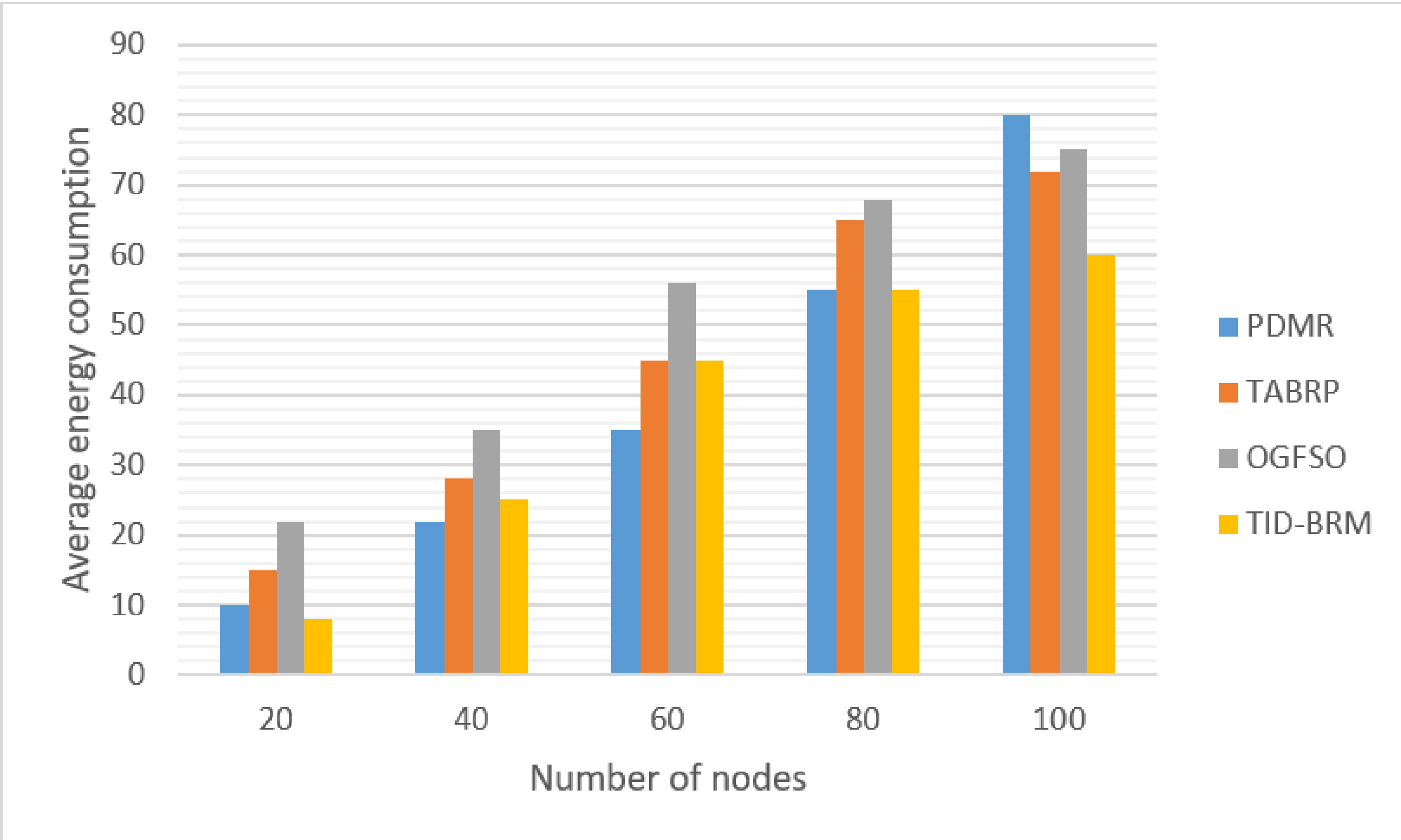

Figure 9

Average Energy Consumption vs Number of Nodes